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EPA Superfund
Record of Decision:

Anaconda Company Smelter
(ARWW&S) OU
Anaconda, MT
9/29/1998

RECORD OF DECISION

ANACONDA REGIONAL WATER, WASTE, AND SOILS OPERABLE UNIT

Anaconda Smelter National Priorities List Site
Anaconda, Montana

SEPTEMBER 1998

U.S. Environmental Protection Agency

and

Montana Department of Environmental Quality

RECORD OF DECISION

ANACONDA REGIONAL WATER, WASTE, AND SOILS OPERABLE UNIT
ANACONDA SMELTER NPL SITE
ANACONDA, MONTANA

September 1998

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RECORD OF DECISION SUMMARY

ANACONDA REGIONAL WATER, WASTE, AND SOILS OPERABLE UNIT ANACONDA SMELTER NATIONAL PRIORITIES LIST SITE

The U.S. Environmental Protection Agency (EPA), with the concurrence of the State of Montana Department of Environmental Quality (MDEQ), presents this Record of Decision (ROD) for the Anaconda Regional Water, Waste, and Soils (ARWW&S) Operable Unit (OU) of the Anaconda Smelter National Priorities List (NPL) Site. The ROD is based on the Administrative Record for the ARWW&S OU, including three Remedial Investigations (RIs) and five Feasibility Study (FS) Deliverables, human health and ecological risk assessments, the Proposed Plan, the public comments received, including those from the potentially responsible party (PRP), and EPA responses. The ROD presents a brief summary of the RIs and FS Deliverables, actual and potential risks to human health and the environment, and the Selected Remedy. EPA followed the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 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 of 1980, 42 U.S.C. 9601 *et seq.*, as amended (CERCLA), and, to the extent practicable, the NCP;

2. Outline the remedial action objectives, engineering components and remedial 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 at the ARWW&S OU, 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 Assistant Regional Administrator for Ecosystems Protection and Remediation and the MDEQ Director;

2. The **Decision Summary** section provides an overview of the OU 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 Remedial Investigation/Feasibility Study (RI/FS), and other information in the Administrative Record.

DECLARATION

DECLARATION

SITE NAME AND LOCATION

Anaconda Smelter NPL Site
Anaconda, Deer Lodge County, Montana
Anaconda Regional Water, Waste, and Soils (ARWW&S) Operable Unit (OU)
CERCLIS ID #MTD 093291656

STATEMENT OF BASIS AND PURPOSE

This decision document presents the Selected Remedy for the last OU, the ARWW&S OU, of the Anaconda Smelter NPL Site in Deer Lodge County, Montana. EPA, with the concurrence of MDEQ, selected the remedy in accordance with CERCLA and the NCP.

This decision is based on the Administrative Record for the ARWW&S OU of the Anaconda Smelter NPL Site. The Administrative Record (on microfilm) and copies of key documents are available for public review at the Hearst Free Library, located on the corner of Fourth and Main in Anaconda, Montana, and at the Montana Tech Library in Butte, Montana. The complete Administrative Record may also be reviewed at the EPA Records Center in the Federal Building, 301 South Park, in Helena, Montana.

The State of Montana concurs with the Selected Remedy, as indicated by its signature.

ASSESSMENT OF THE SITE

Actual or threatened releases of hazardous substances at and from the ARWW&S OU, 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 ARWW&S OU is the fifth OU to receive remedial action at the Anaconda Smelter NPL Site. The first remedial action, taken at the Mill Creek OU, involved the relocation of residents from the community of Mill Creek after other initial stabilization and removal efforts. The second remedial action, taken at the Flue Dust OU, addressed flue dust at the site through removal, treatment, and containment. At approximately the same time, removal actions were undertaken, including permanent removal and disposal of Arbiter and beryllium wastes and the selective removal of contaminated residential yard materials from the community of Anaconda. The third remedial action addressed various waste sources found within the Old Works/East Anaconda Development Area (OW/EADA) OU, located adjacent to the community of Anaconda, and in areas of future development, and followed an initial removal action in the same area. Certain wastes within the OW/EADA OU received an engineered cover, including the Red Sands waste material and the Heap Roast slag piles, while others were consolidated and/or covered, including the floodplain wastes and miscellaneous waste piles. In addition, the third action allowed economic development (i.e., construction of a golf course in the Old Works area) and provided the final response action at the Mill Creek OU.

The fourth remedial action, the Community Soils OU, addressed all remaining residential and commercial/industrial soils within the Anaconda Smelter NPL Site. The principal contaminant of concern (COC) at the Community Soils OU is arsenic in surficial soils from past aerial emissions and railroad beds constructed of waste material.

This remedial action at the ARWW&S OU will address all remaining cleanup decisions for the Anaconda Smelter NPL Site. It will also address potential impacts to surface and ground water from soils and waste sources such as tailings and slag as well as human and environmental risks associated with arsenic contaminated soils that have not been addressed by other response actions.

The Selected Remedy for the ARWW&S OU is comprised of several remedies for the waste media types found throughout the OU. The major components of these remedies are described below.

Soils and Waste Materials

Major components of the remedy for contaminated soils and waste material include:

- Reduction of surficial arsenic concentrations to below the designated action levels of 250 parts per million (ppm), 500 ppm, and 1,000 ppm through a combination of soil cover or *in situ* treatment.
- Reclamation of the soils and waste area contamination by establishing vegetation capable of minimizing transport of COCs to ground water and windborne and surface water erosion of the contaminated soils and waste areas. This vegetation will also provide habitat consistent with surrounding and designated land uses.
- Partial removal of waste materials followed by soil cover and revegetation for areas adjacent to streams. Removed material will be placed within designated Waste Management Areas (WMAs).

Ground Water

Major components of the remedy for ground water include:

- For alluvial aquifers underlying portions of the Old Works and South Opportunity Subareas, clean up to applicable State of Montana water quality standards through use of soil covers and removal of sources (surface water) to ground water contamination and natural attenuation.
- For the bedrock aquifers and a portion of the alluvial aquifer in the Old Works/Stucky Ridge and Smelter Hill Subareas, waiver of the applicable ground

water standard. The aquifers underlying these subareas cannot be cost effectively cleaned up through reclamation, soil cover, or removal of the sources (wastes, soils, and tailings) of the ground water contamination. Reclamation of soils and waste source areas with revegetation is required, which will contribute to minimizing arsenic and cadmium movement into the aquifers.

- For portions of the valley alluvial aquifers underneath the Old Works/Stucky Ridge, Smelter Hill, and Opportunity Ponds Subareas where ground water is underlying waste-left-in-place, point-of-compliance (POC) monitoring to ensure contamination is contained at the perimeter boundary of the designated WMA. Should POC monitoring show a spread of contaminants beyond the boundary of a WMA, institute treatment options for the ground water where practicable.

Surface Water

Major components of the remedy for surface water include:

- Reclamation of contaminated soils and engineered storm water management options to control overland runoff into surface waters.
- Selective source removal and stream bank stabilization to minimize transport of COCs from fluvially deposited tailings into surface waters. Removed material will be place within a designated WMA.

Institutional Controls (ICs) and Operations and Maintenance (O&M)

- The remedy will employ ICs and long-term O&M for the OU to ensure monitoring and repair of implemented actions. These actions will be coordinated through development of an ICs Plan and O&M Plan and will allow for communication with local government and private citizens. The plans will function as a tracking system for the agencies and describe and plan for potential future land use changes.
- The remedy calls for a fully-funded ICs program at the local government level. The Anaconda-Deer Lodge County (ADLC) government will be responsible for on-going oversight of O&M in the OW/EADA OU, implementation of a county-wide Development Permit System (DPS), and provision of public information and outreach through a Community Protective Measures program.
- In addition, the remedy will bring closure to previous response actions within the site that are already implemented, such as the Flue Dust remedy or the Old Works remedy, primarily through long term O&M for some or all of those actions which are integrated into this remedy.

Remedial Design/Remedial Action Management

The ARWW&S OU encompasses a very large area, with Remedial Action slated for approximately 20,000 acres. The size of the OU and the focus on land reclamation as the key remedy will require management tools during Remedial Design/Remedial Action (RD/RA) activities to help direct, prioritize, and sequence response actions and allow for changing community interests. Management of the OU can be accomplished with the following elements:

- Site Management Plan (SMP) - The SMP will provide a framework for future RD/RA activities and will incorporate remedial unit designations and sequencing criteria for the RD/RA actions.
- Historic Preservation and Mitigation Plan - Final implementation of the Regional Historic Preservation Programmatic Agreement will be accomplished. Separate agreements to address tribal cultural resources will be included.
- Wetlands Mitigation - Assessment and mitigation of impacts to wetlands from implementation of the remedy and communications with U.S. Fish and Wildlife Service will be coordinated.

The Selected Remedy will achieve reduction of risk to human health and the environment through the following:

- Preventing human ingestion of, inhalation of dust from, or direct contact with, contaminated soil and/or waste media where such ingestion or contact would pose an unacceptable health risk for the designated land use.
- Stabilization of contaminated soil and waste material against wind and surface erosion.
- Minimizing transport of contaminants to ground water and surface water receptors.

STATUTORY DETERMINATIONS

The Selected Remedy is protective of human health and the environment, complies with federal and state requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost effective. This remedy uses permanent solutions (e.g., reclamation, soil removal and engineered covers) and alternative treatment technologies to the maximum extent practicable for this site.

Since hazardous substances above health-based risk levels will remain on site (in WMAs), periodic reviews will be conducted throughout the remedial action and upon its completion to ensure that the remedy continues to provide adequate protection of human health and the environment.

Max H Dodson

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

9/29/98
Date

Mark A. Simonich

Mark A. Simonich, Director
Montana Department of Environmental Quality

9/28/98
Date

DECISION SUMMARY

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LIST OF ABBREVIATIONS AND ACRONYMS

ADLC	Anaconda-Deer Lodge County
ALDC	Anaconda Local Development Corporation
AOC	Administrative Order on Consent
ARAR	Applicable or Relevant and Appropriate Requirement
ARCO	Atlantic Richfield Company
ARM	Administrative Rules of Montana
ARWW	Anaconda Regional Water and Waste
ARWW&S	Anaconda Regional Water, Waste, and Soils
BAF	bioavailability factor
bcy	bank cubic yard(s)
BMP	Best Management Practice
$CaCO_3$	calcium carbonate
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act, as amended
CFR	Code of Federal Regulations
COC	contaminant of concern
CPMP	Community Protective Measures Program
CSKT	Confederated Salish and Kootenai Tribes
CTE	Central Tendency Exposure
cy	cubic yard(s)
°F	degrees Fahrenheit
DNRC	Montana Department of Natural Resource and Conservation
DPS	Development Permit System
EE/CA	Engineering Evaluation/Cost Analysis
EPA	U.S. Environmental Protection Agency
FR	Federal Regulation
FS	feasibility study
gpm	gallons per minute
HHRA	Human Health Risk Assessment
IC	Institutional Control
LOAEC	Lowest Observable Adverse Effect Concentration
LRES	Land Reclamation Evaluation System
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goals
MDEQ	State of Montana Department of Environmental Quality
mg/kg	milligram(s) per kilogram
μg/L	microgram(s) per liter
msl	mean sea level
NCP	National Contingency Plan
NOAEC	No Observable Adverse Effect Concentration
NPL	National Priorities List
O&M	Operations and Maintenance
OU	operable unit
OW/EADA	Old Works/East Anaconda Development Area

LIST OF ABBREVIATIONS AND ACRONYMS (Continued)

pH	negative log of hydrogen concentration (measurement of acid or base content of a medium)
POC	point-of-compliance
POTW	Publicly Owned Treatment Works
ppm	parts per million
PRAG	Preliminary Remedial Action Goal
PRAO	Preliminary Remedial Action Objective
PRP	Potentially Responsible Party
RCRA	Resource Conservation and Recovery Act
RD/RA	Remedial Design/Remedial Action
RDU	Remedial Design Unit
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
RME	Reasonable Maximum Exposure
ROD	Record of Decision
SMP	Site Management Plan
SST	streamside tailings
TI	technical impracticability
USFWS	U.S. Fish and Wildlife Service
WER	water effects ratio
WMA	Waste Management Area
WQB	Water Quality Bureau

1.0 SITE NAME, LOCATION, AND DESCRIPTION

Anaconda Smelter NPL Site
Anaconda Regional Water, Waste, and Soils (ARWW&S) Operable Unit (OU)
Anaconda, Montana
CERCLIS ID #MTD 093291656

The ARWW&S OU covers approximately 300 square miles in the southern Deer Lodge Valley and the surrounding foothills area (Figure 1-1). The area consists of agricultural, pasture, rangeland, forests, and riparian and wetland areas which contain large volumes of wastes, slag, tailings, debris, and contaminated soil, ground water, and surface water from copper and other metal ore milling, smelting, and refining operations conducted on site by the Anaconda Mining Company, and its predecessors and successors, from approximately 1884 to 1980. Waste disposal occurred over approximately 6,000 acres;13,000 acres of upland terrestrial soils are contaminated by smelter emissions; 4,800 acres of alluvial ground water contain elevated concentrations of arsenic, cadmium, and copper; and 28,600 acres of bedrock ground water exceed the State of Montana standard for arsenic (18 micrograms per liter [μg/L]).

The ARWW&S OU is intended to be the last OU at the site requiring a remedy decision and will address all remaining contamination and impacts to surface and ground water, waste source areas (e.g., slag and tailings) and non-residential soils not remediated under prior response actions, including the OW/EADA and Community Soils OUs. The ARWW&S OU will also bring closure to all previous OUs and removal actions including the Smelter Hill OU, Mill Creek OU and Flue Dust OU. The OU is intended to coordinate land use decisions made by the ADLC through adoption of a Master Plan and DPS, land ownership by the PRP (Atlantic Richfield Company [ARCO]), long-term maintenance of wastes-left-in-place through designation of WMAs, and use of ICs to support protective engineering remedies in the final ROD.

Due to the large size of the ARWW&S OU, EPA subdivided the large OU into five subareas which are listed below and shown on Figure 1-2.

- Opportunity Ponds;
- North Opportunity;
- South Opportunity;
- Old Works/Stucky Ridge; and
- Smelter Hill.

A brief description of each subarea is given below.

1.1 OPPORTUNITY PONDS SUBAREA

The Opportunity Ponds Subarea is located within the central portion of the ARWW&S OU and encompasses an area of approximately 11 square miles. The results of the Remedial Investigation (RI) (ARCO 1996a) for this subarea indicate large volumes of waste are located within the Opportunity Ponds A, B-1, B-2, C-1, C-2, D-1, and D-2 cells; the Triangle Waste Area; the South Lime Ditch Area, and the Toe Waste Area. Contaminated soils affected by past smelter emissions have also been identified in some locations throughout the subarea. A portion of the alluvial aquifer underlying the subarea is contaminated with elevated levels of arsenic and cadmium above State of Montana standards for ground water.

The ADLC Planning Board designated the land which falls within EPA's defined Opportunity Ponds Subarea as open space/recreational use and WMAs. EPA has also determined that removal of waste material found in Opportunity Ponds and Cell A is impracticable and/or cost prohibitive due to the large waste volumes involved. The determination to leave waste in place means that ground water will not be remediated underneath these waste materials. Ground water recharge shows no movement of site contaminants of concern (COCs) to surface water in the Lower Mill Creek or North Drain Ditch.

1.2 NORTH OPPORTUNITY SUBAREA

The North Opportunity Subarea is located in the northeast portion of the ARWW&S OU and covers an area of approximately 27 square miles in the area north of State Highway 48 and east of the Lost Creek/Galen Highway. Results of RIs for this subarea indicate large volumes of contaminated soils and waste are located throughout the subarea and along Warm Springs Creek. All surface water is a potential receptor from transport of COCs via runoff and stream bank erosion.

Land use for the North Opportunity Ponds Subarea is a mixture of rural/residential, agricultural, airport and open space/recreational. Land use deed restrictions were developed for some portions of agricultural lands restricting future residential development of these properties. This subarea covers the lower segment of Warm Springs Creek to its confluence with the Mill-Willow Bypass. Results of ground water monitoring in the shallow alluvial aquifer indicate ground water quality in the subarea is generally good. However, levels of cadmium above the State of Montana standard have been observed from recent ground water monitoring results in the shallow alluvial aquifer in the south west portion of the subarea.

1.3 SOUTH OPPORTUNITY SUBAREA

The South Opportunity Subarea is located in the southern portion of the ARWW&S OU and encompasses an area of approximately 25 square miles. Property in this area is used for a mixture of residential, agricultural, and recreational/open space activities. Sections of property are slated for incorporation into the regional historic trails program, linking the Greenway project along Silver Bow Creek to trails in the Old Works/Anaconda area. The subarea encompasses the lower segments of Mill Creek and Willow Creek to their confluence at the Mill-Willow Bypass.

Approximately 309,000 bank cubic yards (bcy) of wastes have been identified in the South Opportunity Subarea as a result of completion of the RI at the ARWW&S OU. These wastes include:

- Tailings, sediment, and contaminated berm material of the Yellow Ditch;
- Railroad grade material near the Blue Lagoon;

- Contaminated sediment located on the floor of the Blue Lagoon; and
- Streamside tailings located adjacent to Willow Creek.

Portions of all the wastes identified in the subarea are considered a source of ground water contamination to portions of the alluvial aquifer. Wastes identified in the Yellow Ditch and in streamside tailings located near Willow Creek are also considered potential source areas for contamination of surface water in portions of the Yellow Ditch and in the lower reach of Willow Creek, respectively.

1.4 OLD WORKS/STUCKY RIDGE SUBAREA

A majority of the Old Works/Stucky Ridge Subarea property was addressed under the OW/EADA ROD. For remaining properties, located primarily in the upland portions of Stucky Ridge, land use is designated as open space, agricultural and potential residential. Final ground water and surface water decisions were deferred from the OW/EADA ROD to the ARWW&S OU.

As a result of previous actions, a remedial decision for some areas of concern in the Old Works/Stucky Ridge Subarea has been approved by EPA and MDEQ. These areas of concern (Heap Roast Slag, Flood Plain Wastes, and Red Sands) and 323 acres of high arsenic and sparsely vegetated soils have remedial actions currently under construction or completed. The Old Works/Stucky Ridge Subarea overlies both bedrock and alluvial aquifers that are contaminated; however, the bedrock aquifer is fractured and is considered untreatable as a result of a technical impracticability (TI) evaluation (EPA 1996a).

1.5 SMELTER HILL SUBAREA

The Smelter Hill Subarea is located in the southwest portion of the site and covers an area of approximately 24 square miles. Land uses include WMAs, recreational/open space, agricultural/grazing, wildlife management, and residential land. This subarea covers the major site of smelting and processing activities that occurred between 1907 and 1980 and encompasses the Disturbed Area of Smelter Hill, which includes the Handling/Storage/Process Area, Stack Area, and Smelter Hill Waste Repositories; the Anaconda Ponds; the Main Granulated Slag Pile; East Anaconda Yard Wastes; West Stack Slag; debris located in Nazer Gulch and miscellaneous other small waste piles. The total volume of wastes contained in the subarea is estimated to be 125,079,000 bcy. Based on decisions made in the waste removal evaluation, from this total, approximately 124,900,000 bcy of wastes will remain in place as a designated WMA. This decision to leave wastes in place was made based on a technical impracticability assessment of meeting Applicable or Relevant and Appropriate Requirements (ARARs) for ground water and cost prohibitiveness criteria. The wastes included in the WMA in the Smelter Hill Subarea include the Anaconda Ponds, Smelter Hill Disturbed Area Wastes, the Main Granulated Slag Pile and buried tailings in the East Anaconda Yards. A portion of the Disturbed Area and the exterior berm of the Anaconda Ponds have been reclaimed with a cover of clean soil and vegetation under previous remedial actions. Areas of wastes and mixed waste and soil located in the Disturbed Area, waste and debris located in Nazer Gulch, and slag located in the West Stack Slag area are identified as sources of ground water contamination to the underlying bedrock aquifers. Buried wastes in the East Anaconda Yard and the Main Granulated Slag area, and wastes in the Anaconda Ponds are potential loading sources to ground water in portions of the underlying alluvial aquifer.

A major portion of contaminated bedrock aquifers covers the back side of Smelter Hill into the . Aspen Hills/Clear Creek drainages, in addition to a significant area of the Northern Portion of the State of Montana Mount Haggin Wildlife Management Area (including the Cabbage Gulch drainage). Estimated acreages of contaminated ground water is 23,830 acres. The drainages are a contributor to upper portion of Mill and Willow Creeks, perennial streams with a State of Montana B-1 classification.

2.0 OPERABLE UNIT HISTORY AND ENFORCEMENT ACTIVITIES

The Anaconda Smelter NPL Site was placed on the NPL in September 1983, under the authority of CERCLA. The EPA issued both general and special notice letters to ARCO on several occasions and ARCO has been actively involved in conducting investigations and response actions at the site since that time. On April 12, 1984, ARCO entered into an Administrative Order on Consent (AOC) with EPA to conduct demolition activities at the smelter. In October 1984, ARCO entered into another AOC to conduct several investigations at the Anaconda Smelter NPL Site to characterize soils, surface water, ground water, and solid wastes. Early draft reports based on initial investigations indicated wide-spread contamination and the need for more in-depth study.

In the initial stages of the investigations, it was discovered that the soils within the community of Mill Creek, located two miles east of Anaconda, had elevated levels of arsenic. Children in Mill Creek also had elevated urinary arsenic levels indicating an excess exposure to arsenic in their environment. Families with young children were temporarily relocated from the community in May 1986. At that time, flue dust, the most concentrated arsenic and metal source on the site, was sprayed with surfactant to reduce fugitive emissions, and contaminated road dust in the community was treated to reduce inhalation exposures. Following temporary relocation, none of these children had levels of urinary arsenic above the levels of concern as determined by the Center for Disease Control.

In July 1986, EPA entered into an AOC with ARCO to conduct an expedited RI/FS for the Mill Creek community. The ROD for Mill Creek was completed in October 1987. The Selected Remedy was the permanent relocation of all Mill Creek residents. EPA signed a Consent Decree with ARCO concerning the implementation of the relocation remedy for Mill Creek residents on January 7, 1988. The permanent relocation was completed in fall 1988.

The generation and airborne transport of stack particulate and fugitive dust emissions during smelting operations also resulted in contamination of soils and household dust by arsenic, cadmium, copper, lead, and zinc in other areas surrounding the smelter. In addition, it was suspected that contaminated material from the Old Works Smelter facilities was present around homes in three Anaconda neighborhoods (Teresa Ann Terrace, Elkhorn Apartments, and Cedar Park Homes).

In 1988, EPA, ARCO, and the Montana Department of Health and Environmental Sciences (MDHES, predecessor to MDEQ) entered into a series of orders and agreements. The primary document became the AOC, Docket No. CERCLA VIII-88-16, initiating several RI/FS studies on various OUs and incorporating a Site Management Plan to structure, coordinate and prioritize the multiple OUs.

On September 28, 1988, ARCO entered into an AOC with EPA to conduct an EE/CA for the Community Soils OU. Results of sampling conducted by ARCO from 1988–1990 in the areas of Teresa Ann Terrace, Elkhorn Apartments, and Cedar Park Homes indicated the presence of elevated arsenic and metal concentrations at or near the soil surface. On September 17, 1991, an Action Memorandum (with a concurrent AOC) required ARCO to conduct a Time-Critical

Removal Action by excavating and removing contaminated soils in areas of Teresa Ann Terrace, Elkhorn Apartments, and Cedar Park Homes.

Also in September 1988, EPA entered into an AOC with ARCO to conduct an RI/FS for the Flue Dust OU. The ROD was completed in September 1991. The remedy selected was treatment and disposal of all flue dust located on Smelter Hill. Also in September 1988, EPA entered into a consent order with ARCO to conduct an EE/CA for the Old Works OU. The actions taken as a result of the EE/CA and resulting Non Time Critical Removal Action have included stabilizing the Red Sands adjacent to Warm Springs Creek, repair of breaks in Warm Springs Creek levees, and the installation of fencing to limit access to certain areas of the Old Works site.

A focused investigation of wastes within the ponds and bunkers at the Arbiter Plant site and beryllium wastes located at the Opportunity Ponds and Smelter Hill was conducted for the Accelerated Removal EE/CA in 1991. The waste materials within the Arbiter ponds and bunkers as well as the beryllium wastes were removed as part of the Accelerated Removals response action in 1992.

Also in 1991, ARCO and EPA amended AOC VIII-88-16 to conduct the Anaconda Soils Investigation to provide information to support future RI/FS activities at the Anaconda Smelter NPL Site. The investigation focused on five geographic areas: community soils; near community soils; community targeted soils; regional soils; and regional targeted soils. One of the primary objectives of the investigation was to delineate the nature and extent of metals contamination resulting from airborne particulate deposition.

In 1992, ARCO initiated an Arsenic Exposure Study, through the University of Cincinnati, to measure arsenic in Anaconda residents and evaluate possible exposure pathways. Several hundred families participated in this study to provide environmental (i.e., soil, dust, food, and water) and biological (i.e., urine) data. Data from this study was utilized by EPA in the Final Baseline Human Health Risk Assessment (HHRA) for the Anaconda Smelter NPL Site (EPA 1996b).

In May 1992, as a part of an amendment to AOC VIII-88-16 and the Anaconda Smelter NPL Site Conceptual Site Management Plan, OUs at the site were reorganized. This plan formed the OW/EADA OU from those formerly referred to as the Old Works and Arbiter Plant OUs and portions of the Smelter Hill OU. The Anaconda Regional Water and Waste (ARWW), Regional Soils, and Community Soils OUs were also combined from previous studies.

The OW/EADA RI/FS, initiated in 1992, was completed in September 1993. The March 1994 ROD for the OW/EADA OU selected a combination of engineering and ICs as the remedy. Remediation of recreational and commercial/industrial areas was conducted where waste and soils exceeded arsenic levels of 1,000 ppm (recreational land use) and 500 ppm (commercial/industrial land use).

Also in 1992, EPA approved the final work plan for the ARWW Screening Study. ARCO commenced a three year ground water and surface water sampling and waste characterization program. The ARWW RI/FS was formally started with a Scope of Work attached to the 8th amendment to AOC VIII-88-16 signed in September 1994. ARCO used results of the screening study, in combination with additional data collection, to complete the RI analysis. EPA approved the final RI in March 1996.

In 1995, ARCO and EPA amended an AOC to conduct remaining investigations to support both the Community Soils and ARWW&S OUs (combination of the ARWW and Regional Soils RIs). The September 1996 Community Soils ROD selected a combination of soil removal, engineered and vegetative covers as well as ICs as the remedy for this OU.

For completion of the ARWW&S OU, EPA combined RI/FS efforts among various OUs into a comprehensive analysis of the site. The following documents comprise the RI/FS for the final site-wide OU:

Remedial Investigation Reports

- ARCO. 1996a. *Anaconda Regional Water and Waste Operable Unit Final Remedial Investigation Report.* Prepared by Environmental Science & Engineering, Inc. for ARCO. February 1996, Volumes I - IV.
- ARCO. 1996b. *Anaconda Smelter NPL Site Smelter Hill Operable Unit Remedial Investigation Report.* Prepared by PTI Environmental Services for ARCO. December 1996, Volumes I - III.
- ARCO. 1997a. *Anaconda Smelter NPL Site Anaconda Regional Soils Operable Unit Remedial Investigation Report.* Prepared by Titan Environmental Corporation for ARCO. February 1997, Volumes I - II.

Risk Assessment Reports

- Life Systems. 1993. *Baseline Risk Assessment for the Old Works/East Anaconda Development Area.* Prepared by Life Systems, Inc. for Fluor Daniel, Inc. for EPA. August 19, 1993.
- EPA. 1996b. *Final Baseline Human Health Risk Assessment, Anaconda Smelter NPL Site Anaconda, Montana.* Prepared by CDM Federal for EPA. January 24, 1996.
- EPA. 1997a. *Final Baseline Ecological Risk Assessment, Anaconda Regional Water, Waste, and Soils Operable Unit.* Prepared by CDM Federal for EPA. October 1997, Volumes I - II.

Feasibility Study Reports

- ARCO. 1996c. *Anaconda Regional Water, Waste, and Soils Operable Unit: Preliminary Remedial Action Objectives, General Response Actions, Technology and Process Option Scoping, Waste Management Area Evaluation, and*

Preliminary Points of Compliance Identification. Prepared by Titan Environmental Corporation for ARCO. February, 1996. (FS Deliverable No. 1)

- ARCO. 1997b. *Anaconda Regional Water, Waste, and Soils Operable Unit: Revised Conceptual Model of Fate & Transport, Pathway Assessment, and Areas and/or Media of Concern.* Prepared by Titan Environmental Corporation for ARCO. February 1997. (FS Deliverable No. 2)

- EPA. 1996a. *Draft Feasibility Study Deliverable No. 3A, Ground Water Technical Impracticability Evaluation, Anaconda Regional Water, Waste, and Soil Operable Unit.* Prepared by CDM Federal for EPA. December 19, 1996.

- EPA. 1996c. *Final Feasibility Study Deliverable No. 3B for Anaconda Regional Water, Waste, and Soils Operable Unit (Identification of Problem Statement, Remediation Goals and Objectives, Waste Removal Evaluation, Development of Alternatives, Alternative Selection Evaluation for Each Subarea).* Prepared by CDM Federal for EPA. October 24, 1996.

- EPA. 1997b. *Draft Feasibility Study Deliverable No. 5, Detailed Analysis of Alternatives for Anaconda Regional Water, Waste, and Soils Operable Unit (FS No. 4, Operations and Maintenance, Appendix F).* Prepared by CDM Federal for EPA. February 14, 1997, Volumes I - II.

- EPA. 1997c. *Stucky Ridge Vegetation and Soil Evaluation For Land Reclamation Considerations, Anaconda Regional Water, Waste, and Soils Operable Unit.* Prepared by CDM Federal and Reclamation Research Unit, Montana State University for EPA. August 27, 1997.

The draft documents described above do not require revision, after continued review, and are considered final documents by EPA in support of this ROD.

ARCO's obligation to perform the tasks set out in the 1995 ARWW&S OU Statement of Work was terminated by EPA in a letter from M. Dodson to S. Stash, ARCO, dated July 30, 1996. EPA completed the remainder of the FS documents under fund lead efforts.

3.0 HIGHLIGHTS OF COMMUNITY PARTICIPATION

The dialogue between EPA and the community of Anaconda has been active since the inception of the site in 1983. As a result, four earlier remedial actions were completed, and in most cases community support outweighed limited opposition. EPA personnel have worked closely with individuals and groups to successfully achieve optimal community based environmental protection.

The ARWW&S OU project developed out of other OUs, where community involvement had been strong, and thus earlier community involvement cannot be isolated from the ARWW&S activities. In this section, however, the specific activities addressing community involvement needs during the RI/FS and decision process will be noted. More detailed community involvement activities can be found in earlier RODs and in the attached Responsiveness Summary.

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 will:

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 will keep a transcript of the meeting and make such transcript available to the public. The notice and analysis published under item No. 1 above will 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 presentation of the RI/FS and Proposed Plan, a 110-day public comment period, public meetings and open houses, a formal public hearing, and presentation of the Selected Remedy in this ROD. Specifically included with this ROD is a Responsiveness Summary that summarizes public comments and EPA responses.

The Administrative Record, including the following RIs and FS Deliverables for the ARWW&S OU, were available for public comment during the Proposed Plan public comment period:

Remedial Investigations

- Anaconda Regional Water and Waste Operable Unit Final Remedial Investigation Report (ESE 1996).
- Anaconda Smelter NPL Site Anaconda Regional Soils Operable Unit Remedial Investigation Report (ARCO 1997a).
- Anaconda Smelter NPL Site Smelter Hill Operable Unit Remedial Investigation Report (ARCO 1996b).

Feasibility Studies

- FS Deliverable No.1 - Preliminary Remedial Action Objectives/General Response Actions/Technology and Process Option Scoping, Waste Removal Evaluation (ARCO 1996c).
- FS Deliverable No. 2 - Conceptual Model of Fate and Transport, Pathways, and Areas/Media of Concern (ARCO 1997b).
- FS Deliverable No.3A - Ground water Technical Impracticability Evaluation for Anaconda Smelter NPL Site (EPA 1996a).
- FS Deliverable No. 3B - Waste Removal Evaluation and Development of Remedial Alternatives from the Treatment Technologies Screened in FS Deliverable No. 1 - (EPA 1996c).
- FS Deliverable No. 4 - Monitoring, and Operations and Maintenance Plan. - (Appendix F in FS Deliverable No. 5, CDM Federal 1997a).
- FS Deliverable No. 5 - Summary of the Results of the Prior Deliverables and a Detailed Analysis of the Remedial Action Alternatives for Each area of concern in the Anaconda Regional Water, Waste, and Soils Operable Unit (CDM Federal 1997a).
- Stucky Ridge Vegetation and Soil Evaluation For Land Reclamation Considerations (EPA 1997c).

Risk Assessments

- Final Baseline Human Health Risk Assessment (EPA 1996b).
- Final Baseline Ecological Risk Assessment (EPA 1997a).

The Proposed Plan for the ARWW&S OU was released for public comment on October 21, 1997. Copies of the RIs, Risk Assessments, FS Deliverables 1 through 5, and Proposed Plan were made available to the public in the Administrative Record located at the EPA Record Center in Helena, the Hearst Free Library in Anaconda, and the information repository at the Community Service Center in Anaconda. The Proposed Plan was distributed to the parties on the EPA Anaconda mailing list (approximately 350) and the Anaconda Local Development Corporation (ALDC) mailing list (about 400), and also made available at several locations in Anaconda. The notice of availability of the RI/FS and Proposed Plan was published in the Anaconda newspaper, *The Anaconda Leader*, October 24, 1997. A formal public comment period was originally designated from October 22, 1997 to December 20, 1997. At the request of the Technical Assistance Group and county attorney, the period was extended until January 30, 1998.

Two public information meetings were held after releasing the Proposed Plan, one on October 30, 1997 at the Anaconda High School Auditorium and one on November 20, 1997 at the Opportunity Community Club. In addition, EPA hosted an open house on November 18, 19, and 20, 1997 at the Anaconda Community Service Center for all interested people throughout the community who would like to learn more about the ARWW&S OU and its proposed remedial action alternatives. Reminder mailings were sent to EPA and ALDC's mailing lists.

A formal public hearing was held in Anaconda on January 15, 1998. The hearing was dedicated to accepting formal oral comments from the public. A court reporter transcribed the formal oral comments and EPA made the transcript available by placing it in the Administrative Record. A response to the comments received during the public comment period is included in the Responsiveness Summary, which is part of this ROD.

4.0 SCOPE AND ROLE OF OPERABLE UNIT

The Anaconda Smelter NPL Site is currently organized with respect to the following actions:

- Anaconda Smelter Demolition and Initial Stabilization Actions;
- Mill Creek Children Relocation Removal Action;
- Mill Creek Relocation Remedial Action;
- Anaconda Yards Time Critical Removal Action;
- Arbiter Non-Time Critical Removal/Beryllium Non-Time Critical Removal Action and Repository Construction;
- Old Works Stabilization Removal Action;
- Flue Dust Remedial Action;
- OW/EADA Remedial Action;
- Community Soils Remedial Action; and
- ARWW&S OU Remedial Action.

The actions were prioritized based on their potential risk to human health and the environment. Mill Creek was considered the highest priority and EPA relocated Mill Creek residents in 1988. Since then, EPA has also taken action at several other areas, including Flue Dust, Arbiter, Beryllium, OW/EADA, and Community Soils. These actions were prioritized for action based on principle threat human health risks (Flue Dust), immediate economic development requirements (OW/EADA), and potential exposure of remaining residents to elevated arsenic soil concentrations (Community Soils).

As noted in Section 2.0, Operable Unit History and Enforcement Activities, the site has been organized and OUs prioritized since 1988, with the Conceptual Site Management Plan attached to the AOC VIII-88-16. This order was formally revised in October 1995, with the Community Soils and ARWW&S OUs identified for remaining ROD completion. A brief description of the ARWW&S OU is provided below:

The ARWW&S OU combines the former ARWW, Anaconda Soils, and Smelter Hill OUs in a final site-wide RI/FS. Independent Remedial Actions will not be required under the Anaconda Soils and Smelter Hill OUs. The ARWW&S OU is intended to be the last comprehensive OU of the Anaconda Smelter NPL Site by addressing all remaining issues not addressed under other remedial actions. This OU will continue to address potential impacts to surface and ground water from soils and waste sources such as tailings and slag. This OU will address both the human and environmental risks associated with site-related contamination that have not been addressed by other OUs.

The purpose of the RIs and FS Deliverables for the ARWW&S OU was to gather sufficient information to support informed risk management decisions for remediation of all the remaining human and ecological health risks at the Anaconda NPL Site. The RIs and FS Deliverables were performed in accordance with the NCP, 40 CFR Part 300, and CERCLA.

The objectives of the RIs and the FS Deliverables were to:

- characterize to the extent necessary, the nature and extent of arsenic and metal contamination in soil, waste material, surface water, ground water and air in each subarea and area of concern throughout the ARWW&S OU;
- identify potential receptors, exposure pathways and food chain relationships;
- estimate human health and ecological risk due to exposures to arsenic and metal contaminated media;
- identify the current or reasonably anticipated future land use that may require development of remedial alternatives;
- screen and evaluate each of the remedial action alternatives defined in the FS deliverables against the NCP remedy selection criteria (40 CFR §300.430); and
- compare the relative performance among each alternative with respect to the evaluation criteria.

The remedy outlined in this ROD is intended to be the final remedial action for the ARWW&S OU. It is also intended to be the final remedial action for all remaining waste in the Anaconda Smelter NPL Site.

5.0 SUMMARY OF SITE CHARACTERISTICS

5.1 GENERAL SITE CHARACTERISTICS

The ARWW&S OU, which covers an area of approximately 300 square miles, is located in the southern Deer Lodge Valley and the surrounding foothills area (Figure 1-1). The southern Deer Lodge Valley is described as a north-south oriented intermontane basin with a structural history similar to numerous other Tertiary extensional basins in southwest Montana and adjacent parts of Idaho (Thompson et al. 1981). The estimated thickness of basin fill in the study area is approximately 5,000 feet (McLeod 1987; Cremer 1966). The basin is described as a half graben, controlled along its western margin by east-dipping listric normal faults. Interpretation of the basin's structural geology, from results of unpublished seismic surveys, suggests antithetic faults oriented with a west dip and located near the west margin of the basin may offset upper-level basin fill material.

Ground elevations at the site range from 4,800 to 6,300 feet above mean sea level (msl). In general, topography in the surrounding foothills exhibits a gentle to moderately steep slope toward principal drainages of the Upper Clark Fork River System. Topography of the valley-floor exhibits a very gentle northeast to east slope direction towards the principal water course of Silver Bow Creek and the upper Clark Fork River. Southwest of the site, the Anaconda-Pintler Mountains rise to elevations above 10,000 feet msl (ESE 1992). Northwest of the site is the Flint Creek Range. The majority of the site is located in the valley so slopes are generally in the range of 0 to 10 percent. However, steep slopes up to 50 percent are observed in the mountainous areas located at the western edge of the site.

5.1.1 CLIMATE

The climate of Anaconda is classified as semi-arid with moderate wind conditions; long, cold winters; and cool summers. Climate in the higher mountain elevations is alpine to subalpine. The average annual temperature in Anaconda is 43 degrees Fahrenheit (°F). The warmest month, based on a 30-year average daily maximum temperature is July (79°F); the coldest month is January (14.5°F), based on the 30-year average daily minimum temperature.

Weather data collected from 1951 to 1980 at the National Climatic Data Center site in Anaconda (Montana No. 2604, elevation 5,511 feet) indicate the average annual precipitation is approximately 14 inches. The wettest months are May and June with 1.9 and 2.3 inches, respectively. The area receives at least 0.1 inch of precipitation an average of 113 days per year. Mean annual snowfall in Anaconda is 63 inches, based on data collected from 1951 through 1974.

5.1.2 SURFACE WATER

Five principal perennial streams (Lost Creek, Warm Springs Creek, Mill Creek, Willow Creek, and Silver Bow Creek) that intersect the ARWW&S OU are tributaries of the Upper Clark Fork River System (Figure 5-1). The confluence of Silver Bow Creek, the Mill-Willow Bypass, and Warm Springs Creek in the east-central portion of the OU marks the formation of the Upper

Clark Fork River. Silver Bow Creek and the Upper Clark Fork River follow a northerly course along the east margin of the southern Deer Lodge Valley to form the present-day flood plain. These streams have deposited recent alluvium along the axis of the basin and have incised geologically older alluvial fans that form a series of high terraces located along the east margin of the OU. Mill Creek and Willow Creek also contribute to the deposition of alluvial material in the southern portion of the OU. These creeks combine to form the Mill-Willow Bypass to route relatively uncontaminated surface water around the Warm Springs Ponds, a water treatment system for Silver Bow Creek. A thin layer of silty overbank deposits overlie glacial outwash in portions of the floodplain in the northern portion of the study area along the corridors of Warm Springs Creek and Lost Creek.

Numerous drainage ditches collect shallow ground water from the Opportunity Ponds area. This drainage ditch network includes the North Ditch, South Lime Ditch, Old Lime Ditch, and two decant ditches located in the area east of the Opportunity Ponds. The South Sewer Ditch and the New Lime Ditch are located at the base of Smelter Hill and capture storm water runoff and snowmelt on the north and east sides of Smelter Hill and transport it to the Opportunity Ponds.

The streams in the valley are classified for use as drinkable, swimmable, and fishable; however, none of the streams are currently used for drinking water supplies. A portion of surface water flow in Mill, Willow, Warm Springs, Silver Bow, and Lost Creeks, and the Clark Fork River, is dedicated to agricultural use through ditch irrigation.

5.1.3 GROUND WATER

Conceptually, the hydrogeology of the area has been divided into two major hydrologic units, the alluvial aquifer and the bedrock aquifer. The principal aquifer of concern at the site underlies the floor of the southern Deer Lodge basin and is referred to as the alluvial aquifer. It is comprised of coarse textured alluvial deposits that are generally highly permeable. The alluvial aquifer is bound laterally and vertically by hydrologic units comprised of consolidated bedrock or deposits of alluvium and colluvium of relatively lower permeability. This system is commonly referred to as the bedrock aquifer.

The upper portion of the unconfined alluvial aquifer is a highly transmissive aquifer underlying the western portion of the basin floor, grading to a moderately transmissive aquifer in an eastward direction. The alluvial aquifer is comprised of various types of alluvial deposits, including floodplain (Qal), glacial outwash (Qgo), and recent alluvial fan deposits. Depth to ground water in the alluvial aquifer ranges from less than 5 feet to more than 100 feet along some segments of the valley margin.

The alluvial aquifer is bound at the valley margin by a relatively less transmissive hydrologic system. This hydrologic system is commonly referenced as the bedrock aquifer, and is composed of deposits of glacial till (Qt), indurated sinter (Qts), and unconsolidated by commonly clayey alluvial fan deposits (QTf2), Tertiary volcanic bedrock (Tv), Cretaceous granitic rocks (Kg), and Mesozoic and Paleozoic sedimentary rocks (Mz and Pz). The unifying characteristic of the bedrock aquifer is its relatively low hydraulic conductivity compared with that of the alluvial aquifer. Depth to ground water in the bedrock aquifer ranges from less than 10 feet to greater than 100 feet.

The lower boundary of the alluvial aquifer is difficult to define because unconsolidated basin fill extends well beyond the range of monitor well drilling. Only a few monitor wells penetrate more than the upper 10 to 30 feet of the aquifer, therefore, the lower boundary has been defined conceptually at a depth of 150 feet below the top of the water table in areas where the base of the aquifer has not been penetrated by monitor well control.

Ground water flow in the study areas enters the alluvial aquifer as valley through-flow, as ground water recharge from the surrounding bedrock aquifer, or through the base of the aquifer. The lateral boundary of the alluvial aquifer generally coincides with geologic contacts observed near the margin of the South Deer Lodge Valley. The valley is bound by mountainous terrain characterized by steep topographic gradients. The water table gradient of the bedrock aquifer in these areas may resemble the topographic slope. As a result, ground water entering the alluvial aquifer as recharge from the surrounding bedrock aquifer will generally flow in a direction perpendicular to the valley margin. Ground water flow in the alluvial aquifer is generally in a direction perpendicular to the topographic contours of the valley.

Although regional ground water flow at the site is principally in a horizontal direction, vertical components of ground water flow are also evident in portions of the aquifers at the site. In general, data suggest a downward component of ground water flow for most of the bedrock aquifer underlying Smelter Hill and for the alluvial aquifer underlying the Anaconda Ponds, the Opportunity Ponds, the Blue Lagoon, Warm Springs Ponds, portions of the floodplain of Warm Springs Creek, Mill Creek, Willow Creek, Lost Creek, Silver Bow Creek, and portions of the area surrounding the Anaconda County airport. A general upward component of ground water is identified for the alluvial aquifer located at the base of Smelter Hill, underlying the lower floodplain segments of Warm Springs Creek, Mill Creek, Willow Creek, Lost Creek, Dutchman Creek, Silver Bow Creek, and the upper Clark Fork River; underlying a portion of the area surrounding the Opportunity Ponds and Blue Lagoon; underlying the Mill-Willow Bypass; and underlying a portion of the area surrounding the Warm Springs Ponds.

Data show that the hydraulic conductivity of the alluvial aquifer is significantly higher (over three orders of magnitude) than that of the bedrock aquifer at the site. The exceptions to this trend are portions of alluvial fan deposits consisting of silts and clays which exhibit a hydraulic conductivity comparable to that of the bedrock aquifer.

An evaluation of the distribution of aquifer hydraulic conductivity at the site indicates the alluvial aquifer in the vicinity of the Old Works area and area upgradient of the Opportunity Ponds generally demonstrates the highest values of hydraulic conductivity at the site (greater than 100 feet per day). This portion of the alluvial aquifer generally consists of coarse sands and gravels, and may be related to paleochannel deposits of Warm Springs Creek. Portions of the Tertiary alluvial and bedrock aquifers demonstrating relatively low permeability (less than 1 foot per day) are generally present underlying Smelter Hill.

Water use in the area is controlled primarily by surface land ownership, water rights, and major land use. Ground water is used as water supply for irrigation in portions of the site, primarily in the southern portions of the valley and near Fairmont Hot Springs. Consumption is limited to domestic purposes from small capacity water wells in the Aspen Hills subdivision located on the back side of Smelter Hill, the community of Opportunity, and rural homes. The city of Anaconda is permitted for using ground water and surface water from their public water supply, but the wells and reservoirs are outside and upgradient of the NPL site.

5.1.4 SOILS AND TOPOGRAPHY

The ARWW&S OU can be divided into three general areas of topography: floodplain area, lowland area, and upland area. The floodplain area is defined by the boundary of the 100-year floodplain. In general, the 100-year floodplain at the site is restricted to narrow corridors located along Lost Creek, Dutchman Creek, Warm Springs Creek, Mill Creek, Clear Creek, Willow Creek, Silver Bow Creek, and the Upper Clark Fork River. Topographic slope in the floodplain area generally ranges from 0 to 8 percent. Floodplain soil types have been classified on a preliminary basis for portions of the site by the United States Department of Agriculture Soil Conservation Service. Soil types of the 100-year floodplain in these areas range from silt and clay loam in the lower reaches of Lost Creek, Dutchman Creek, Warm Springs Creek, Mill Creek, and Willow Creek (slope generally less than 4 degrees), to gravelly loam in steeper sections (4 to 8 percent slope) of upper Lost Creek and upper Willow Creek, and rubble in the floodplain of Clear Creek.

The lowland area is defined as the segment of the valley located topographically above the 100-year floodplain to the intersection of the floor of the southern Deer Lodge Valley with the surrounding foothills. Topographic slope in this portion of the site generally ranges from 0 to 4 percent. Soils in the lowland area are generally thick and well-developed over broad alluvial fans. Soils in the lowland area are often well-drained (gravelly loam) along the margins of the foothills area to poorly drained, wetland-type soils (silty loam) in the interior portion of the site.

Soils located in the foothills area were developed on steeply sloping alluvial fans, colluvium, and bedrock of sedimentary and volcanic rock types. Topographic slope in this portion of the site ranges from less than 10 percent to greater than 50 percent. Soils in this region of the site are generally thin and may contain a large percentage of rock fragments.

5.2 TERRESTRIAL AND AQUATIC ENVIRONMENTS

5.2.1 TERRESTRIAL SYSTEMS

Terrestrial ecosystems comprise the majority of the Anaconda Smelter NPL Site and include agricultural areas (i.e., cropland and pasture), rangeland (mosaics of grass, forbs, shrubs and trees), forests, and riparian and wetland areas. These areas received contamination from smelter stack emissions during the 100-year operation of the Anaconda Smelter and, although the smelter has not operated since 1980, smelting byproducts persist as wastes and contaminated soils.

The climax vegetation (i.e., uninfluenced by European human activity) in the lowland and foothill areas of Anaconda is classified as either silty or saline range sites that would consist of perennial grasses, forbs, and shrubs, and forest in the upper elevations. The primary rangeland habitat types found in the Anaconda area classify into either the rough fescue or Idaho fescue climax series. Under climax or near climax conditions the plant communities on these range/forest sites and in these habitat types would be very productive and dominated by native perennial plant species. This is in sharp contrast to the plant communities in many areas of the Anaconda Smelter NPL Site that exhibit low canopy coverage and annual above-ground production, or are dominated (or co-dominated) by weedy or metal-tolerant plant species. Plant community diversity and structure vary considerably across the site depending on the characteristics of the soil and the physical environment. These factors include concentrations of smelting-related COCs, soil moisture, organic matter, soil pH and nutrient status, slope, aspect, reclamation activities, and other influences such as logging, fire, irrigation, and grazing.

Investigations and field work indicate areas of barren soil and stressed vegetation, especially in the vicinity of Stucky Ridge, Smelter Hill, Mount Haggin, and the Anaconda and Opportunity Tailings Ponds. According to one estimate, the vegetation condition in approximately 18 square miles (11,400 acres) of uplands has been visibly altered by anthropogenic activities, including smelting. These activities resulted in the total elimination of native plant communities and extensive topsoil loss from lack of vegetation in some areas. The result has been a shift in plant community structure from forests or rangeland to barren or sparsely vegetated grasslands having low species and structural diversity, and being composed of monocultures of weedy and/or metals-tolerant species. These vegetational and landscape changes are documented by historic photographs and records, and recent research at the site.

Wetlands have also been identified in portions of the ARWW&S OU. An inventory of wetlands areas at the Anaconda Smelter NPL Site was performed by ARCO during the period of 1991 through 1993 (EA 1994) and resulted in the identification of approximately 10,000 acres of wetlands, riparian, and aquatic habitat. Few wetlands were observed on the steep hilly acres located on the west side of the study area. The wetlands found in this area are narrow riparian zones associated with intermittent streams such as Hensley and Homestead Gulches. The broad valley floor located north of Warm Springs Creek supports considerable wetland acreage. Shallow depth to ground water and somewhat poorly drained soils contribute to many wet meadows that characterize much of this geographical area. The topographically high terrace located north of Lost Creek in the north portion of the OU has only a few identified wetlands areas. The relatively flat, low-lying agricultural areas located south of Opportunity, Montana including the town of Opportunity also supports fairly expansive wetlands. The wetlands in this portion of the OU are characterized by shallow ground water and flat topography.

Wildlife species associated with the upland habitats include a wide variety of species adapted to semi-arid montane conditions, and those that have adapted to the vegetational changes. These include birds of prey, woodpeckers, songbirds, squirrels, porcupine, marten, black bear, moose, elk, deer, invertebrates, amphibians, and reptiles. The bald eagle and the peregrine falcon, both Federally listed as endangered, may occur at the ARWW&S OU. In addition, the gray wolf is also listed as endangered and may eventually occur at this site. Riparian and wetland habitat also support many wildlife species such as birds of prey, waterfowl, woodpeckers, songbirds, otter, muskrat, mink, raccoon, beaver, deer, amphibians, reptiles, and invertebrates.

5.2.2 AQUATIC ENVIRONMENTS

The four perennial streams within the Anaconda Smelter NPL Site (Mill Creek, Willow Creek, Warm Springs Creek, and Lost Creek) are important aquatic resources since they constitute the major aquatic habitats in this dry region. (Silver Bow Creek is part of the Silver Bow Creek/Butte Area NPL Site.) These streams also represent a portion of the headwaters for the Upper Clark Fork and Columbia Rivers. Interviews with local fisheries experts and sportsman indicate that healthy, self-sustaining salmonid fisheries exist in these streams upgradient of Anaconda, and that other small inflow streams located between Warm Springs Creek and Lost Creek also support fish. Habitats deteriorate in the lower reaches of each stream due in part to dewatering for agricultural purposes, which affects the amount and timing of surface water flow, and from COC-contaminated surface water and sediment. Fish found in at least some of the streams and lakes in the Anaconda area include brook trout, brown trout, bull trout, rainbow trout, cutthroat trout, shiner, sculpin, sucker, and whitefish. The bull trout is listed as threatened by the Federal government.

In addition to the four perennial streams, there are several standing bodies of water that serve as a source of drinking water or habitat for wildlife. These water bodies include the Blue Lagoon, Slag Gulch, Nazer Gulch, and the ponds and drainage ditches surrounding the Opportunity Tailings Ponds. These waters serve as pathways for chemical exposure to aquatic macro invertebrates, amphibians, reptiles, birds, and mammals that use or reside in or near these water bodies. Data indicate that total concentrations of COCs in surface water in some stream segments frequently exceed the EPA chronic ambient water quality criteria derived for total metals (Table 5-1).

Invertebrates found in perennial streams and other aquatic habitats at the Anaconda Smelter NPL Site include dragonflies, midges, mayflies, worms, stoneflies, caddisflies, and damselflies. Amphibians and reptiles typically associated with aquatic environments in western Montana include the boreal toad, spotted frog, northern leopard frog, and long-toed salamander. Reptiles typically found in aquatic or relatively moist environments in western Montana include the western painted turtle, wandering garter snake, northern alligator lizard, and western skink. The northern alligator lizard and western skink are also often found in dry environments, occasionally long distances from water and may be present at the site.

5.3 SUBAREA DESCRIPTIONS

Due to the large size of the ARWW&S OU, it has been separated into five subareas to facilitate the screening of potential remedial technologies and the evaluation of alternatives; these are the Opportunity Ponds, North Opportunity, South Opportunity, Old Works/Stucky Ridge, and Smelter Hill Subareas. The nature and extent of contamination in the subareas is discussed below. Portions of the subareas containing waste or contaminated media are referred to as "areas of concern", and are summarized in Table 5-2.

5.3.1 OPPORTUNITY PONDS SUBAREA

The Opportunity Ponds Subarea encompasses approximately 11 square miles and occupies the central region of the ARWW&S OU (Figure 1-2).

The Opportunity Ponds Subarea is divided into three large waste areas: the Opportunity Ponds, Triangle Waste Area, and South Lime Ditch. The Opportunity Ponds contain approximately 129.3 million cubic yards (cy) of tailings covering an area of approximately 3,600 acres. The thickness of tailings in the Opportunity Ponds ranges from a few feet to over 50 feet. Tailings located beyond the east exterior berm of the Opportunity Ponds cover an additional area of approximately 26 acres and constitute an estimated 60,000 cy of wastes. Table 5-3 lists the physical composition of tailings in the Opportunity Ponds Subarea. A portion of the wastes at the base of the Opportunity Ponds are in direct contact with ground water of the alluvial aquifer. As a result, tailings contained in the Opportunity Ponds are characterized as a source of ground water contamination to the underlying alluvial aquifer, and are a potential source of ground water contamination to the aquifer underlying a portion of the South Lime Ditch area. Tables 5-4 through 5-6 show results of chemical analyses and related statistical information for the Opportunity Ponds Subarea.

Wastes in the Triangle Waste Area are diverse, ranging from tailings generated by the Old Works (pre-1900) and Washoe Works (post-1902) smelters to municipal solid waste and sewage sludge material. Wastes in this portion of the subarea encompass an area of approximately 300 acres and range in thickness from less than 1 foot to approximately 10 feet. The total volume of waste material in the Triangle Waste Area is estimated to be approximately 1.4 million cy. Wastes in the Triangle area are not identified by EPA as a significant source of ground water contamination to the underlying alluvial aquifer. Concentrations of metals in sediments from the Triangle Waste Area are shown in Table 5-7.

Wastes in the South Lime Ditch Area are contained in a 490 acre area located along the southern perimeter of the Opportunity Ponds. The South Lime Ditch is a drainage ditch which was constructed by the Anaconda Company to capture ground water in the shallow alluvial aquifer and to convey storm water emanating from Smelter Hill to the Warm Springs Ponds. Wastes were deposited in the area during a breach in the exterior berm of the Opportunity Ponds. The thickness of waste material in the South Lime Ditch area is estimated to range from less than 1 foot to approximately 8 feet. The estimated volume of waste material in the South Lime Ditch area is 1.7 million cy. Wastes in the South Lime Ditch area are identified as a potential source of ground water contamination to the underlying alluvial aquifer. Concentrations of metals in soils from the South Lime Ditch Area are shown in Table 5-8.

Widespread areas of contaminated soil are identified in the Opportunity Ponds Subarea resulting from deposition of smelter stack emissions and deposition of fugitive dust emissions from large areas of waste. In some portions of the subarea, elevated levels of metals in contaminated soils are phytotoxic to native plant species; thus, a majority of the area with significant soil contamination is also characterized by a poor vegetative cover. A portion of the poorly vegetated area of contaminated soils is considered a potential loading source for metals to surface water and bed sediment of Mill Creek. In addition, approximately 300 acres of contaminated soils in the subarea exhibit arsenic levels greater than the Preliminary Remedial Action Goal (PRAG) (1,000 milligrams per kilogram [mg/kg]) identified by EPA for recreational lands.

Ground water is contaminated in the Opportunity Ponds Subarea in portions of the alluvial aquifer underlying the Opportunity Ponds and South Lime Ditch area. Levels of arsenic and cadmium above the PRAGs are observed in the alluvial aquifer underlying the Opportunity Ponds (Tables 5-9 and 5-10), and elevated levels of arsenic are observed in the aquifer in the South Lime Ditch area (Table 5-10). The vertical extent of ground water contamination is limited to the upper 10 to 25 feet of the aquifer.

Surface water resources in the Opportunity Ponds Subarea include the lower segment of Mill Creek at the site and a drainage ditch network located in the perimeter of the Opportunity Ponds. Surface water contamination in Mill Creek occurs on at least a seasonal basis and includes elevated levels of total and dissolved arsenic, copper, and lead above PRAGs identified by EPA. Potential sources of contamination to Mill Creek include runoff of contaminated storm water from areas of wastes and contaminated soil located in the Smelter Hill Subarea, and runoff of contaminated storm water from poorly vegetated areas of contaminated soils located adjacent to Mill Creek in the Opportunity Ponds Subarea. Surface water contamination in the Opportunity Ponds drainage ditch network includes elevated levels of total and dissolved copper and zinc above PRAGs in ponds located east of the Opportunity Ponds D-2 cell, and elevated levels of dissolved arsenic above the PRAG in a small drainage ditch located east of the Opportunity Ponds D-2 cell. A potential loading source of metals to surface water in this area is runoff of storm water and snowmelt from wastes deposited outside the exterior berm of the Opportunity Ponds D-2 cell.

Bed sediment in Mill Creek and portions of the drainage ditch network surrounding the Opportunity Ponds is contaminated with elevated levels of metals. Potential loading sources of metals to bed sediment of Mill Creek include runoff from areas of contaminated soil and waste located upstream of the Opportunity Pond Subarea in the Smelter Hill Subarea, and poorly vegetated areas of contaminated soil located adjacent to Mill Creek in the Opportunity Ponds Subarea. Elevated levels of metals in bed sediment in portions of the drainage ditch network are a result of loading from tailings which are deposited outside the berm of the ponds.

5.3.2 NORTH OPPORTUNITY SUBAREA

The North Opportunity Subarea is located in the northeast portion of the site and covers an area of approximately 27 square miles (Figure 1-2). The campus for the State of Montana Warm Springs Hospital and the rural community of Galen are located in the North Opportunity Subarea (Figure 1-1).

Widespread areas of contaminated soils are identified in the North Opportunity Subarea as a result of deposition of smelter stack emissions and from fluvially-deposited waste materials adjacent to Warm Springs Creek. Under certain site conditions, elevated levels of metals in contaminated soils in the subarea are phytotoxic to most native plant species, thus, a portion of the subarea is characterized by a poor vegetative cover. Due to its erosive nature, a portion of the poorly vegetated area of contaminated soils is regarded as a potential loading source for metals to surface water and bed sediment of Warm Springs Creek and Lost Creek. In addition, approximately 320 acres of contaminated soils in the subarea exhibit arsenic levels greater than the PRAG (1,000 mg/kg) identified by EPA for recreational lands.

Wastes in the subarea are identified in a portion of the Warm Springs Creek floodplain located near the confluence of the North Drain Ditch with Warm Springs Creek. Tailings in this portion of the subarea cover an estimated area of 0.4 acres and include an estimated volume of 1,116 cy of material. Additional deposits of streamside tailings were discovered in the fall of 1997 during a creek re-naturalization project to restore historic channels. The extent of streamside tailings throughout Warm Springs Creek is unknown at this time. Wastes in the Warm Springs Creek floodplain are a potential loading source of metals to surface water and bed sediment of Warm Springs Creek.

Surface water contamination, which includes elevated levels of total recoverable copper, lead, and arsenic, is identified in the lower stream reach of Warm Springs Creek during periods of high flow. Potential loading sources for metals to Warm Springs Creek include runoff of contaminated storm water from poorly vegetated areas of contaminated soils, and erosion of floodplain wastes. Surface water quality of Lost Creek is relatively good in the subarea, and does not include significant levels of total recoverable and dissolved metals.

Metal levels in bed sediment are significantly elevated in the upstream reach of Warm Springs Creek in the subarea. Metals in bed sediment of Warm Springs Creek are likely derived from erosion of wastes and poorly vegetated area of contaminated soils located in the Old Works/Stucky Ridge area. As remediation of wastes and areas of contaminated soils adjacent to Warm Springs Creek in the Old Works/Stucky Ridge Subarea is completed, reductions in loading rates of metals to surface water and bed sediment of Warm Springs Creek in the North Opportunity Subarea should be realized. Metal levels in bed sediment of Lost Creek have not been sampled but are thought to be significantly lower than those levels observed in Warm Springs Creek since wastes are not observed in the Lost Creek floodplain and metal levels in nearby soils are relatively low.

5.3.3 SOUTH OPPORTUNITY SUBAREA

The South Opportunity Subarea is located in the southern portion of the site and encompasses an area of approximately 25 square miles (Figure 1-2). The rural communities of Opportunity, Crackerville, and Fairmont Hot Springs areas are located in the South Opportunity Subarea (Figure 1-1).

Widespread areas of contaminated soil are characterized in the South Opportunity Subarea as a result of deposition of smelter stack emissions. Under certain conditions, levels of metals in contaminated soils are phytotoxic to native plants, thus, a portion of the subarea is characterized by a poor vegetative cover. The poorly vegetated areas of contaminated soil in the subarea are identified as a potential loading source for metals to surface water and bed sediment to Willow Creek and a portion of Yellow Ditch. In addition, areas of contaminated soils which are presently flood irrigated on a year-round basis are a potential source of ground water contamination to the underlying alluvial aquifer.

Approximately 400,000 cy of wastes are characterized in the South Opportunity Subarea. These wastes include tailings and metal-laden sediment of Yellow Ditch (120,000 cy), waste rock in railroad grade material near the Blue Lagoon (67,000 cy), contaminated bed sediment of the Blue Lagoon (4,000 cy), and floodplain tailings located adjacent to Willow Creek (157,000 cy). Analytical results of soil and sediment samples collected from Yellow Ditch and the vicinity of the Blue Lagoon are shown in Tables 5-11 and 5-12, respectively. Wastes in the subarea are considered a potential source of ground water contamination to portions of the shallow alluvial aquifer. Wastes located along Yellow Ditch and in the floodplain of Willow Creek near MW-225 are considered a potential source of contamination to surface water and bed sediment in the subarea (Tables 5-11 and 5-13).

Ground water contamination is characterized in portions of the alluvial aquifer underlying areas of contaminated soils which are flood irrigated on a year-round basis in the vicinity of Yellow Ditch, and in portions of the aquifer underlying wastes and contaminated soils at the Blue Lagoon. Elevated levels of arsenic above the PRAG identified by EPA are characterized in the alluvial aquifer underlying contaminated soils which are flood irrigated (Table 5-14). The depth of ground water contamination in this portion of the aquifer is estimated to range from less than 10 feet to approximately 30 feet. Concentrations of arsenic in the ground water adjacent to Yellow Ditch in the MW-232 area are shown in Table 5-15. Ground water contamination in the alluvial aquifer at the Blue Lagoon includes elevated levels of cadmium, copper, and zinc above PRAGs (Table 5-16). Potential loading sources for metals to the aquifer in this area include leaching of metals from wastes in railroad grade material, from contaminated soils, and from contaminated sediment of the Blue Lagoon (Table 5-12). The depth of ground water contamination at the Blue Lagoon is thought to be limited to the upper 10 feet of the aquifer.

Willow Creek is the principal stream located in the South Opportunity Subarea. Surface water and bed sediment in Willow Creek are contaminated with metals throughout the stream's reach in the South Opportunity Subarea. Elevated levels of total recoverable and dissolved arsenic, copper, and lead above the PRAGs occur in Willow Creek during seasonal periods of high flow (Table 5-1). Potential loading sources for metals to surface water and bed sediment of Willow Creek include runoff of contaminated storm water from areas of contaminated soil, and runoff of contaminated storm water and erosion of floodplain tailings adjacent to Willow Creek. Contaminated surface water is also characterized in the Blue Lagoon and the active portion of the Yellow Ditch. Surface water contamination in the Blue Lagoon includes very high levels of copper, zinc, and cadmium above PRAGs. Potential loading sources of metals to the Blue Lagoon include transport of metals from railroad bed material located upstream of the lagoon and transport of metals from contaminated soils. Surface water contamination in the Yellow Ditch is limited to elevated levels of arsenic above the PRAG. Potential loading sources for arsenic to the Yellow Ditch include runoff of contaminated storm water and irrigation water from areas of contaminated soils, and direct contact of surface water with contaminated sediment.

5.3.4 OLD WORKS/STUCKY RIDGE SUBAREA

The Old Works/Stucky Ridge Subarea is located in the west portion of the site in the area north of the town of Anaconda (Figure 1-2). This subarea encompasses approximately 31 square miles, and includes a portion of the Deer Lodge National Forest and a small rural residential development located adjacent to Lost Creek.

A total of 1,400,000 cy of wastes are identified by EPA in the Old Works/Stucky Ridge Subarea. Table 5-17 lists the physical characteristics of waste and solids in this subarea. A remedy for all wastes in the subarea was selected by EPA with completion of the ROD for the OW/EADA OU. The Selected Remedy will allow wastes in the Old Works area to remain in place, and it will utilize a combination of engineering controls ranging from consolidation and grading of wastes to construction of soil covers to promote drainage, minimize infiltration, and prevent erosion of wastes in the Old Works/Stucky Ridge Subarea.

Widespread areas of contaminated soil resulting from deposition of smelter stack emissions are characterized in the Old Works/Stucky Ridge Subarea. Under certain conditions, metal levels in surface soils in these areas are phytotoxic to most native plant species. As a result, these areas are susceptible to high rates of erosion due to their steep topography (>10 percent slope) and poor vegetative cover. A management strategy for containment of storm water emanating from areas of contaminated soil and waste located near the Upper and Lower Works on Stucky Ridge is included in the *Old Works/East Anaconda Development Area Operable Unit Record of Decision* (EPA 1994). Sedimentation ponds will be used to contain storm water runoff in this portion of the subarea.

Ground water contamination is characterized in portions of the bedrock and alluvial aquifers in the subarea. Elevated levels of arsenic above the PRAG identified by EPA are characterized in a portion of the bedrock aquifer underlying areas of contaminated soil on Stucky Ridge (Table 5-18). The depth of ground water contamination in this portion of the subarea is not known, but is thought to be limited to the upper 115 feet of the aquifer. In addition, elevated levels of cadmium, copper, and zinc above PRAGs are characterized in a portion of the alluvial aquifer underlying waste-left-in-place in the Old Works area, and in the area downgradient of the Red Sands in the vicinity of the Arbiter Plant and Drag Strip (Tables 5-19). Potential loading sources include leaching of metals from wastes in the Old Works area and from contaminated soils and/or wastes in the vicinity of the former Arbiter Plant and Drag Strip (Table 5-20).

Contamination of surface water and bed sediment is characterized in the subarea in Warm Springs Creek, and on an occasional basis in surface water of Lost Creek. Elevated levels of total recoverable copper and lead in surface water of Warm Springs Creek exceed PRAGs during seasonal periods of high flow, while levels of total recoverable copper in surface water of Lost Creek are above PRAGs on an occasional basis in the subarea (Table 5-1). Potential loading sources for copper and/or lead to surface water and bed sediment of Warm Springs Creek and Lost Creek include runoff of contaminated storm water from areas of wastes and contaminated soils located adjacent to Warm Springs Creek, and runoff of contaminated storm water from contaminated soils located adjacent to Lost Creek.

5.3.5 SMELTER HILL SUBAREA

The Smelter Hill Subarea is located in the southwest portion of the site and covers an area of approximately 24 square miles (Figure 1-2). The Smelter Hill Subarea includes a portion of the

State of Montana Mount Haggin Wildlife Management Area and a rural residential development located in the Aspen Hills Area.

Widespread soil contamination is identified in the Smelter Hill Subarea. Elevated levels of arsenic in soils in a portion of the Smelter Hill Subarea are above the PRAG for recreational land-use areas (1,000 mg/kg). Volumes of soil with arsenic concentrations greater than the PRAG in the Smelter Hill Subarea are shown in Table 5-21. Deposition of historic smelter stack emissions is the primary source of highly elevated concentrations of arsenic, cadmium, copper, lead, and zinc in surface soils. Areas of soil contamination located adjacent to the Mill Creek floodplain are considered a primary source for metal loading to surface water and bed sediment of Mill Creek. Highly elevated arsenic in soils, and mixed soils and waste in portions of Nazer Gulch, Slag Gulch, and Walker Gulch, are considered to be source areas for elevated levels of arsenic characterized in surface water flow emanating from these drainages to the East Anaconda Yard. In addition, elevated levels of arsenic in soils in the subarea are identified as the primary source of widespread but relatively shallow ground water contamination in the underlying bedrock aquifer.

Wastes identified in the Smelter Hill Subarea include buried wastes in the Disturbed Area of Smelter Hill, the Anaconda Ponds, the Main Granulated Slag Pile, buried wastes in the East Anaconda Yard, West Stack Slag, and debris located in Nazer Gulch. The results of chemical and x-ray fluorescence analyses for slag samples are shown in Tables 5-22 and 5-23, respectively. Statistical summaries of metals concentrations and physical and chemical parameters for non-reclaimed soil samples in the Disturbed Area of Smelter Hill, tailings in the Anaconda Ponds, soil in the Handling, Process, and Storage (HPS) Area of the East Anaconda Yard, soil in the Disturbed Area of East Anaconda Yard, non-reclaimed soil samples from the Primary HPS Area of Smelter Hill, soil in the stack area of Smelter Hill, and the Loop Track Railroad Beds are shown in Tables 5-24 through 5-31, respectively. The estimated volume of wastes in the subarea is approximately 125,436,000 cy. A portion of the wastes contained in the Disturbed Area of Smelter Hill and the exterior berm of the Anaconda Ponds have been reclaimed with a cover of clean soil and vegetation. Statistical summaries of metals concentrations in reclaimed soil samples in the Disturbed Area and Primary HPS Area of the Smelter Hill Subarea are shown in Tables 5-32 and 5-33, respectively. Pore water quality results for wastes in the Smelter Hill Subarea are shown in Tables 5-34 and 5-35.

Elevated concentrations of arsenic above the PRAG are identified in a portion of the bedrock aquifer underlying the Disturbed Area of Smelter Hill and underlying widespread areas of contaminated soils in the subarea (Tables 5-36 through 5-38). Elevated levels of cadmium above the PRAG for cadmium are also observed in portions of the bedrock aquifer underlying the Disturbed Area of Smelter Hill (Tables 5-36 through 5-38). The approximate depth of ground water contamination in the bedrock aquifer ranges from approximately 115 feet below the top of the aquifer underlying portions of the Disturbed Area to approximately 10 feet underlying areas of contaminated soils. Potential loading sources of arsenic and cadmium to the bedrock aquifer include leaching of arsenic and cadmium from buried wastes in the Disturbed Area of Smelter Hill and leaching of arsenic from widespread areas of contaminated soils.

The alluvial aquifer underlies a majority of the subarea surrounding Smelter Hill, including the East Anaconda Yard, the Main Granulated Slag Pile, the Anaconda Ponds, a portion of the Disturbed Area located at the base of Smelter Hill, and a portion of the Mill Creek valley. Elevated concentrations of arsenic above the PRAG have been delineated or are inferred in a portion of the alluvial aquifer underlying the East Anaconda Yard, Main Granulated Slag, and Anaconda Ponds (Tables 5-36 and 5-37). The vertical extent of ground water contamination in the alluvial aquifer is limited to the upper 10 to 20 feet of the aquifer. Potential sources of arsenic in the shallow alluvial aquifer include recharge of the alluvial aquifer from contaminated ground water in the surrounding bedrock aquifer; leaching of arsenic from buried wastes located in the East Anaconda Yard, Main Granulated Slag area, and Anaconda Ponds; and recharge of the aquifer by infiltration of contaminated storm water discharging from drainages located on Smelter Hill.

Mill Creek and its associated tributaries, including Cabbage Gulch, and drainages located on Smelter Hill are the primary surface water features identified in the Smelter Hill Subarea. Levels of total and dissolved arsenic in surface water are above the PRAG throughout the reach of Mill Creek located in the Smelter Hill Subarea. Levels of total and dissolved copper and lead in surface water are also above the PRAG on at least a seasonal basis (spring runoff conditions) in the stream reach of Mill Creek located in the subarea. Potential loading sources for metals to surface water of upper Mill Creek include runoff of contaminated storm water and snowmelt from areas of waste and contaminated soils located in portions of the Smelter Hill Subarea, and arsenic loading from discharge of contaminated ground water to tributaries of Mill Creek such as Cabbage Gulch, Slag Gulch, and Nazer Gulch.

5.4 CURRENT AND POTENTIAL FUTURE SITE AND RESOURCE USES

5.4.1 LAND USE

The communities of Anaconda-Deer Lodge County have gone through extensive land use planning in the last 10 years, partly precipitated by Superfund activities and the desire of the communities to focus on economic redevelopment. These planning efforts, funded in part by the PRP, resulted in adoption in 1992 of the Master Plan, which prioritized areas mostly likely to be developed (e.g., East Anaconda Development Area) versus areas least likely to be developed in the near future (e.g., Waste Management Areas). This information was instrumental in structuring and prioritizing the OW/EADA ROD finalized in 1994. EPA further assessed land use priorities, and in the Community Soils ROD, overlaid known residential activities within the designated land uses (e.g., agricultural, open space, town residential) to help identify where to focus residential yard clean-up efforts.

For the ARWW&S, EPA continued to build on known land use planning efforts and incorporated 1996 and 1997 proposed updates to the 1992 Master Plan. (As of publication of this ROD, the revisions to the Master Plan have been adopted by the Planning Board, but not the County Commissioners.) Figure 5-2 presents the best estimates of current and potential future land use, used by EPA. EPA used this information in assessing human health risk levels to varying intensities of land use (residential, commercial/industrial, recreational, open space) and in the detailed FS. An overview of how this information influenced the remedial decision making process is found in Section 6.0, Summary of Risks, and Section 7.0, Description of Alternatives.

Additional county planning elements and private property controls are described in the following paragraphs.

Private property restrictive covenants are placed on property recently purchased by ARCO and leased for cattle grazing in the Opportunity Ponds and North Opportunity Subareas. These covenants contain restrictions related to remedial action and land development and establish best management practices for cattle grazing. Lands in the South Opportunity Subarea have conservation easements placed on the WH Ranch Company and Glen Willow Ranch properties relating to remedial action, land development and grazing practices. These covenants also include irrigation restrictions. Associated surface water rights recently purchased by ARCO and previously used for irrigation purposes would now be used for in-stream base flows on Willow Creek. Property around S&N Concrete is slated for industrial development through expansion of gravel pits for concrete production.

The Opportunity Ponds, Cell A, South Lime Ditch, Triangle Waste, Main Granulated Slag, Disturbed Area, Anaconda Ponds and East Anaconda Yards areas of concern all lie within the ADLC's Waste Management Development Districts and the Superfund Overlay District, both which operate under the Master Plan's Development Permit System. Additionally, ARCO, as the private property owner of these lands, has implemented deed restrictions which establish limited permitted uses.

5.4.2 GROUND WATER USE

Potable water supplies for the largest community in the County, the town of Anaconda, comes from a mixture of surface waters out of the Hearst Lake/Silver Lake water system, located to the west of the community and unimpacted by smelter or waste products, and from groundwater production wells, located west and upgradient of any contaminated groundwater in the area. All other domestic water use comes from individual or small community (2-25 users) wells scattered throughout the alluvial aquifer (town of Opportunity and Warm Springs State Hospital, small ranches and individual homes), individual wells located in the bedrock aquifers up in the Aspen Hills, Clear Creek and Stucky Ridge areas, and potentially from springs sources in the Aspen Hills area. To date, all known domestic water supplies have been tested and meet federal and state drinking water standards.

As part of the OW/EADA ROD and concurrent transfer of properties from the PRP to the County, water development bans were placed on groundwater resources within the Old Works and East Anaconda Yards areas. ARCO, the PRP at the site, has also placed restrictions on ground water development and use for all ARCO owned properties, including Smelter Hill, Anaconda Ponds, and Opportunity Ponds areas. All of these areas did not have prior potable water use, and these actions to restrict future use are considered preventive in nature.

6.0 SUMMARY OF SITE RISKS

6.1 SUMMARY OF HUMAN HEALTH RISK ASSESSMENTS

Baseline risk assessments provide the basis for taking action at a site and indicate the sources and exposure pathways to be addressed by remedial action. They indicate the potential baseline health risks if no action were taken at the site. Over the last 10 years, risks have been characterized for several OUs at the Anaconda Smelter Site:

Mill Creek OU: *Endangerment Assessment/Public Health Evaluation, Revised Final Report, Mill Creek OU.* October 2, 1987. Prepared by Clement Associates, Inc. for CDM Inc. for EPA.

Flue Dust OU: *Final Baseline Risk Assessment, Flue Dust OU.* November 15, 1990. Prepared by Life Systems, Inc. for Fluor Daniel, Inc. for EPA.

Community Soils OU: *Final Baseline Human Health Risk Assessment, Anaconda Smelter NPL Site, Anaconda Montana.* January 24, 1996. Prepared by CDM Federal Programs Corporation for EPA.

Old Works/East Anaconda Development Area OU: *Baseline Risk Assessment for the Old Works/East Anaconda Development Area.* August 19, 1993. Prepared by Life Systems, Inc. for Fluor Daniel, Inc. for EPA.

These risk assessments quantify risks to receptors within certain areas of the ARWW&S OU, including residents, commercial/industrial workers, and recreational visitors. However, risks have not been characterized for the entire ARWW&S OU, as data are relatively limited for some areas of the OU. Risk-based screening levels presented in the OW/EADA Risk Assessment (Life Systems 1993) and the Baseline HHRA (EPA 1996b) were selected for comparison to contaminant levels in site media (i.e., soils, waste, and ground water), when available, to determine the potential for risk. Risk-based screening levels calculated for earlier risk assessments (i.e., Flue Dust and Mill Creek Risk Assessments) were not used due to the availability of more current information regarding exposure parameters. Action levels were selected from the risk-based screening levels, and from Maximum Contaminant Levels (MCLs), non-zero Maximum Contaminant Level Goals (MCLGs), and State of Montana Numeric Water Quality Standards (Water Quality Bureau [WQB] standards), for comparison to site data to guide remedial activities.

The OW/EADA Risk Assessment (Life Systems 1993) developed risk-based screening levels for a future commercial/industrial worker exposed to contaminants in tailings and waste material and ground water at the OW/EADA OU. The OW/EADA Risk Assessment also developed risk-based screening levels for a dirt-bike rider (maximally-exposed recreational visitor) exposed to contaminants in tailings and waste material; the risk-based screening levels presented in this risk assessment are applicable to waste areas and ground water within the ARWW&S OU.

The Baseline HHRA for the Anaconda Smelter Site (EPA 1996b) calculated risk-based screening levels for residents, commercial/industrial workers, agricultural workers, and dirt bike riders exposed to soils within the Community Soils OU contaminated by historical deposition of aerial emissions from the Anaconda Smelter. Because the Community Soils OU is located within the ARWW&S OU geographic area and shares one of the primary sources of contamination (i.e., soils contaminated by deposition of historical aerial emissions from the smelter), the risk-based screening levels presented in the Anaconda Smelter Site HHRA are applicable to soils of the ARWW&S OU contaminated by historical smelter emissions. This section of the ROD summarizes the assumptions used to develop the risk-based screening levels presented in the OW/EADA Risk Assessment and Anaconda Smelter Site HHRA and describes the action levels selected from these screening levels for application across the ARWW&S OU.

Chemicals of Potential Concern

Although mining, milling, and smelting wastes contain a number of metals, experience at other mining and smelting sites and from previous Anaconda risk assessments (i.e., Mill Creek, Flue Dust, OW/EADA) has shown that risks to humans and the environment at these sites are dominated by the presence of arsenic, cadmium, copper, lead, and zinc in soils and waste. Although other metals may contribute to risk, their relative contribution to total risk is believed to be insignificant compared to risks from the primary COCs.

Three primary sources of contamination are generally present at ARWW&S OU: soils impacted by historic aerial emission deposition, tailings/waste piles, and contaminated ground water. The Anaconda Smelter Site HHRA evaluated the concentrations of arsenic, cadmium, copper, lead, and zinc in soils impacted by historic smelter emissions. Soil concentrations of cadmium, copper, and zinc were less than risk-based screening levels; as a result, these chemicals were eliminated as COCs. The COCs selected for soils of the Anaconda Smelter Site were, therefore, arsenic and lead. For the OW/EADA Risk Assessment, COCs for waste piles/tailings and ground water consisted of arsenic, cadmium, copper, lead, and zinc. Risk characterization information presented in the risk assessments for the Anaconda Smelter Site and the OW/EADA OU indicates that arsenic is the primary chemical associated with human health risk in the ARWW&S OU.

Potentially Exposed Populations

As discussed in the Anaconda Smelter Site HHRA and the OW/EADA Risk Assessment, land within the ARWW&S OU is used for a variety of purposes, including residences, commerce, agriculture, and recreation. Undeveloped land is also present in the OU which could be used in the future for recreational, commercial, residential, or agricultural purposes. Lands that are currently used for agricultural purposes could be developed for other uses, such as residential development. Additionally, certain areas of the site are not, at present, readily accessible to the public due to remoteness or steepness of slopes. It is likely that trespassers would be the only receptors in these areas. Although trespassers were not included in either of the risk assessments as receptors of concern, comments by ARCO (ARCO 1997c) prompted preparation of a technical memorandum (CDM Federal 1998 - also see Appendix I of EPA's Responsiveness Summary) presenting exposure pathways, exposure assumptions, and risk-based screening levels for trespassers.

Based on current and reasonably anticipated future land uses, the following populations are considered most likely to be exposed to COCs at the ARWW&S OU:

- Current and future residents;
- Agricultural workers;
- Recreational users;
- Commercial workers; and
- Trespassers.

Existing current land uses within the ARWW&S OU are shown on Figure 5-2.

Identification of Exposure Pathways

The two primary sources of contamination within the ARWW&S OU are soils impacted by historic air emissions from the Old Works and Anaconda Smelter stacks, and tailings and other wastes remaining from the smelting processes. Historical smelting activities resulted in widespread, aerial deposition of fugitive dusts and contaminants released from stacks, resulting in contamination of soils in the ARWW&S OU. Materials released from the smelter stacks were small particulates not captured by emission controls in place. In general, contaminant concentrations in soil decrease with increasing distance from the smelter.

Historic smelter activities resulted in large volumes of waste materials. Waste source areas in the ARWW&S OU include Anaconda and Opportunity Tailings Ponds and the disturbed area of Smelter Hill. Anaconda and Opportunity Tailings Ponds were constructed to contain mill tailings and wastes. Waste piles and slag are also present at Smelter Hill.

The primary release mechanism for tailings and slag is wind erosion, although release to ground water via infiltration/percolation and to soils and surface water via runoff also occurs. Contamination in air emissions is transported via dry or wet deposition from the air into three secondary sources: soil, surface water, and sediment. Transport of contaminants also occurs among secondary sources.

Site conceptual models presented in the OW/EADA Risk Assessment and the Anaconda Smelter Site HHRA show primary sources of contamination, release and transport pathways, contaminated media, and exposure pathways to receptors of concern. Exposure pathways to receptors of concern consist of:

- Residents (adults and children aged 0 to 6 years)
    - Ingestion of surface soils and wastes
    - Ingestion of interior dust
    - Ingestion of ground water

- Agricultural Workers (adults)
    - Ingestion of surface soils
    - Ingestion of dust

- Recreational Users (dirt bike riders)
  - Ingestion of surface soils and wastes
  - Inhalation of dust

- Recreational Visitors (swimmers)
  - Ingestion of surface water
  - Dermal exposure to surface water

- Commercial Workers (adults)
  - Ingestion of surface soils and wastes
  - Ingestion of interior dust
  - Ingestion of ground water

- Trespassers (adults)
  - Ingestion of surface soils

As shown above, all receptors except agricultural workers and trespassers are assumed to be exposed to both soils and wastes. It is unlikely that crops would be grown on waste piles or in areas where waste piles are present; therefore, agricultural worker exposure to waste piles was not evaluated. As described in the technical memorandum regarding trespassers (CDM Federal 1998 - see Appendix I of EPA's Responsiveness Summary), the trespasser exposure scenario is pertinent only to areas where access would not be convenient due to the remote nature of the area or steep slopes. Trespasser exposure to waste piles is not evaluated, but rather is addressed by the recreational scenario.

Human Exposure Assumptions

In general, it is expected that different people living or working in an area may have different levels of contact with various contaminated media, resulting in different levels of exposure. Therefore, it is appropriate to think of exposure of a population as a range or distribution of values, rather than as a single value. In order to account for this, EPA calculates exposure both for an average person, and for someone at the upper end of the distribution (approximately the 95th percentile). The average exposure is termed Central Tendency Exposure (CTE), while the latter is termed the Reasonable Maximum Exposure (RME). Both estimates are useful in understanding exposures and risks that can exist at a site.

Risk-based screening levels were developed based on estimates of chemical toxicity and exposure assumptions for receptors and exposure pathways of concern. Tables 6-1, 6-2, and 6-3 list exposure assumptions used in the Anaconda Smelter Site HHRA, the OW/EADA Risk Assessment , and the trespasser technical memorandum (CDM Federal 1998), respectively, to calculate CTE and/or RME screening levels for the receptors and exposure pathways of concern at the site. Some of these values are reasonably well established default values (e.g., body weight, exposure frequency of workers), while other values are based on site-specific data (e.g., soil ingestion, arsenic bioavailability) or professional judgment.

The arsenic bioavailability factor (BAF) is site-specific to the source of contamination based on metal speciation. A site-specific arsenic BAF of 18.3% is presented in the Anaconda Smelter HHRA for the Community Soils OU; this arsenic BAF is specific to soils impacted by historic aerial smelter emissions, and is applicable to areas of the ARWW&S OU where there are similar types of arsenic contamination (i.e., aerially-deposited arsenic with a spectrum of arsenic phases similar to those of the Community Soils OU). The OW/EADA Risk Assessment used an arsenic BAF of 50% for tailings and waste material based on a study of arsenic absorption from soil of Teresa Ann Terrace. Due to physical and chemical differences between arsenic in soil and wastes (i.e., grain size, arsenic speciation), the OW/EADA arsenic BAF of 50% is used as the BAF for arsenic for wastes in the ARWW&S OU. Arsenic in ground water is assumed to be 100% bioavailable. Bioavailability information is not available for other COCs.

Exposure Point Concentrations

An exposure point is an area within a site where humans are expected to come into contact with one or more contaminated media. Typically, the boundaries of an exposure point are selected to represent an area over which exposure of an individual is expected to be approximately random. Based on this, the exposure point concentration for a chemical is defined as the upper 95th confidence limit of the arithmetic mean of the measured values for that chemical within the exposure area (calculated based on the assumption of log normal distribution of measured values).

Although exposure areas for the ARWW&S OU have not been previously defined, the land use areas presented in Figure 5-2 are appropriate for use as exposure areas. Existing data for the ARWW&S OU were too limited to calculate exposure point concentrations by area, therefore, a regional kriging effort was conducted to estimate arsenic soil concentrations. Other chemical concentrations were also estimated in the kriging effort, which used a kriged block size of 70 acres (3,033 total blocks). Estimated average arsenic concentrations in the regional kriged blocks range from 29 ppm in outlying areas to 1,856 ppm in the undisturbed portion of Smelter Hill. Thirty-two blocks exceeded an average kriged arsenic value of 1,000 ppm with the highest blocks found in the rural areas between the Anaconda and Opportunity Tailings ponds and on Smelter Hill (Figure 6-1; areas indicated as "high arsenic soils").

Quantification of Risks

As discussed above, risks were previously quantified for the OW/EADA OU and the Community Soils OU in the OW/EADA Risk Assessment and the Anaconda Smelter Site HHRA, respectively. Because risk characterizations indicate that arsenic is the primary risk driver, only arsenic risk-based screening levels are discussed herein.

Risk-based screening levels presented in the Anaconda Smelter Site HHRA for residents, commercial/industrial workers, agricultural workers, and dirt bike riders exposed to arsenic in aerially-contaminated soils are shown in Table 6-4; these screening levels are applicable to soils of the ARWW&S OU contaminated by historic smelter emissions. Risk-based screening levels presented in the OW/EADA HHRA for a commercial/industrial worker exposed to arsenic in tailings, waste piles, and ground water and for a dirt-bike rider exposed to arsenic in tailings, waste piles, and fugitive dusts are shown in Table 6-5; these screening levels are applicable to waste areas and ground water within the ARWW&S OU. Arsenic risk-based screening levels for the trespasser scenario, presented in a technical memorandum (CDM Federal 1998 - see Appendix I of EPA's Responsiveness Summary) are applicable to soils of the ARWW&S OU and are presented in Table 6-6.

Based on average kriged values of arsenic in soils, the reasonably anticipated land use, and risk-based screening levels, it appears that most areas of the site are generally within EPA's targeted risk range of 1E-04 to 1E-06, but greater than EPA's point of departure for evaluating remedial actions. EPA considers a risk of 1E-06 as the point of departure. Exceptions include some agricultural lands and the Smelter Hill facility area which exceed the targeted risk range for particular land uses. In addition, most waste source areas (i.e., Anaconda and Opportunity Tailings Ponds) are also within EPA's targeted risk range but are greater than EPA's point of departure.

Results of the OW/EADA Risk Assessment indicate that arsenic concentrations in some ground water wells may exceed risk-based screening levels and/or MCLs. The Anaconda Smelter Site HHRA evaluated residential exposure to community drinking water; sources of drinking water were generally not from wells impacted by contaminants in the ARWW&S OU and, therefore, ground water risks are unlikely to reflect those associated with potential exposure to contaminated ground water of the ARWW&S OU.

Analysis of Uncertainties

Risk-based screening levels are calculated using site-specific information, national default assumptions, toxicology literature, and professional judgement. There are uncertainties associated with all of these sources, and hence, there is uncertainty in calculated screening levels. However, the calculated screening levels are based on detailed site-specific studies, including arsenic exposure, bioavailability, and soil ingestion studies, conducted in Anaconda that significantly reduce the uncertainty of the calculated value.

Action Levels

Action levels are chemical concentrations which are compared to site data to govern remedial actions. The values are selected based on technical and risk management considerations. Action levels for the ARWW&S OU were selected for recreational, agricultural, commercial/industrial, trespasser, and residential scenarios for surface soil, wastes, ground water, and surface water. Values were selected from risk-based screening levels, MCLs, non-zero MCLGs, and the State of Montana Numeric Water Quality Standards.

Surface Soil and Wastes

As discussed above, individual hotspots within the ARWW&S OU may pose an unacceptable risk. Additionally, estimates of risk are uncertain for areas with few data points. Action levels are necessary for evaluation of hotspots and soil data collected in future sampling events. EPA has developed action levels for surface soil and wastes for the targeted cancer risk range of 1E-04 to 1E-06. Arsenic action levels were selected from the risk-based screening levels for comparison to arsenic concentrations in soils and waste to determine the potential for risk. The action levels, selected based on technical and risk management considerations, are as follows:

Land Use Designation	Media	Concentration	Risk
Residential	Soil and Waste	250 ppm	8E-05
Commercial/Industrial	Soil and Waste	500 ppm	4E-05
Recreational	Soil and Waste	1,000 ppm	4E-05
Agricultural	Soil only	1,000 ppm	1E-04
Steep Slope/Open Space	Soil only	2,500 ppm	1E-05

Ground Water

Action levels for metals in ground water are based on the State of Montana Circular WQB-7 Standard:

Chemical	WQB-7 Standard*
Arsenic	**18 µg/L**
Beryllium	4 µg/L
Cadmium	5 µg/L
Copper	**1,000 µg/L**
Lead	15 µg/L
Zinc	5,000 µg/L

*Levels which are more stringent than Federal Safe Drinking Water Act MCLs and non-zero MCLGs are identified in bold. WQB-7 standards for metals in ground water are based on the dissolved metals portion of the sample.

Surface Water

Surface water action levels are based on the State of Montana B-1 classification:

Chemical	WQB-7 Standard
Arsenic	18 µg/L
Cadmium*	1.1 µg/L
Copper*	12 µg/L
Lead*	3.2 µg/L
Zinc*	110 µg/L

*Assume a hardness ($CaCO_3$) of 100 milligrams per liter. WQB-7 standards for metals in surface water are based on total recoverable metals in the sample.

6.2 SUMMARY OF ECOLOGICAL RISK ASSESSMENTS

Baseline Ecological Risk Assessment Process

The ecological risk documentation developed for the Anaconda Smelter NPL Site provides an estimation of the potential health risks to plant and animal receptors from exposure to arsenic and metals. This documentation identifies the relative degree of ecological risk for areas of the site and allows the risk managers to select appropriate remedial alternatives and to prioritize areas for alternative implementation.

The assessment of ecological risks at the Anaconda Smelter NPL Site was a three-step process. In the first step, the *Phase I Screening-Level Ecological Assessment* compared arsenic and metal concentrations in soil, sediment, and surface water to conservative benchmark values to identify areas that may pose a potential risk to site receptors. The *Preliminary Baseline Ecological Risk Assessment,* which was the second step, provided a risk characterization and identified data gaps. Following the preparation of that document, a technical memorandum was prepared called the "PBERA Supplement" that expanded on the risk characterization by incorporating additional environmental and risk-related information. The *Final Baseline Ecological Risk Assessment* (Final BERA - EPA 1997a), prepared October 1997, represented the final step in the ecological risk assessment process for purposes of the Anaconda Smelter NPL Site ROD. The Final BERA is a synthesis of data and information contained in the aforementioned documents and provides summaries of all previously published ecological data and information for the site that are relevant to assessing ecological risk.

The Final BERA is based on guidance for ecological risk assessment provided by EPA. This guidance consists of a framework for performing ecological risk assessment, methods for designing and conducting ecological risk assessments, and a reference guide for choosing and conducting field and laboratory activities at hazardous waste sites. As described in EPA guidance for conducting ecological assessments at hazardous waste sites, three types of information are needed to establish a firm, causal relationship between toxic wastes and ecological effects:

1. Chemical analyses of media (i.e., soil, sediment, surface water) to establish the presence, concentrations, and variabilities of site-specific chemicals of concern (COCs);

2. Ecological surveys to evaluate whether adverse ecological effects have occurred; and

3. Toxicity tests to establish a comparison between the adverse ecological effects and the chemistry and toxicity of the wastes

Existing site-specific and regional data and reports were reviewed to determine if representative media, ecological, and toxicological information exists for the site. The initial data review identified specific reports and studies that could be used to meet the objectives of the Anaconda Smelter NPL Site BERA, and helped identify areas of uncertainty or potential data gaps. This information was presented in the *Final Phase I Screening-Level Ecological Assessment* and the *Final Preliminary Baseline Ecological Risk Assessment.* The critical data gaps were filled using data collected by EPA in 1995 and the reassessment of all usable soil, water, and vegetation data. The following is a summary of the Final BERA.

Ecological Receptors

The Anaconda Smelter Site covers nearly 100 square miles, and contains a wide array of habitat types including agricultural areas, grasslands, shrublands, forests, riparian corridors, streams, and wetland areas. Potential ecological receptors at the Anaconda Smelter Site include plants and animals that are known or expected to inhabit the site. Field surveys conducted throughout the site over the past several years have shown that certain animals utilize all suitable habitats, and are also sporadically observed in barren areas and in WMAs, such as Opportunity Tailings Ponds. Other surveys have identified areas of stressed vegetation and barren areas, as well as shifts in plant community structure in response to environmental stressors. Wildlife receptors selected for evaluation in the food chain analysis (see the Final BERA and ROD Appendix B) are Deer Mouse, American Robin, White-tailed Deer, Red Fox, and Kestrel. These receptors represent primary herbivores, herbivorous and insectivorous birds, grazing herbivores, mammalian carnivores, and carnivorous birds, respectively.

A study of wetlands and threatened and endangered species at the Anaconda Smelter Site (EA 1994) indicates that no federally-listed threatened or endangered plant species occur at the site. However, of the 336 state-identified plant species of special concern, 120 potentially occur in southwestern Montana. Of these 120, 23 have been previously reported in Silver Bow and Deer Lodge Counties, and 11 could potentially occur in the types of habitats found at the Anaconda Smelter Site.

For wildlife species, a total of 20 State species of special concern have been reported to occur in Deer Lodge and Silver Bow Counties, and 12 of these may occur at the Anaconda Smelter Site, based on general habitat characteristics (EA 1994). Two of these 12 species, the Bald Eagle and the Peregrine Falcon, are federally listed as endangered. In addition, the Gray Wolf is also Federally listed as endangered and the Bull Trout is listed as threatened (USDI/FWS 1997). The area potentially used by the Yellowstone and Bitterroot Gray Wolf experimental populations include the Anaconda Smelter Site. Currently, the Gray Wolf is known to inhabit the mountains east of the Anaconda Smelter Site and the Bull Trout can be found in the upper reaches of Warm Springs Creek (Olsen 1997). In the final BERA, the evaluation of potential risks to the Kestrel is used as a surrogate for evaluating potential risks to the Bald Eagle and Peregrine Falcon; the Red Fox is used as the surrogate for the Gray Wolf.

Waste, Soil, and Background Soil Concentrations

Tables 6-7 and 6-8 provide summaries of arsenic and metal concentrations in waste, mixed waste, and soils at the ARWW&S OU. Comparing the data in these tables to regional background data (Table 6-9) indicate that waste and soils at this OU are elevated relative to uncontaminated soil.

Vegetation Risks

Potential risks to vegetation were assessed using several lines of evidence including historical indicators of areas having stressed vegetation, results of laboratory phytotoxicity tests using site soils, phytotoxicity benchmark values, and site-specific vegetation surveys. This information was used in a weight-of-evidence approach to identify portions of the site likely to experience risk to vegetation.

Predictive and Potential Risks to Vegetation

To give risk managers an indication of the range of potential risks to vegetation, low and high phytotoxicity benchmarks, or effects concentrations (ECs), were developed for use in estimating risks. The low and high ECs (Table 6-10) were developed for both acidic (i.e., pH<6.5) and basic (i.e., pH>6.5) soil conditions. The low and high phytotoxicity ECs were compared to surface soil arsenic and metals concentrations that were estimated across the site using a 70-acre grid. Using the low phytotoxicity ECs (i.e., the more conservative benchmark values), a large portion of the OU presents a potential risk to vegetation (46,749 acres, or 92% of total acreage) (CDM Federal 1997b). That is, within the area delineated by the low phytotoxicity lines, one or more of the COCs have a surface soil concentration that has the potential to adversely affect plant growth and community structure (Zone 1 - Table 6-11). Generally, risks decrease from relatively high hazard indices close to the smelter complex, to relatively lower values predicted as the distance from the smelter increases. Similarly, high phytotoxic ECs were exceeded in areas nearest the smelter for at least one of the metals. The area of exceedance of the high ECs (Zone 2), although smaller in size relative to the areas exceeding the lower phytotoxic ECs, still encompasses approximately 37,000 acres (or 73% of total acreage). The total acreage where arsenic, cadmium, copper, and lead exceed the low and high phytotoxic ECs are 18, 693 (37% of total), and 155 (4% of total), respectively. These are areas in which all metals concurrently exceed respective ECs (Zones 3 and 4), as compared with Zones 1 and 2, in which at least one (or more) exceeded the ECs.

EPA Site Investigations

In addition to comparisons of low and high phytotoxicity ECs to kriged estimates of metal soil concentrations, EPA collected field data (CDM 1995; hereafter referred to as the EPA 1995 Survey) within several Vegetation Areas (VAs) to further assess potential risks to vegetation.

During this exercise, EPA recognized that physical-chemical properties of the soil (e.g., pH, organic matter content, moisture availability, etc.) and varying physiography (including slope angle, aspect, and position) may act as co-factors in determining the degree of phytotoxicity in a given location. The EPA 1995 Survey focused on the collection of data related to these co-factors.

Because of the numerous interacting factors that may preclude a clear concentration-response relationship between vegetative stress and arsenic and metal concentrations in the soil, a semi-quantitative/qualitative Comprehensive Plant Stress Analysis model (CPSA) was developed to address these co-factors. This analysis included a comparison of the existing vegetation at the Site to the vegetation that would be expected to occur under climax vegetation conditions, and to the vegetation that currently exists in German Gulch (which has been used as a reference area). The CPSA did not rely on any one piece of evidence, such as phytotoxicity ECs, to delineate areas of risk to the vegetation. Rather, the CPSA used the phytotoxicity EC values along with other environmental factors in a weight-of-evidence manner to identify areas where smelter and ore processing wastes may significantly contribute to plant stress. Results of this holistic analysis indicate that the vegetation in certain areas of the site are at risk due primarily to elevated concentrations of COCs in the soil, while in other areas of the site, soil COC content is one of several factors that may be contributing to plant stress.

The 1995 EPA Survey also used aerial photographs and satellite infrared images to verify areas of barren, or only sparsely vegetated areas, and areas having high vegetation coverage. Based on this evaluation, approximately 4,830 acres of the site are barren or sparsely vegetated and 8,110 acres have very poor plant growth or community condition. Most of this area is adjacent to the historic smelting complex and are, therefore, consistent with areas identified through the kriging/EC analysis as posing phytotoxic risk. This delineated area is also consistent with areas identified historically as having stressed vegetation (Olson-Elliot 1975) in spite of the fact that emissions of sulfur dioxide (which could have been the original predominant vegetative stressor) have not occurred in the last 15 years. Additionally, in the Responsiveness Summary section of this document, analyses are described characterizing the lingering chemical influence of sulfur dioxide fumigation: pH. In the analysis, a dose-response relationship between phytotoxicity scores of plant species in the laboratory (Kaputska 1995) exposed to site soils was used to define the relationships between pH, total metals and phytotoxic endpoints of vegetation. This site-specific, laboratory-derived toxicity curve was then compared to the data collected in the 1995 EPA Survey. The results of this analysis supported the findings of both the kriging/EC analysis and the CPSA model.

The weight-of-evidence, therefore, using multiple lines of evidence consistently suggests that arsenic and metal soil concentrations have a high potential for continuing phytotoxic effects in some areas of the site.

Land Reclamation Evaluation System (LRES)

Since the 1995 EPA Survey was not particularly designed to delineate areas of remediation, but rather to address mitigating or confounding co-factors of phytotoxicity, the LRES was designed as a tool to help the remedial decision makers decide what types of remedial actions should be applied in various areas of the site. The LRES is used to collect the information needed to make the most stringent risk management decisions based on phytotoxic risk. The LRES was applied in the field during 1998 to help identify the most efficient and cost effective means of remedial action based on several attributes of the soil and the plant communities. During Remedial Design, the LRES process will also consider important remedial factors, such as land use, land ownership, and accessability, to tailor specific remedies.

Wildlife Risks

Potential risks to wildlife were assessed by three lines of evidence: 1) using a predictive food chain model to estimate exposures to wildlife receptors and comparing the exposures with extrapolated Toxicity Reference Values (TRVs) based on dietary intake; 2) comparing measured vegetation tissue concentrations to extrapolated dietary TRVs to herbivores; and 3) comparing surface water arsenic and metal concentrations to extrapolated drinking water TRVs to evaluate potential exposures to wildlife through the ingestion of contaminated drinking water.

Predictive and Potential Risks

Potential exposures and risks to wildlife receptors were evaluated using a simple food chain model in combination with geographic information systems (GIS) maps (see Appendix B). Predicted risks were estimated by comparing the exposure (i.e., estimated daily dose) to an extrapolated-from-literature TRV (dose-based in mg/kg/day) to derive a hazard quotient (HQ = estimated dose/TRV) for each COC-receptor combination. The range of TRVs for each COC included both a no-observable-adverse-effect-level (NOAEL) and a lowest-observable-adverse-effect-level (LOAEL). NOAEL TRVs represent extrapolated doses in which no effect from the predicted exposure is anticipated to occur. LOAEL TRVs represent extrapolated doses in which effects from the predicted exposures in at least some of the individuals in a population are potentially occurring. Since ecological risk assessment is focused on protection at the population level, predicted exposures greater than the LOAEL are most concern (i.e. $HQ_{LOAEL} > 1$). For each receptor, HQs were summed for all chemicals to derive a Hazard Index ($HI = HQ_{As} + HQ_{Cd} + HQ_{Cu} + HQ_{Pb} + HQ_{Zn}$) and illustrated for each receptor on GIS maps of the site in four different forms: 1) Site HI_{NOAEL} / Reference HI_{NOAEL}; 2) Site HI_{LOAEL} / Reference HI_{LOAEL}; 3) Site HI_{NOAEL} - Reference HI_{NOAEL} ; 4) Site HI_{LOAEL} - Reference HI_{LOAEL}. The first two forms of predicted risk are expressions of *relative risk*. The last two forms of predicted risk are expressions of *absolute risk*.

Both expressions of the predictive assessment illustrated elevated risk for all receptors (American robin, American kestrel, deer mouse, red fox and white-tailed deer) related to estimated COC exposure. Predicted absolute hazard indices for mammalian carnivores (using red fox as a model and LOAEL-based TRVs) are driven by lead concentrations in small mammals. Omnivorous small mammals (deer mouse as model) and insectivorous passerines (American robin as model) had the next highest hazard indices with small mammals primarily exposed to arsenic in terrestrial invertebrates and American robins exposed to approximately equally deleterious doses of copper, lead, and arsenic mainly in terrestrial invertebrates. Omnivorous/carnivorous avian species (American kestrel used as the model) had elevated hazard indices primarily from lead concentrations in small mammals. Finally, large herbivorous mammals (white-tailed deer used as the model) had elevated hazard indices principally from arsenic and cadmium concentrations in vegetation. Generally, the principle COCs for wildlife receptors were predicted to be arsenic, lead and copper (in no particular order of importance). Similar to vegetative risks, hazard indices decreased with increasing distance from the smelter: Smelter Hill > North Opportunity > Old Works/Stucky Ridge > South Opportunity Subarea.

Risks to White-Tailed Deer from Consumption of Contaminated Vegetation Tissue

From vegetation samples collected during the 1995 EPA survey, approximately 33% of the plant tissue samples had COC concentrations greater than the white-tailed deer NOAEL for forage, and about 20% of the plant tissue samples had COC concentrations that exceeded the LOAEL for forage (Table 6-12). Exceedances of the white-tailed deer NOAEL and LOAEL occurred in samples from all of the VAs studied, except VA24 which was in the northernmost part of the site. Among the COCs, arsenic presented the most frequent and greatest risk from ingestion

(94% of the samples, 15 of 16 had concentrations above the NOAEL). Arsenic was followed by copper (69% of the VAs), zinc (44% of the VAs), cadmium (38% of the VAs), and lead (6% of the VAs). Furthermore, the data indicate that most of the LOAEL exceedances (i.e., where the COC exceeded its LOAEL by more than two times) occurred in VAs adjacent to waste management areas (WMAs) with uncovered tailing present. This suggests that fugitive dust from these uncontrolled areas elevated potential exposures to this receptor, indicating an important release mechanism of the these contaminants that was not adequately addressed in the modeled uptake of these contaminants. It further suggests that predicted risks from the food chain models may be underestimated in VAs with similar circumstances.

Risks to Wildlife Receptors from Ingestion of Contaminated Surface Water

Exceedances of drinking water TRVs indicate that some receptors are at "potential" risk (drinking water data concentrations are between the NOAEL and the LOAEL) or even "likely" risk (data > the LOAEL) from some water bodies on the site (Table 6-13). Most of these water bodies are in association with seep and spring water on Smelter Hill. Of the 47 exceedances detected, 79% (37) occurred for seeps and springs on Smelter Hill and in the hills south of Smelter Hill. Wildlife risks from drinking seep/spring water is related to both primary and secondary consumers (deer mice and red fox respectively). Other areas of potential concern include the Blue Lagoon with average Cu concentrations 6 fold higher than the deer mouse LOAEL. Results from surface water sampling stations located along creeks of the Site indicated minimal risk to wildlife. Wildlife risks from drinking water and forage at the ARWW&S OU are summarized in Table 6-14.

Aquatic Risks

Four streams and a network of drainage and irrigation ditches occur within the Anaconda Smelter NPL Site that compose the extent of aquatic habitat at the Site. The four perennial streams are Warm Springs Creek, Mill Creek, Willow Creek, and Lost Creek. A drainage ditch network in the area surrounding the Opportunity Ponds, and diversion ditches for irrigation of cropland on Warm Springs Creek (Gardiner Ditch) and Willow Creek (Yellow Ditch and Old Lime Ditch) constitute the remaining portions of the aquatic habitat at the Site considered in the BERA. The primary aquatic receptors evaluated were fish and benthic macroinvertebrates.

Predictive and Potential Risks

Potential risk to aquatic receptors were identified based on a comparison of COC concentrations in surface water and sediment with ECs in both matrices. Acute and chronic Ambient Water Quality Criteria (AWQC) for both total recoverable and dissolved metals, and literature values for bulk sediment (Ingersol et al. 1995) concentrations were used as the ECs for surface water and sediment respectively. In addition to AWQC values, site-specific data collected by ARCO (ENSR 1996) were also used to develop surface water ECs. Chronic and acute site-specific measures for total recoverable and dissolved copper were used to derive a water effects ratio (WER) that ARCO believes would account for specific surface water characteristics at the site. ARCO believes that these may reduce the toxicity from copper. The use of ECs derived from national criteria as well as from site-specific data, and the evaluation of potential risks from total recoverable and dissolved metals were used in the BERA as additional lines of evidence and to give the risk manager an awareness of the range of potential impacts to aquatic life. This range is encompassed with comparisons of total recoverable surface water metal concentrations to chronic AWQCs being the most conservative predictor of risk, and comparisons of dissolved surface water metal concentrations to site-specific toxicity test derived thresholds being the most liberal. However, since fish may be exposed through multiple pathways, which include dietary exposure to benthic invertebrates for which no analytical data are currently available, comparison of site-specific thresholds were not emphasized as these suggested values only account for respiratory exposure to the gills of fish. A summary of the conclusions for the risk analyses described above are discussed briefly below and are summarized in Table 6-15. Stream reaches posing a potential risk are shown in Figure 6-2.

Total Recoverable Method - Chronic Exposure

A comparison of exposure data with chronic and acute AWQC for total recoverable COCs in surface water indicate that potential risks to aquatic receptors from exposures to elevated levels of COCs in the water column are relatively widespread at the ARWW&S OU. Based on total recoverable COCs in the water column, copper and lead are the COCs that present the most frequent risks to aquatic receptors at the ARWW&S OU. Chronic exposures of total recoverable copper in the water column pose a potential risk to aquatic receptors in a portion of the lower stream reach of Warm Springs Creek at the ARWW&S OU, throughout most of Mill Creek, portions of Willow Creek, Cabbage Gulch, the Yellow Ditch, South Ditch, and wetlands located outside the east boundary of the Opportunity Ponds D-2 Cell. Low-level concentrations of total recoverable lead appear to pose a risk to aquatic receptors from chronic exposures in the water column in portions of Warm Springs Creek, including the lower segment of Warm Springs Creek in the Old Works area and the steam's lower reach at the ARWW&S OU; the lower stream reach of Mill Creek; segments of Willow Creek; and the Gardiner Ditch.

Other potential risks to aquatic receptors are identified at the ARWW&S OU from chronic exposures of low-level concentrations of total recoverable cadmium, and elevated levels of arsenic and zinc in the water column. Potential risks to aquatic receptors from chronic exposures of total recoverable cadmium are limited to the upper-most reach of Mill Creek and the wetland located outside the Opportunity Ponds D-2 Cell; potential risks from chronic exposures to total recoverable arsenic are limited to the water column of Cabbage Gulch; and risks from chronic exposures of total recoverable zinc are identified in the wetlands located outside the east boundary of the D-2 Cell and in the water column of the decant ditch serving the Opportunity Ponds D-2 Cell.

Site-Specific Method for Total Recoverable Copper - Chronic Exposures

Potential risks to aquatic receptors from chronic exposures to total recoverable copper in the water column are found in portions of the aquatic habitat surrounding the Opportunity Ponds when consideration of site-specific measures for total recoverable copper are used in the risk analysis. The habitat of concern includes portions of the South Ditch and wetlands located outside the boundary of the Opportunity Ponds D-2 Cell.

Total Recoverable Metals - Acute Exposure

Based on acute exposures to total recoverable COCs in the water column, copper presents the most frequent risk to aquatic receptors at the ARWW&S OU. Acute exposures to total recoverable copper in the water column pose a potential risk to aquatic receptors throughout most of Warm Springs Creek, Mill Creek, Willow Creek, Cabbage Gulch, a portion of the upper stream reach of Lost Creek, the Gardiner Ditch, the Yellow Ditch, and wetlands located outside the east boundary of the Opportunity Ponds D-2 Cell.

Other potential risks to aquatic receptors are identified at the ARWW&S OU from acute exposures to low-level concentrations of total recoverable cadmium, and elevated levels of zinc in the water column. Potential risks to aquatic receptors from acute exposures to total recoverable cadmium are identified in the upper stream reach of Mill Creek and Willow Creek. Potential risks from acute exposures to total recoverable zinc are identified in a portion of the lower stream reach of Warm Springs Creek, the lower stream reach of Willow Creek, the wetlands located outside the east boundary of the D-2 Cell, and in the water column of the decant ditch serving the Opportunity Ponds D-2 Cell.

Site-Specific Method for Total Recoverable Copper - Acute Exposures

Potential risks to aquatic receptors from acute exposures to total recoverable copper in the water column are found in the lower stream reach of Warm Springs Creek, the middle stream reach of Mill Creek located adjacent to the Smelter Hill OU, the lower stream reach of Willow Creek adjacent to a deposit of floodplain tailings, and the wetland located outside the boundary of the Opportunity Ponds D-2 Cell.

Dissolved Metals - Chronic Exposures

Based on an analysis of chronic exposures to dissolved COCs in the water column, copper presents the most frequent risk to aquatic receptors at the ARWW&S OU. Chronic exposures to dissolved copper in surface water pose a potential risk to aquatic receptors throughout most of Mill Creek, the lower stream reach of Willow Creek, and in the water column of wetlands located outside the east boundary of the Opportunity Ponds D-2 Cell.

Other potential risks to aquatic receptors are identified at the ARWW&S OU from chronic exposures to low-level concentrations of cadmium and lead, and elevated levels of dissolved arsenic and zinc in the water column. Potential risks to aquatic receptors from chronic exposures to dissolved cadmium are limited to the upper stream reach of Mill Creek and the segment of Willow Creek located downstream from the Blue Lagoon. Potential risks from chronic exposures to dissolved lead are limited to the Gardiner Ditch; potential risks from chronic exposures to dissolved arsenic are identified to the water column of Cabbage Gulch; and risks from chronic exposures to dissolved zinc are identified in the wetlands located outside the east boundary of the D-2 Cell.

MAP
1

Contact Region 8

Plate 1
Geological Map of TI Zones
At the ARWWS OU

MAP
2

Contact Region 8

Plate 2
Concentration of Arsenic (ug/L)
In Groundwater in TI Zones
At the ARWWS OU

MAP
3

Contact Region 8

Plate 3
Concentration of TDS (mg/L)
In Groundwater in TI Zones
At the ARWWS OU

MAP
4

Contact Region 8

Plate 4
Concentration of Sulfate (mg/L) In Groundwater in TI Zones At the ARWWS OU

MAP
5

Contact Region 8

Plate 5
Map of Land Ownership in TI Zones At the ARWWS OU

Site-Specific Method for Dissolved Copper - Chronic Exposures

Potential risks to aquatic receptors from chronic exposures to dissolved copper in the water column are found in a portion of the aquatic habitat surrounding the Opportunity Ponds when consideration of site-specific measures for dissolved copper are used in the risk analysis. In this analysis, the habitat of concern for chronic exposures to dissolved copper in the water column are restricted to the wetlands located outside the boundary of the Opportunity Ponds D-2 Cell.

Dissolved Metals - Acute Exposures

Based on acute exposures to dissolved COCs in the water column, copper presents the most frequent risk to aquatic receptors at the ARWW&S OU. Acute exposures to dissolved copper in the water column pose a potential risk to aquatic receptors in the middle segment of Mill Creek, portions of Willow Creek, and in the water column of wetlands located outside the east boundary of the Opportunity Ponds D-2 Cell.

Other potential risks to aquatic receptors are identified at the ARWW&S OU from acute exposures to low-level concentrations of dissolved cadmium and elevated levels of dissolved arsenic and zinc in the water column. Potential risks to aquatic receptors from acute exposures to dissolved cadmium are identified for the upper stream reach of Mill Creek and a portion of Willow Creek. Potential risks from acute exposures of dissolved arsenic are identified in the water column of Cabbage Gulch. Potential risks from acute exposures to dissolved zinc are identified in the water column of wetlands located outside the east boundary of the D-2 Cell.

Site-Specific Method for Dissolved Copper - Acute Exposures

Potential risks to aquatic receptors from acute exposures to dissolved copper in the water column are restricted to a portion of the middle stream reach of Mill Creek adjacent to the Smelter Hill OU, the lower stream reach of Willow Creek adjacent to a deposit of floodplain tailings, and the water column in the wetland located outside the boundary of the Opportunity Ponds D-2 Cell when acute site-specific measures for dissolved copper are considered.

Risk Characterization from Exposures to COCs in Sediment and Via the Food Chain

Two comparisons of exposure data with a range of sediment ECs are presented in this risk assessment to identify potential risks to aquatic receptors from direct exposures to COCs in sediment, and inferred exposures through the food chain. The first comparison focuses on ECs identified from the No Observable Adverse Effect Concentration (NOAEC) for COCs in sediment, while the second analysis uses the Low-Observable Adverse Effect Concentration (LOAEC). The combination of the two risk analyses provides a risk range to aquatic receptors from exposures to COCs in sediment and COCs potentially in the food chain.

Results from the two comparisons discussed above indicate that potential risks to aquatic receptors from exposures to elevated levels of COCs in sediment and the food chain exist throughout most of Warm Springs Creek and portions of the drainage ditch network surrounding the Opportunity Ponds.

NOAEC Method

Based on analytical results of sediment samples collected at the ARWW&S OU, arsenic is the most frequent COC observed in sediment at levels above the range of ECs for arsenic in sediment. Based on a comparison of concentrations of arsenic in sediment with the NOAEC for arsenic, elevated levels of arsenic in sediment, and potentially the food chain, pose a potential risk to aquatic receptors throughout most of Warm Springs Creek, the North Drain Ditch, and decant ditches located outside the boundary of the Opportunity Ponds D-1 and D-2 Cells. In addition, elevated levels of arsenic are postulated to pose a potential risk to aquatic receptors in the Gardiner Ditch since the Gardiner Ditch diverts flow (and sediment) from Warm Springs Creek at a diversion point located a short distance downstream of the Old Works area. Furthermore, conclusions of this risk analysis indicate elevated levels of cadmium in sediment pose a potential risk to some aquatic receptors in the North Drain Ditch and decant ditches of the Opportunity Ponds; elevated levels of copper pose a potential risk to receptors in portions of Warm Springs Creek, the Gardiner Ditch, the North Ditch, and the decant ditches of the Opportunity Ponds; and elevated levels of lead and zinc pose a potential risk to aquatic receptors in a portion of Warm Springs Creek, the Gardiner Ditch, and decant ditches of the Opportunity Ponds.

LOAEC Method

Conclusions from this risk analysis indicate that elevated levels of arsenic in sediment pose a potential risk to aquatic receptors in the stream reach of Warm Springs Creek located downstream from wastes in the Old Works area including portions of the Gardiner Ditch, and in the decant ditches located outside the boundary of the Opportunity Ponds D-1 and D-2 Cells. Elevated levels of cadmium, copper, lead, and zinc pose a potential risk to aquatic receptors in decant ditches at the Opportunity Ponds.

Results of Macroinvertebrate Surveys

Macroinvertebrate surveys were conducted in August 1995 at two monitoring stations located on Warm Springs Creek, Mill Creek, and Willow Creek. Additional surveys were conducted at a monitoring station located on the lower reach of Warm Springs Creek prior to 1995. Results from these surveys indicate an adverse impact to the benthic macroinvertebrate community in the lower stream reach of Warm Springs Creek and Mill Creek, and in the upper and lower stream reach of Willow Creek from exposures to elevated levels of metals. Conclusions from the surveys are generally consistent with risk analyses formulated from comparisons of exposure data to surface water and sediment ECs. However, inconsistencies in the conclusions of macroinvertebrate surveys conducted in the upper stream reach of Warm Springs Creek and Mill Creek with results of risk analyses based on exposure data have been identified. These inconsistencies may suggest that results from a single macroinvertebrate survey at stations located on Warm Springs Creek, Mill Creek, and Willow Creek may not yield the data required to confirm or refute results of a risk analysis that is based on ECs and exposure data. It should be noted that macroinvertebrate surveys were not conducted for Lost Creek, the drainage ditch network surrounding the Opportunity Ponds, or for the irrigation diversion ditches.

De-Watering Effects

Although not subject to CERCLA authority, de-watering of some streams at the site can degrade habitat conditions and thereby pose a temporary risk to some aquatic receptors. For instance, diversion of flow from Warm Springs Creek to the Gardiner Ditch may reduce downstream flow rates below minimum flow requirements deemed by the Department of Natural Resources and Conservation to sustain optimal conditions for food production, bank cover, and spawning and rearing habitat for fish. In addition, diversion of flow from multiple points on Mill Creek may create severe de-watering in large segments of Mill Creek at the ARWW&S OU, and the diversion of flow from Willow Creek to the Yellow Ditch has eliminated a portion of the aquatic habitat of the stream reach at the site. Finally, diversion of flow (approximately 25 cubic feet per second) from Lost Creek to the Beckstead Ditch can temporarily reduce flow in that stream's lower reach to rates below those required to sustain optimal spawning and rearing habitat for fish. ARCO has recently purchased irrigation water rights to be used as in-stream flows to Warm Springs, Mill, and Willow Creeks. Increased base flow may mitigate adverse de-watering effects for the creeks.

6.3 RISK ASSESSMENT SUMMARY BASIS FOR ACTION

Actual or threatened releases off hazardous substances from this site, if not addressed by implementing the response action selected in this ROD, may present a current or potential threat to public health, welfare, or the environment.

7.0 DESCRIPTION OF ALTERNATIVES

7.1 SUMMARY OF ALTERNATIVES

A brief description of the alternatives considered for the areas of concern in the ARWW&S OU is provided below. Development and screening of process technologies and an initial assessment of waste volumes and a screening of waste removals was presented in FS Deliverable No. 1 (ARCO 1996c). A more detailed analysis of the feasibility of waste removal, and subsequent restoration of contaminated ground water resources, was presented in FS Deliverable No. 3B (EPA 1996c). EPA determined that it was technically impracticable and cost prohibitive (30+ years at an estimated $2.2 billion) to remove large waste areas and restore ground water resources. The alternatives below, and initially presented in FS Deliverable No. 3B (EPA 1996c), were identified to meet the CERCLA and NCP requirements for developing an appropriate range of options to undergo a detailed analysis after the initial screenings. Alternatives identified in this section were selected based on the site conditions, previous remedial actions at other OUs, and the results of a pilot-scale testing of technologies at this and other Clark Fork River NPL Sites. These activities included identification, screening, and evaluation of potential general response actions, remedial technologies, and process options in accordance with 40 CFR §300.430 (e)(2)-(7).

For ease of screening during the FS process, the alternatives were divided into two groups, solids (soils and waste combined) and water (ground and surface water). Therefore, the alternatives summarized in the ROD are also presented as solid and water alternatives.

7.1.1 SOLIDS

All solids alternatives would be applied to areas lacking established suitable vegetation. Well vegetated or previously reclaimed solids that are successfully minimizing human and ecological risks and are complying with ARARs would not be disturbed to implement a solid alternative.

(1) No Further Action

The No Further Action alternative would result in no change in the solids contaminant levels as no treatment or removal of waste would be included in this alternative. However, some ICs such as permitted and limited land use, are already in place to minimize exposure to waste.

(2) Capping

The capping alternative for solids would involve covering solid waste areas with a geosynthetic clay liner covered by 2 feet of soil. Reclamation Level I (see reclamation alternative definitions below) practices would be used for seeding, fertilization, and mulching. No irrigation system would be used. The cap would prevent both infiltration of contamination into ground water and airborne dispersion of contaminated solids. This alternative may also involve consolidation of wastes from other parts of the ARWW&S OU prior to installation of the cover. Storm water management controls such as grading, consolidation, surface water controls, sedimentation basins, and ditching to control runoff and erosion in order to prevent the migration of contamination to surface water would be included as part of this alternative.

(3) Soil Cover

The soil cover alternative for solids would involve covering all or part of solid waste areas with 18 inches of soil combined with reclamation to prevent areal dispersion of contaminated solids and to limit percolation of contamination to ground water underlying solid waste areas. Reclamation Level I (see reclamation alternative definitions below) practices would be used for seeding, fertilization and mulching. No irrigation system would be used. Consolidation of waste from other areas in the ARWW&S OU may occur prior to installation of the soil cover. Storm water management controls such as grading, consolidation, surface water controls, dozer basins designed to control runoff (as required) and erosion of the solids, and to prevent the migration of contamination to surface water would be included as part of this alternative.

(4) Reclamation

The reclamation alternative for solids would involve varying degrees of physical soil manipulation, amendment applications and revegetation/reforestation, therefore, this alternative has been divided into three broad classes as described below. Grading and surface water controls, including dozer basins as required, would be included in this alternative at each level.

<u>Level I.</u> This land reclamation category includes the application of only basic agricultural technologies and standard agricultural reseeding of soils and waste areas. No soil amendments would be added using this alternative. Level I reclamation would require reseeding that may involve surface tilling (if needed); mechanical seeding (drill or broadcast), mechanical interseeding, or hand broadcast seeding; planting tree, shrub, and/or grass seedlings; and fertilizing and mulching. This level of reclamation would be assessed during the design phase as a stand alone alternative and also would be incorporated in both the capping and soil cover alternatives.

<u>Level II.</u> This land reclamation category employs the use of an appropriate mixing implement (Baker plow or equivalent) to incorporate limited amendments such as calcium carbonate, manure, and/or calcium hydroxide into the solid waste. This level of reclamation would generally be used in areas of shallow contamination where plowing may reach a depth of up to 2 feet. Seeding, planting, fertilization, and mulching would be applied under Level II reclamation.

<u>Level III.</u> This level of land reclamation category would be the most intensive and would be used in areas of high soil contamination or depth of waste material. This level would employ a mixer (Bomag or equivalent) to incorporate Level II soil amendments and lime into the soil prior to reseeding, planting, fertilization and mulching. This level of reclamation would provide both containment and treatment as the lime addition would reduce the mobility of the metals in the contaminated solids.

In addition, the revegetation/reforestation in each level of reclamation would establish self sustaining plant species to provide erosion control, grazing and wildlife habitat. The reclamation alternative for any area of concern would involve implementation of one or more levels of reclamation.

(5) Partial Reclamation

Partial reclamation would involve implementation of one of the three levels of reclamation only in sections of the areas of concern requiring wind and surface water erosion controls, visual corridors, and/or wildlife corridors. Storm water management controls such as grading, consolidation, surface water controls, and transportation trenches would be included as part of this alternative. Partial reclamation may include the installation of ICs such as fences to prevent human exposure to waste areas not fully reclaimed.

(6) Reclamation/Soil Cover

The reclamation/soil cover alternative would consist of a combination of 6 inches of soil cover and 12 inches of *in situ* reclamation as defined above to remediate large waste areas. The intent is to establish a minimum of 18 inches of non-toxic rooting media.

(7) Rock

The rock alternative would involve adding lime rock, cobbles, or pea gravel as a cover to solid waste. This addition would provide dust suppression and consequently a possible reduction in mobility of metals from the solid material to clean areas of the ARWW&S OU. The depth of the rock amendment would be kept shallow to minimize invasion of undesirable vegetation. Fences for additional control of wind erosion may also be included as part of this alternative. Grading and surface water controls designed to control runoff and erosion of the solids and prevent migration of contamination to surface water would be included as part of this alternative.

(8) Removal

The removal alternative would involve excavation of wastes for consolidation in designated subareas of the ARWW&S OU. Backfill and compaction of excavated areas are part of this alternative. Grading and surface water controls for storm water runoff and erosion would be included as part of this alternative. Reclamation would be applied where required using Level I practices for seeding, planting, fertilization and mulching.

(9) Partial Removal

The partial removal alternative would involve excavation of part of a waste area for consolidation in designated subareas of the ARWW&S OU. Backfill and compaction of excavated areas are part of this alternative. Grading and surface water controls for storm water runoff and erosion would be included as part of this alternative. Reclamation would be applied where required using Level I practices for seeding, planting, fertilization and mulching.

7.1.2 WATER

Water alternatives would be applied under the following conditions:

- Treatment of valley alluvial aquifer plumes in the South Opportunity and Old Works/Stucky Ridge Subareas;
- Contingency measures for treatment of ground water with a contaminant plume shown to be spread beyond the boundaries of a WMA; and,
- Cleanup of contaminated surface water determined to be a source and not a receptor in conjunction with solids alternatives to treat an aquifer.

(1) No Further Action

The No Further Action alternative would result in no change in the ground water contaminant levels as no treatment or removal of waste would be included in this alternative. Point-of-compliance monitoring of ground water would be employed, as well as restrictions of water usage for irrigation and domestic uses where applicable.

(2) Slurry Wall

The slurry wall alternative would involve installation of a slurry wall at a WMA boundary should POC monitoring show a spread of contamination beyond the WMA. Monitoring costs for ground water at the slurry wall to ensure containment of contamination are also included in this alternative.

(3) Hydraulic Controls - Interceptor Trenches/Extraction Wells

The interceptor trenches in this alternative would involve the installation of collection trenches for hydraulic control of the contaminated ground water plume. The collected ground water would then undergo monitoring and treatment, if required. Treated water would be either reinjected, released to surface water, or released to a Publicly Owned Treatment Works (POTW).

The extraction wells in this alternative would control contaminated ground water plumes under the same conditions as the interceptor trenches. The collected ground water would then undergo monitoring and either onsite or offsite treatment if required. Treated water would be either reinjected, released to surface water, or released to a POTW.

(4) Pump and Treat - Ion Exchange

The pump and treat - ion exchange alternative would involve treatment of extracted ground water or surface water with an ion exchange technology. Treated water from this alternative would be monitored to ensure PRAGs for either ground or surface water are met. This treated water would then either be reinjected, released to surface water, or released to a POTW.

(5) Pump and Treat - Oxidation/Precipitation

The pump and treat - oxidation/precipitation alternative would involve treatment of extracted ground water or surface water via oxidation/precipitation technology. Treated water from this alternative would be monitored to ensure PRAGs for either ground or surface water are met. This treated water would then either be reinjected, released to surface water, or released to a POTW.

(6) Wetlands

The wetlands alternative would involve creation of onsite wetlands to bioremediate contaminated surface water. This alternative also includes monitoring of downstream surface water.

7.2 DESCRIPTION OF ALTERNATIVES FOR EACH WASTE MEDIA TYPE IN EACH SUBAREA

In FS Deliverable No. 5, the remedial action alternatives were evaluated for areas of concern located in each subarea throughout the ARWW&S OU. Determination of the areas of concern was based on the types of waste media presented in Section 5.3 of the ROD. Since the same alternatives were evaluated for similar areas of concern in each subarea, the description of alternatives is presented for each waste media type below.

7.2.1 HIGH ARSENIC SOILS

The alternatives evaluated for high arsenic soils (soils with arsenic concentrations >1,000 ppm) in the Opportunity Ponds, North Opportunity, Old Works-Stucky Ridge and Smelter Hill subareas are described below.

(1) No Further Action

Under the No Further Action alternative, no remedial action would be taken to remedy any high arsenic soils within any area of concern to reduce the toxicity, mobility, or volume of the waste. Included in the No Further Action alternative are 5-year site reviews as required by CERCLA. Current ICs, including the ADLC land development permit controls (see Section 5.4) would require treatment of soils to below 1,000 ppm arsenic if land use changed. Other ICs, such as deed restrictions, would also continue to apply to these lands.

(2) Soil Cover

This containment option involves construction of a soil cover over the high arsenic soils in the Opportunity Ponds, North Opportunity, Old Works/Stucky Ridge and Smelter Hill Subareas. This cover would consist of 18 inches of soil with vegetation as described in Level I of the reclamation alternative. In order to promote surface water drainage, the high arsenic soils would be consolidated as required and the site graded. In addition, ditches would be constructed to help direct and control surface water drainage. The vegetative layer would be capable of supporting plant species that would minimize erosion.

(3) Reclamation

Reclamation of the high arsenic soils in the Opportunity Ponds, North Opportunity, South Opportunity, Old Works/Stucky Ridge and Smelter Hill Subareas would involve either Level I or II reclamation or a combination of both as described in Section 7.1 of this document. All levels of reclamation include surface water controls that would minimize erosion. In order to promote surface water drainage, the high arsenic soils would be consolidated as required and the site graded. In addition, ditches would be constructed to help direct and control surface water drainage.

(4) Partial Reclamation

Partial reclamation would affect only parts of the high arsenic soils areas of concern in the Opportunity Ponds, North Opportunity, South Opportunity, Old Works/Stucky Ridge, and Smelter Hill Subareas. This reduced acreage generally consists of high arsenic soils bordering on highways or high traffic roads. The partial reclamation alternative would only involve Level I reclamation criteria. This alternative would also involve the installation of perimeter fencing around the high arsenic soils to limit human contact with the high arsenic soils. Storm water management of the high arsenic soils would also be included in this alternative.

7.2.2 SPARSELY VEGETATED SOILS

The alternatives evaluated for sparsely vegetated soils in the Opportunity Ponds, North Opportunity, South Opportunity, Old Works-Stucky Ridge and Smelter Hill Subareas are described below.

(1) No Further Action

Under the No Further Action alternative, no remedial action would be taken to remedy any sparsely vegetated soils located in the Opportunity Ponds, North Opportunity, South Opportunity, Old Works/Stucky Ridge and Smelter Hill Subareas to reduce the toxicity, mobility, or volume of the waste. Included in the No Further Action alternative are 5-year site reviews as required by CERCLA.

(2) Reclamation

Reclamation would affect all of the sparsely vegetated soils in the Opportunity Ponds, North Opportunity, South Opportunity, Old Works/Stucky Ridge and Smelter Hill Subareas using either Level I, Level II or a combination of both levels of reclamation as described in Section 7.1. Both levels of reclamation include surface water controls that would minimize erosion. In order to promote surface water drainage, the sparsely vegetated soil would be consolidated as required and the site graded. In addition, ditches would be constructed to help direct and control surface water drainage.

(3) Partial Reclamation

The partial reclamation alternative would only involve sparsely vegetated soils in what are considered high erosional areas of the Opportunity Ponds, North Opportunity, South Opportunity, Old Works/Stucky Ridge and Smelter Hill Subareas. These areas would be reclaimed using Level I reclamation criteria and would involve surface water controls and soil consolidation as required. However, this alternative does not provide remedial action in the sparsely vegetated soils outside of the high erosional areas.

7.2.3 WASTE MEDIA - OPPORTUNITY PONDS, CELL A, MAIN GRANULATED SLAG, DISTURBED AREA AND ANACONDA PONDS

The alternatives evaluated for the Opportunity Ponds, Cell A, Main Granulated Slag, Disturbed Area and Anaconda Ponds waste media in the Opportunity Ponds, North Opportunity, Old Works/Stucky Ridge and Smelter Hill Subareas are described below.

(1) No Further Action

Under the No Further Action alternative, no remedial action would be taken to remedy the waste media in the Opportunity Ponds, Cell A, Main Granulated Slag, Disturbed Area or the Anaconda Ponds to reduce the toxicity, mobility, or volume of the waste. These areas of concern would be designated as WMAs with POC monitoring at the WMA perimeter boundary for underlying ground water. Included in the No Further Action alternative are 5-year site reviews as required by CERCLA.

(2) Soil Cover

This containment option involves construction of a soil cover over the Opportunity Ponds, Cell A, the Disturbed Area, and the Anaconda Ponds waste media areas of concern. This cover would consist of 18 inches of soil with vegetation as described in Level I of the reclamation alternative. In order to promote surface water drainage, waste media would be consolidated as required and the site graded. In addition, ditches would be constructed to help direct and control surface water drainage. The vegetative layer would be capable of supporting plant species that would minimize erosion.

(3) Reclamation

Reclamation would affect the Opportunity Ponds, Cell A, the Disturbed Area, and the Anaconda Ponds waste media areas of concern using Level III reclamation as described in Section 7.1. This level of reclamation includes surface water controls that would minimize erosion. In order to promote surface water drainage, the waste media would be consolidated as required and the site graded. In addition, ditches would be constructed to help direct and control surface water drainage.

(4) Partial Reclamation

The partial reclamation alternative would only involve sections of the Opportunity Ponds, Cell A, the Disturbed Area, and the Anaconda Ponds waste media areas of concern required to provide wildlife corridors and erosion control. These areas would be reclaimed using Level II reclamation criteria and would involve surface water controls and soil consolidation as required.

(5) Reclamation/Soil Cover

The reclamation/soil cover alternative would involve using a combination of a six-inch soil cover and Level III reclamation (12 inches deep) in parts of large waste areas such as the Opportunity Ponds, Disturbed Area and Anaconda Ponds areas of concern. In order to promote surface water drainage, the waste media in these areas of concern would be consolidated and the site graded. In addition, ditches would be constructed to help direct and control surface water drainage.

(6) Rock Amendment

The rock amendment alternative involves placing a four-inch layer of pea gravel over the Opportunity Ponds, Cell A, the Disturbed Area, and the Anaconda Ponds waste media areas of concern. In order to promote surface water drainage, the waste media would be consolidated as required (e.g., move tailings outside of the outer perimeter berms of Opportunity and Anaconda Ponds back into the ponds proper) and the site graded. In addition, ditches would be constructed to help direct and control surface water drainage. This remedy would only address movement of COCs via wind and would not reduce or minimize transport of COCs to ground water.

(7) Removal

The removal alternative would consist of excavation of the entire volume of waste media in the Opportunity Ponds, Cell A, Main Granulated Slag, Disturbed Area and the Anaconda Ponds waste media areas of concern. Excavated waste would be hauled to an active mining site, such as in Butte, Montana, for disposal. After excavation and removal, the site would be graded and vegetated using Level I reclamation criteria. No backfilling would be performed.

7.2.4 REMAINING WASTE AREAS - SOUTH LIME DITCH, TRIANGLE WASTE, WARM SPRINGS CREEK STREAMSIDE TAILINGS (SST), WILLOW CREEK SST, YELLOW DITCH, BLUE LAGOON AND EAST ANACONDA YARD

The alternatives evaluated for the South Lime Ditch, Triangle Waste, Warm Springs Creek SST, Willow Creek SST, Yellow Ditch, Blue Lagoon and East Anaconda Yard waste media located in the Opportunity Ponds, North Opportunity, South Opportunity and Smelter Hill Subareas are described below.

(1) No Further Action

Under the No Further Action alternative, no remedial action would be taken to remedy the waste media in the South Lime Ditch, Triangle Waste, Warm Springs Creek SST, Willow Creek SST, Yellow Ditch, Blue Lagoon and East Anaconda Yard to reduce the toxicity, mobility, or volume of the waste. Included in the No Further Action alternative are 5-year site reviews as required by CERCLA.

(2) Capping

The capping alternative for the South Lime Ditch, Triangle Waste, Warm Springs Creek SST, Willow Creek SST, Yellow Ditch, Blue Lagoon and East Anaconda Yard would involve covering the waste areas with an impermeable cap. This alternative would minimize both infiltration of contamination into ground water and airborne dispersion of contaminated solids. The cap would include a 2-foot soil cover (with vegetation as described in the Level I reclamation alternative) and a geosynthetic clay liner. In order to promote surface water drainage, the South Lime Ditch, Triangle Waste, Warm Springs Creek SST, Willow Creek SST, Yellow Ditch, Blue Lagoon and East Anaconda Yard would be consolidated and the site graded. In addition, ditches would be constructed to help direct and control surface water drainage. The vegetative layer would be capable of supporting plant species that would minimize erosion.

(3) Soil Cover

This containment option would involve construction of a soil cover over the South Lime Ditch, Triangle Waste, Warm Springs Creek SST, Willow Creek SST, Yellow Ditch, Blue Lagoon and East Anaconda Yard waste materials. This cover would consist of 18 inches of soil with vegetation as described in the Level I of the reclamation alternative. In order to promote surface water drainage, waste media would be consolidated as required and the site graded. In addition, ditches would be constructed to help direct and control surface water drainage. The vegetative layer would be capable of supporting plant species that would minimize erosion.

(4) Reclamation

Reclamation would affect the South Lime Ditch, Triangle Waste, Warm Springs Creek SST, Willow Creek SST, Yellow Ditch, Blue Lagoon and East Anaconda Yard waste materials using Level III reclamation as described in Section 7.1. This level of reclamation includes surface water controls that would minimize erosion. In order to promote surface water drainage, the waste media would be consolidated as required and the site graded. In addition, ditches would be constructed to help direct and control surface water drainage.

(5) Partial Reclamation

The partial reclamation alternative would only involve sections of the South Lime Ditch, Triangle Waste, Warm Springs Creek SST, Willow Creek SST, Yellow Ditch, Blue Lagoon and East Anaconda Yard waste materials required to provide wildlife corridors and erosion control. These areas would be reclaimed using Level II reclamation criteria and would involve surface water controls and soil consolidation as required. However, this alternative does not provide remedial action in the sparsely vegetated soils outside the high erosional areas.

(6) Removal

The removal alternative would consist of excavation of the entire volume of waste media in the South Lime Ditch, Triangle Waste, Warm Springs Creek SST, Willow Creek SST, Yellow Ditch, Blue Lagoon and East Anaconda Yard waste materials. Excavated waste would be hauled to an appropriate disposal site, such as the Anaconda or Opportunity Ponds, for disposal. After excavation and removal, the site would be graded and vegetated using Level I reclamation criteria. No backfilling would be performed.

(7) Partial Removal

The partial removal alternative would consist of excavation of the partial volume of waste media in the South Lime Ditch, Triangle Waste, Warm Springs Creek SST, Willow Creek SST, Yellow Ditch, Blue Lagoon and East Anaconda Yard waste media areas of concern. Excavated waste would be hauled to an appropriate location, such as the Anaconda or Opportunity Ponds, for disposal. After excavation and removal, the site would be graded and vegetated using Level I reclamation criteria. No backfilling would be performed. This alternative has no provisions for treatment of the volume of waste media left in place.

7.2.5 GROUND WATER

The alternatives evaluated for both the alluvial and bedrock aquifers in the Opportunity Ponds, South Opportunity, Old Works/Stucky Ridge and Smelter Hill Subareas are described below.

(1) No Further Action

Under the No Further Action alternative, no remedial action would be taken to remedy any contaminated water underlying a subarea to reduce the toxicity, mobility, or volume of the waste. Waste media over ground water aquifers would be designated a WMA. This alternative includes conducting ground water monitoring semi-annually at the POC boundary for the WMA. Existing and new ground water monitoring wells would be used. Also included in the No Further Action alternative are 5-year site reviews as required by CERCLA. The ground water areas of concern lie in the Superfund Overlay District, which operates under the DPS that was adopted by ADLC. Specific standards and regulations are established under this District including prohibition of water well drilling.

(2) Ground Water Extraction

Should POC monitoring show a spread of the contaminant plume beyond the boundary of a WMA, ground water would be extracted via a series of wells. This alternative is only applicable for the ground water underlying the Opportunity Ponds, Old Works/Stucky Ridge and Smelter Hill Subareas. The preliminary design concept uses wells to extract ground water, and the cost estimate is priced as such. Twenty-eight wells, each extracting approximately 20 gallons per minute (gpm), would be spaced 300 feet apart. The total ground water volume extracted would be approximately 560 gpm.

The extracted ground water would be either treated directly at the Warm Springs Ponds (Option A) or treated onsite and then discharged to Warm Springs Ponds (Option B). Through Option A, the extracted ground water would be piped and/or flow through an open channel to the Warm Springs Ponds, which is located approximately 0.5 mile away. An existing culvert underneath the railroad tracks and the highway can be used to transport the extracted water.

Under Option B, an on-site treatment plant would be built and used to treat the extracted ground water. Treatment would be accomplished through: 1) a combination of chemical oxidation and chemical precipitation (oxidation/precipitation); or 2) ion exchange. The chemical oxidation/precipitation option is recommended and, therefore, is used in these discussions and cost estimates. The treated effluent would be piped and/or flow through an open channel to the Warm Springs Ponds or to a POTW.

(3) Slurry Wall

A slurry wall would be constructed at boundaries of the Opportunity Ponds and Old Works/Stucky Ridge Subareas if POC monitoring showed a spread of contamination beyond the WMA. The slurry wall would help contain the contaminated ground water. Because water pressure would build up at the slurry wall, extraction wells would have to be used to alleviate the mounding. Fourteen wells, located approximately 600 feet apart would be used. Approximately 280 gpm of ground water would be extracted.

The extracted ground water would be either treated directly at the Warm Springs Ponds (Option A) or treated on site and then discharged to Warm Springs Ponds (Option B). Through Option A, the extracted ground water would be piped and/or flow through an open channel to the Warm Springs Ponds, which is located approximately 0.5 mile away from the Opportunity Ponds. An existing culvert underneath the railroad tracks and the highway can be used to transport the extracted water.

Under Option B, an onsite treatment plant would be built and used to treat the extracted ground water. Treatment would be accomplished through: 1) a combination of chemical oxidation and chemical precipitation (oxidation/precipitation); or 2) ion exchange. The chemical oxidation/precipitation option is recommended and, therefore, is used in these discussions and cost estimates. The treated effluent would be piped and/or open channel flowed to the Warm Springs Ponds or to a POTW.

7.2.6 SURFACE WATER

The alternatives evaluated for the Yellow Ditch and Cabbage Gulch surface water areas of concern located in the South Opportunity and Smelter Hill Subareas are presented below.

(1) No Further Action

Under the No Further Action alternative, no remedial action would be taken to remedy any surface water in these areas of concern to reduce the toxicity, mobility, or volume of the waste. Surface water is a receptor and would be remediated through the alternatives selected for the solid waste source of the surface water contamination. Also included in the No Further Action alternative are 5-year site reviews as required by CERCLA.

(2) Pump and Treat Oxidation/Precipitation

Surface water from the Cabbage Gulch would be pumped to a catch basin, then treated via a combination of chemical oxidation and chemical precipitation (oxidation/precipitation) in an onsite treatment facility. This facility would be built and used to treat the surface water through: 1) a combination of chemical oxidation and chemical precipitation (oxidation/precipitation); or 2) ion exchange. The treated effluent would be piped and/or open channel flowed to the Warm Springs Ponds or to Opportunity Ponds.

(3) Wetlands

A constructed wetlands system would be built along Cabbage Gulch (just below the beaver dams) to treat the surface water. The system would consist of a settling pond, a wetland, and a polishing cell. If the water has an initial pH greater than 5.5 and also has net alkalinity, an aerobic settling pond that precipitates iron (Fe III) hydroxides may be effective in lowering the arsenic concentrations. (If the pH and the alkalinity of the water needs to be raised prior to the water entering the settling pond, a possible pretreatment stage upstream of the settling pond would include an anoxic limestone drain in which the water is forced through a buried bed of limestone.) The settling pond would be created by either constructing an earthen dam along the stream or redirecting the flow through a catch basin. The settling pond serves as a retention basin for precipitates and allows control of flow into the rest of the treatment system. The pond would be lined with geosynthetics. An irrigation gate located at the downstream end of the flow would allow the flow rate into the rest of the system to be monitored and adjusted. Within the settling pond, Fe (III) hydrolyzes and the ferric hydroxide precipitate has a high positive surface charge that readily adsorbs the arsenate ions.

The downstream end of the irrigation gate would connect to a pipe through which water is transported to the wetlands anaerobic cell. The anaerobic cell would be lined with geosynthetics and filled with compost as well as sandy soil and perhaps limestone. Laboratory studies would be required to determine the most effective substrate or combination of substrates to be used.

If necessary, the anaerobic cell would be followed by a polishing cell operating under aerobic conditions. The polishing cell would either be designed as a shallow wetland or a rock filter. In either case, the effectiveness of the cell may be increased through inoculation with algae; however, if the system is not designed properly, the water in the pond could turn anoxic. The polishing cell would be used as a safety net as it would facilitate the precipitation of any metals remaining in the water.

Treated water exiting the constructed wetland system would drain back into the existing stream bed.

8.0 SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

Section 300.430(e)(9) of the NCP requires that the agencies evaluate and compare 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 ARARs for this ROD (listed in Appendix A), are threshold criteria that must be met by the Selected Remedy, unless an appropriate ARAR waiver is invoked. The Selected Remedy must then represent the best balance of the remaining primary balancing and modifying criteria.

8.1 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 ICs.

2. **Compliance with ARARs** addresses whether or not a remedy will comply with federal environmental and state environmental or siting standards, criteria, or requirements, or provides grounds for invoking a waiver.

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 once cleanup goals have been met.

4. **Reduction of Toxicity, Mobility, or 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 feasibility of a remedy, including the availability of materials and services needed to carry out a particular option.

7. **Cost** evaluates the estimated capital costs and operation and maintenance costs, calculated at present value, for each alternative.

   The present worth analysis was performed on all remedial alternatives using a 7 percent discount (interest) rate over a period of 30 years. Inflation and depreciation were not considered in preparing the present worth costs in accordance with EPA guidance, and should be factored into final cost evaluations.

8.1.3 MODIFYING CRITERIA

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

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

8.2 COMPARISON OF THE ALTERNATIVES

EPA and MDEQ compared each of the alternatives using a low, moderate or high rating for each of the NCP criteria. A low rating means the alternative provides the minimum requirement of a criteria or only partially addresses the concerns to human health and the environment represented by that criteria. One example of a low rating is the in place deed restrictions which provide a small measure of protection of human health and the environment under the No Further Action alternative. Both moderate and high ratings surpass the minimum requirements of a criteria; however, the high rating provides an extra degree of protection not provided by an alternative with a moderate rating. Costs estimates for each alternative evaluated within each subarea were calculated for use in the cost comparison step of the NCP evaluation. Capital costs were calculated for direct implementation of the action (i.e., mobilization, site preparation, materials, temporary roads, storm water management, construction monitoring) and indirect costs (i.e., supervision, inspections, contractor bonds, design). These combined capital costs were spread over the estimated time for implementation of the alternative. O&M costs for each alternative were then calculated for a 30 year estimate and included activities such as inspections, vegetation repair work, surface and ground water monitoring, ongoing storm water management and site reviews. O&M costs were also calculated for all No Further Action alternatives, reflecting the fact that large areas containing contaminated soils and wastes would be left in place without further action. The total present worth costs for each alternative are the sum of the capital costs plus O&M costs.

The results of the NCP comparison is presented for the waste media types throughout the areas of concern in Tables 8.1-8.6 and are discussed in the sections below.

8.2.1 HIGH ARSENIC SOILS

For high arsenic soils (areas exceeding 1,000 ppm arsenic) in the Opportunity Ponds, North Opportunity, Old Works/Stucky Ridge and Smelter Hill Subareas, EPA's Selected Remedy is Reclamation. The No Further Action alternative is not compliant with any of the seven evaluation criteria. The Partial Reclamation alternative was applied to limited acreage along highway visual corridors and the alternative would meet the requirements of protection of human health and the environment only in those areas reclaimed. Furthermore, the alternative includes slightly increased costs due to additional engineering storm water management controls on the unreclaimed areas. The Soil Cover Alternative is similar to the Reclamation alternative and would provide better (high versus moderate) long term effectiveness and permanence, and would comply with ARARs. Using information about available cover material in 1996, the Soil Cover alternative, however, is almost ten times more costly than the Reclamation alternative. EPA and

MDEQ are re-evaluating quantities and quality of local cover material in 1998 and if suitable material is found, soil cover may be chosen during remedial design.

A comparison of the present worth costs for all the high arsenic soils alternatives is presented in Table 8-1.

8.2.2 SPARSELY VEGETATED SOILS

EPA and MDEQ assessed only two alternatives in addition to the No Action alternative for sparsely vegetated soils. Under the No Further Action alternative, no remedial action would be taken to remedy any sparsely vegetated soils in any subarea of concern to reduce the toxicity, mobility, or volume of the contaminated soils. Acreages determined for the Partial Reclamation scenario were based on an assessment of high erosional areas determined during site characterization. The Partial Reclamation alternative would be compliant with ARARs and would reduce erosion in areas affected by reclamation. However, this is only true of the reclaimed areas. Sparsely vegetated soils not affected by this alternative would have no provisions for protection of the environment. Therefore, this alternative would not provide a fully protective remedy for the remaining sparsely vegetated soils. Reclamation is protective of the environment, compliant with ARARS, moderately effective in meeting permanence, reduces toxicity, mobility and volume, and is easy to implement and is the Selected Remedy.

A comparison of the present worth costs for all the sparsely vegetated soils alternatives is presented in Table 8-2.

8.2.3 WASTE MANAGEMENT AREAS (WMAs) - OPPORTUNITY PONDS, CELL A, ANACONDA PONDS, MAIN GRANULATED SLAG AND SMELTER HILL DISTURBED AREA

EPA evaluated removal of these areas in FS Deliverables No. 1 and 3B, and concluded that removal was cost prohibitive. EPA designated: 1) the Opportunity Ponds, including Cell A; and 2) the Anaconda Ponds, Main Granulated Slag, and Disturbed Area of Smelter Hill, as two WMAs. For the detailed FS analysis presented in FS Deliverable No. 5, EPA assessed long-term management, protection of human health and the environment, and attainment of ARARs for these wastes-left-in-place.

For the Opportunity Ponds, Anaconda Ponds and Smelter Hill Disturbed Areas, the No Further Action alternative would not be protective, would not be compliant with the Montana State mine closure reclamation ARARs, and the mobility of the contaminants would not be reduced. Partial reclamation would only address protection of human health and environmental resources, attain ARARs, reduce mobility of contaminants and be effective for those acres reclaimed. Of the remaining alternatives, Soil Cover, Reclamation and Reclamation/Soil Cover provide more protective, effective, and permanent remedies for the WMAs than is provided by the Rock Amendment. The Rock Cover alternative would not address minimization of COC transport to ground water. In addition to being the most cost effective of alternatives, Reclamation is expected to provide greater reduction in mobility and a reduction of toxicity of the contaminants as the lime amendment acts as an *in situ* treatment of the metals.

As noted for the sparsely vegetated soils, EPA and MDEQ are re-evaluating the quantity and quality of lower cost, locally available soil cover material. Soil cover ranked high for permanence and long-term effectiveness, and if costs for soil cover can be reduced, the final remedial design for the waste areas may select this option.

Cell A of the Opportunity Ponds was identified as a future waste disposal area for mining wastes for ADLC. Based on this information, EPA and MDEQ looked at the No Further Action, Rock Amendment and Removal alternatives to address transport of contaminants off-site. Based on public comment during the review of the Proposed Plan, ADLC would like to locate a mine waste disposal area in the B-2 cell. Cell A is formally part of the WMA which will require final closure and either a reclamation or soil cover remedy.

For the Main Granulated Slag Pile, No Further Action and Rock Amendment are the only alternatives considered. Since the slag is currently being mined with immediate prospects for additional mining, EPA and MDEQ propose No Further Action to remediate the slag pile area. If the mining operations are abandoned in the future, other alternatives for this waste area would be evaluated and selected at that time. Furthermore, once all the slag is removed from the area, contaminated soil and waste source remaining under the slag may require remediation in the future.

A comparison of the present worth costs for all the WMA alternatives is presented in Table 8-3.

8.2.4 REMAINING WASTE AREAS

For all remaining identified waste areas, except the East Anaconda Yards wastes which are already covered, the No Further Action alternative is not compliant with ARARs, is ineffective both short and long term, and provides no reduction in toxicity, mobility, or volume of contaminants.

The five remaining alternatives of capping, soil cover, reclamation, removal and partial removal, are easy to implement. The soil cover, reclamation and partial removal alternatives are moderately effective alternatives in both the short and long term. These alternatives are also protective of human health and the environment. EPA and MDEQ, therefore, chose a preferred alternative for each individual waste source based on proposed land use, proximity to surface water resources and cost. The South Lime Ditch area will remain in place and become part of the Opportunity Ponds WMA. The Triangle Waste area will also remain in place and will be reclaimed for open space land use and to maintain protection of existing ground water resources which are uncontaminated.

The East Anaconda Yards were capped with 12-18 inches of clean cover material and revegetated during site demolition actions, and the Flue Dust and OW/EADA RODs actions. EPA and MDEQ further evaluated removal, partial removal, capping and additional soil cover to eliminate transport of metals from the buried waste into the contaminated ground water. EPA and MDEQ determined that further action in the East Anaconda Yards would probably not allow full clean up of the ground water due to additional arsenic entering the aquifer system from Smelter Hill.

A comparison of the present worth costs for all the remaining waste area alternatives is presented in Table 8-4.

8.2.5 GROUND WATER

EPA and MDEQ have deemed it technically impracticable to restore contaminated ground water in alluvial and bedrock aquifers in the Opportunity, Stucky Ridge and Smelter Hill Subareas of the site. EPA and MDEQ policy requires clean up efforts to further minimize contamination and degradation of ground water if ground water cannot be restored. The preferred alternatives for waste and contaminated soils selected in this ROD are meant to address this ground water protection goal. EPA and MDEQ further evaluated whether extraction wells or slurry walls should be installed at the edge of plumes to contain the contaminated water in place. Based on current understanding of ground water movement at various location across the site, EPA and MDEQ propose no additional active ground water clean up within the TI zones or underneath the WMAs at this time. EPA and MDEQ propose to evaluate additional ground water actions in the future if the points of compliance are violated.

For the remaining alluvial aquifer plumes located in the Old Works/Red Sands area, Yellow Ditch/South Opportunity area, and Blue Lagoon, EPA and MDEQ evaluated options of source removal and active ground water treatment to restore the aquifer to its designated beneficial uses. The agencies have chosen alternatives to meet the objective of restoring those contaminated portions of the aquifer to applicable State of Montana ground water standards. Each identified remedy addresses source control (soil covers, elimination of flood irrigation practices, and partial removal), monitors for natural attenuation, and uses ICs to manage future water use.

A comparison of the present worth costs for all the ground water alternatives is presented in Table 8-5.

8.2.6 SURFACE WATER

For contaminated surface water in Cabbage Gulch and Yellow Ditch, EPA evaluated active treatment of the surface water sources to attain State of Montana water quality standards. EPA recognizes other major contributions of arsenic to these sources (i.e., contaminated ground water, surface water springs and seeps) and therefore proposes implementing soils source control measures and monitoring water quality to assess eventual attainment of the standards. EPA, in consultation with the State of Montana, may require the PRP to re-evaluate treatment of the water in the future.

A comparison of the present worth costs for all the surface water alternatives is presented in Table 8-6.

8.2.7 STORM WATER MANAGEMENT

EPA and MDEQ evaluated a stand-alone storm water management alternative for high arsenic soils, sparsely vegetated soils, and the Disturbed Area through sole use of engineering components (e.g., sedimentation basins, conveyance ditches). These alternatives would be compliant with ARARs but would only meet the PRAOs for minimizing transport of contaminants to surface water and controlling surface water erosion. The storm water management alternative would have no provisions for protection of human health or the environment and therefore, would not meet those parts of the PRAOs for this area of concern. Therefore, the storm water management alternative would not provide a fully protective remedy for the high arsenic soils, sparsely vegetated soils or the Disturbed Area in the Smelter Hill Subarea.

9.0 SELECTED REMEDY

Based on consideration of CERCLA requirements, the detailed analysis of alternatives, and public comments, EPA, in consultation with MDEQ, has determined that the Preferred Alternatives, as presented in the Proposed Plan and with minor modifications as outlined below, comprise the appropriate remedies for the ARWW&S OU. While certain other alternatives may better satisfy certain individual selection criteria, the Selected Remedy best meets the entire range of selection criteria and achieves, in EPA's and MDEQ's determination, the appropriate balance considering site-specific conditions and criteria identified in CERCLA and the NCP, as provided in Section 10.0, Statutory Determinations.

The Selected Remedy is divided into portions, affecting each waste media type as described below. A summary of the Selected Remedy and its respective cost for each area of concern is shown in Table 9-1. Institutional Controls are a component of the remedy for each area and are described in detail in Section 9.7.

9.1 WASTE MANAGEMENT AREAS (WMAs) REMEDY

The Selected Remedy is to close the tailings ponds and waste source areas under the ARAR requirements of the State of Montana Solid Waste Requirements and selected portions of the Montana Strip and Underground Mine Reclamation Act and Montana Metal Mine Reclamation Act. The Selected Remedy will address remaining waste source areas within the site by naming three separate and distinct "Waste Management Areas." No further waste management areas will be designated. Establishment of WMAs is consistent with CERCLA concepts of wastes-left-in-place, and is compatible with ADLC's designation of these lands as WMAs under the county's Land Use Master Plan and DPS. EPA and MDEQ recognize that removal of waste material within the WMA boundary and restoration of ground water beneath is technically impracticable and cost prohibitive (estimated $2.2 billion); therefore, waste material will be contained/stabilized in place and ground water contaminated with elevated concentrations of arsenic, cadmium, and copper beneath the waste material will not be remediated. However, when restoration of ground water to beneficial uses is not practicable, EPA and MDEQ expect to prevent further migration of the plume, prevent exposure to the contaminated ground water, and evaluate further risk reduction. Contaminated ground water within the WMA boundaries will be contained and transport of COCs to ground water will be minimized by the establishment of an effective and permanent vegetative cover. Performance standards are defined throughout this section.

9.1.1 REMEDIAL ACTION OBJECTIVES

Through implementation of the Selected Remedy (Section 9.1.2), the following Remedial Action Objectives will be achieved:

- Provide a permanent and effective vegetative/soil cover over waste and highly contaminated soil material to prevent direct contact with elevated arsenic concentrations , thus minimizing the potential risk of human exposure;

- Minimize surface water percolation and COC transport to ground water in order to prevent further migration of the plume;

- Minimize surface water erosion and COC transport to surface water in order to meet water quality ARARs as outlined in Appendix A;

- Minimize wind erosion and movement of COCs onto adjacent lands, thus preventing risk of human and wildlife exposure above risk-based levels, and prevent non-attainment of air quality ARARs as outlined in Appendix A;

- Reduce COC levels in waste and highly contaminated soils in order to allow re-establishment of vegetation, thus reducing risk to upland terrestrial wildlife and allow re-establishment of wildlife habitat;

- Allow final closure of waste areas to be compatible with the existing and anticipated future land use with minimal future maintenance activities; and

- Meet State of Montana selective mine closure reclamation ARARs and other ARARs, as outlined in Appendix A;

9.1.2 REMEDIAL REQUIREMENTS

1. Permanently close WMAs as designated mine waste disposal units through construction of engineered covers and/or use of *in situ* revegetation treatment over all contaminated wastes. Engineered covers and/or *in situ* revegetation treatment will:

    - Provide an effective and permanent vegetative cover;

    - Prevent waste material from migrating to adjacent lands via wind and/or surface water erosion; and

    - Minimize movement of COCs through waste material into ground water in order to prevent further migration of the plume.

2. Construct surface water controls to manage runon/runoff from the WMAs to:

    - Prevent COC transport and discharges to Mill Creek, Willow Creek, Warm Springs Creek and other surface waters in order to meet water quality ARARs set forth in Appendix A; and

    - Be consistent with the regional storm water management plan.

    The D1 Cell of the Opportunity Ponds is currently slated to be used as the endpoint for conveyed regional storm water. Discharge from settling ponds in the D1 Cell which currently meets WQB-7 water quality criteria is conveyed to the Warm Springs Ponds by the D1 Decant Ditch. During remedial design, the conveyance structures may be upgraded to handle additional flows, as necessary.

3. Consolidate waste materials (e.g., tailings, slag, mixed tailings/soils) outside of WMAs boundaries into the WMAs through:

    - Consolidating waste material located in areas outside of a WMA designated for residential, commercial, industrial, recreational/open space or agricultural use into a WMA, and reclaiming remaining soils to meet ARAR requirements.

    Waste material that may be within a dedicated development (e.g., irrigation ditch, active railroad bed, historic feature, trails/roads) may remain outside a WMA. An engineered cover/*in situ* revegetation action will be designed for these areas to provide a permanent barrier to waste material, and ICs will be used to further maintain the effectiveness of the action and protect human health.

4. Implement ICs to protect engineering and/or revegetation controls and manage future land and water use by:

    - Maintaining existing ICs (i.e., governmental trespass and zoning regulations) to currently restrict or limit access;

    - Utilizing additional temporary barriers (i.e., fencing or signing), if necessary; and

    - Prohibiting ground water use for domestic consumption where ground water exceeds state water quality standards for the intended use. In some instances, ground water in WMAs may be treated and/or used for irrigation, agricultural or industrial purposes, providing the quality meets necessary criteria for those areas.

5. Provide for O&M, and monitoring activities, as necessary, by:

    - Inspecting engineered/vegetative cover and other structures;

    - Repairing engineered/vegetative cover and structures, as needed;

    - Monitoring ground water points of compliance to ensure compliance with Performance Standards to regulate containment of ground water plumes and minimization of COC concentrations in ground water, over time; and

    - Monitoring surface water, including storm water control systems.

    Specifications of the O&M plan will be approved upon completion of construction of individual components of the remedy.

9.1.3 RECLAMATION (COVER SOIL) CRITERIA

Successful closure and reclamation of WMAs is defined as the establishment of self-perpetuating plant communities capable of stabilizing the waste material against wind and water erosion, limiting infiltration of water, and providing a barrier to human contact in perpetuity. EPA and MDEQ have determined that soil cover, *in situ* revegetation (ARTS) and/or a combination of both techniques meets the objectives for ARARs compliance and risk reduction as noted above. Figure 9-1 presents the "Waste Material LRES Decision Diagram" to describe the logic process for determining what combination of options are acceptable to employ on specific units within the WMA. For a complete description of the application of the LRES to the WMAs, see Appendix C. For any option to accomplish the objectives, the physiochemical characteristics of engineered cover soils (i.e., rooting media) must have the following minimal specifications. Individual specifications may be modified if it is determined that the overall cover soil is suitable for meeting performance standards. These specifications are hereafter referred to as the Anaconda cover soil design specifications.

1. **Depth:** 18 inches of non-toxic rooting media. This is the absolute minimum for the long-term success of the vegetation. Enough cover soil needs to be applied to account for settling, sloughing, and erosion.

2. **Coarse fragment contents:** Particles greater than 2 millimeters will constitute less than 45% (by volume) of the cover soil. Maximum rock size is 6 inches in diameter.

3. **Texture:** Sandy loam or finer (to have the proper water holding capacity). "Clays" are not acceptable.

4. **pH:** Between 6.5 and 8.5 for entire depth of cover soil.

5. **Metal concentration:** Cover soil guidelines: arsenic < 30 ppm, cadmium < 4 ppm, copper < 100 ppm, lead < 100 ppm, and zinc < 250 ppm.

6. **Organic matter:** Cover soil or engineered media having >1.5% (by weight) of composted organic matter in the upper 6 inches.

7. **Specific conductance:** Cover soil or engineered rooting media must be less than 4.0 millimhos per centimeter for entire depth of cover soil.

8. **Surface manipulation:** Rip, chisel plow, and/or disk plow must be used to reduce the compaction caused by heavy machinery and achieve a moderately rough (by agricultural standards) seedbed. Plowing should be done as deep as possible within the cover soil, .

9. **Surface water controls:** Include the implementation of dozer basins, pits, gouges, contour furrowing, etc. to prevent water erosion.

10. **Seeding:** Seeding with native and/or adapted species, plus fertilization and mulching.

9.1.4 GROUND WATER REMEDY FOR WMAs

Ground water contaminated with concentrations of COCs above state ground water standards, as set forth in Appendix A, beneath the waste materials must not exit the WMAs.

The WMAs and associated ground water POCs for Anaconda are shown on Figures 7, 8, and 9, and are as follows:

1. Opportunity Ponds WMA (Figure 9-2). Alluvial aquifer underneath:

    - Opportunity Ponds Cells A, B1, B2, C1, C2, D1 and D2
    - South Lime Ditch

Ground Water POC: Downgradient point at toe of Opportunity Ponds Cells D1 and D2 as monitored at monitoring wells MW-214, MW-26, MW-26-M, MW-28, MW-28M, MW-215, MW-81, MW-31, MW-31M, and MW-216.

2. Smelter Hill WMA (Figure 9-3). Tertiary bedrock aquifer and alluvial aquifer underneath:

    - Disturbed Portion of Smelter Hill
    - Anaconda Ponds
    - Main Granulated Slag
    - East Anaconda Yards

Ground Water POC: Downgradient point at toe of Anaconda Ponds as monitored at monitoring wells MW-211, MW-36, MW-36D, MW-218S, MW-218D, MW-75 and MW-219 and MW-220.

3. Old Works/Stucky Ridge Subarea (Figure 9-4). Valley alluvial aquifer under:

    - Waste contained within the bounds of the Jack Nicklaus Old Works Golf Course, including Floodplain Wastes (Jig Tailings), Heap Roast Slag, and Waste Piles 1-8
    - Red Sands Main Deposit (21 acres)

Ground Water POC: Edge of Red Sands as monitored at monitoring wells MW-213 and MW-204.

9.1.5 GROUND WATER CONTINGENCY PLAN

EPA and MDEQ have determined that "remediation levels should generally be attained throughout the contaminated plume, or at and beyond the edge of the WMA when waste is left in place." (*1990 NCP Preamble at 55 FR 8713.*) EPA and MDEQ believe contaminated ground water will be contained within the WMAs boundaries. Non-degradation standards require uncontaminated ground water to remain uncontaminated. A sampling program for monitoring the POC boundaries and determining compliance with the ground water standards will be developed during remedial design and will include, at a minimum:

- Analytical parameters, including COCs (arsenic, cadmium, copper) and other constituents to characterize ground waters;
- Sampling points (including the POC wells listed above), sampling frequency and duration;
- Specific analytical methods that can achieve data quality objectives for limits of detection and estimates of data quality (accuracy and precision); and
- Statistical methods for evaluating whether data comply with standards.

EPA assessed the feasibility of active containment strategies (e.g., slurry walls and extraction wells) as part of the feasibility study analysis and determined that these strategies are viable alternatives. If a POC boundary is violated, based on determined statistical analyses, EPA will respond by conducting one or more of the following actions: 1) re-assess containment alternatives for contaminated ground water at the compliance boundary; and 2) complete a TI evaluation for the aquifer in areas of ground water contamination located outside the compliance boundary.

9.2 MISCELLANEOUS WASTE MATERIALS

During the various RI investigations conducted on the site over more than 15 years, numerous waste piles have been identified. The majority of the waste and waste/soils material will remain on-site and will be managed through implementation and closure of WMAs. It is generally EPA's practice to require consolidation of waste material (e.g., tailings, slag, mixed tailings/soils) outside of WMAs boundaries into the WMAs (see Section 9.1.2) EPA and MDEQ expect that additional waste materials may be identified in the future and that these materials would also be consolidated into the WMAs (i.e., abandoned railroads, abandoned portions of Yellow Ditch). The expectation that wastes would be removed, consolidated, and deposited has been previously noted and planned for in other site RODs, specifically the OW/EADA and Community Soils RODs (yard removals, waste consolidation in the Old Works golf course), and in the ADLC DPS through the proposal of a county-wide mine waste repository.

Remedial action objectives for these miscellaneous waste sources are the same as the objectives for wastes in the WMAs. Additional remedial action requirements are identified to specifically address the noted waste materials:

West Stack Slag

Three small slag piles are located west of Walker Gulch above the East Anaconda Yards. This material will be removed from the drainage gulch and consolidated with the Main Granulated Slag Pile within the Smelter Hill WMA, or used for EPA-approved purposes.

Anaconda Landfill Slag

This slag pile is currently being marketed for commercial use by a local company. The material is almost depleted. The remaining non-use material and surrounding soils will be sampled and characterized and a site remediation and closure plan developed for final approval by EPA. The closure plan will be consistent with existing land use and will meet applicable ground water, soil, and waste clean up action levels.

Old Works Slag

Slag remaining within the OW/EADA OU will become part of the Old Works WMA.

Nazer Gulch Debris/Wastes

Waste materials which have been disposed of in Nazer Gulch will be removed and consolidated into the Anaconda Ponds, prior to closure and reclamation of the Ponds.

Railroad Beds and Ties

A railroad track on Smelter Hill (portions of the old Loop Track within the Undisturbed Area)contains some of the highest metals concentrations on the Hill. The elevated metals values in the surface soils are a reflection of the materials used for bed construction (slag and waste rock) and possibly from ore concentrate spills. These materials will be excavated, transported to the former flue dust storage facility, consolidated with railroad bed material from the Aspen Hills portion of the Loop Track, and permanently disposed into the Anaconda Ponds prior to closure and reclamation of the Ponds.

Railroad ties from abandoned lines located on Smelter Hill are currently stockpiled in the Smelter Hill Repository Complex area. A plan to address the stockpiled ties in accordance with ARARs or off-site disposal requirements will be developed during RD/RA.

Construction Debris

A construction debris area is located in the southeast corner of the Main Granulated Slag Pile. This area contains debris from demolition of homes around Johnson's Curve near Warm Springs, Montana, and demolition of homes conducted under the Mill Creek ROD. This debris area will be closed pursuant to an EPA-approved work plan and in accordance with applicable State solid waste disposal regulations for construction debris. The plan will be developed during Remedial Design.

Cashman Pile

Approximately 12,000 tons of material is presently located on Smelter Hill. Since 1986, EPA has deferred definition of the material located between Walker Gulch and Nazer Gulch as a waste based on the understanding that the material may have potential uses as a ore concentrate product. EPA has also acknowledged that the material may contain a mixture of flue dust, concentrates, and slag.

The material will not be considered waste subject to remediation for a period of five years from the date of issuance of the ROD. In the event that processing of the concentrate material has not been initiated within the five-year period, the agency may determine that the concentrated is a waste material subject to remediation. The material will be sampled using Toxicity Characteristic Leaching Procedures to determine if the material is a hazardous waste, and if so, treated, excavated, and removed from the gulches and disposed of in an appropriately designed repository on Smelter Hill. If the material is not hazardous, a solid waste disposal plan will be developed, approved, and implemented in the Smelter Hill WMA.

Opportunity Ponds Toe Wastes

The Opportunity Ponds Toe Wastes are approximately 60,000 cy of tailings that breeched over the Ponds' berms on the east side, and are located between the Ponds and the I-90 frontage road. The wastes have been identified as the source of elevated COCs in the aquatic environment in the Opportunity Ponds D2 Drain Ditch. The wastes will be consolidated back into the Opportunity Ponds, the D2 Drain Ditch properly reconstructed, as necessary, and the area reclaimed to meet appropriate land uses.

Triangle Wastes

The Triangle Wastes are located on the western end of the Opportunity Ponds and are bounded by the intersection of Highways 1 and 48. The area contains an estimated 1.4 million cy within about 300 acres. Ground water investigations in the area have determined that the wastes are not contributing to any known contamination, therefore, EPA and MDEQ have not included this area as part of the formal Opportunity Ponds WMA and expect the ground water resource to be protected from potential contamination.

The Triangle Wastes may remain in place, based on current designated land uses (open space); however, due to high arsenic levels (>1,000 ppm arsenic), the final remedy will require soil cover and revegetation or deep tillage reclamation to reduce arsenic to below 1,000 ppm.

9.3 MAIN GRANULATED SLAG PILE REMEDY

The Main Granulated Slag Pile will remain in place and be located within the boundary of the Smelter Hill WMA. The area underlying the slag pile has been identified as a source of arsenic contamination to the alluvial aquifer, but it is technically impracticable to restore this ground water (see Section 9.5 and Appendix D for more information); therefore, the pile will require long-term management. EPA and MDEQ will allow on-going use of the slag material and will require management of the slag to be generally consistent with the objectives outlined in the WMA section of the ROD. After slag is removed, a final remediation plan will be developed to close the area to be compatible with the existing and anticipated future land use with minimal future maintenance activities. Performance Standards are defined throughout this section.

9.3.1 REMEDIAL REQUIREMENTS

The remedial requirements for the Main Granulated Slag Pile are described below.

1. Maintain the status of the slag as a resource, rather than a waste:

    - PRP may provide long-term agreements to guarantee commercial use of the slag as a base resource in approved productions.

    - EPA and MDEQ has approved use of the slag for purposes of blasting media, manufactured roofing material and other building material, as underground pipe bedding material, and for controlled landscaping (e.g., golf course sand traps). EPA and MDEQ will continue to review and approve future uses of the slag.

    - If long-term agreements for slag use are not initiated or maintained, EPA and MDEQ will re-evaluate and select additional actions for long-term management of the slag and underlying property.

2. Operate the facility in compliance with applicable regulations:

    - Developers of the slag for commercial use will follow all applicable environmental regulations regarding production and disposal of the slag material, including, but not limited to, OSHA and RCRA regulations.

    - Slag will be managed to meet all independently applicable laws as well as ARARs set forth in Appendix A.

3. Implement and maintain Best Management Practices (BMPs):

    - Production of slag will be conducted in a manner to minimize wind erosion and transport of material outside the WMA.

    - Construct surface water controls to manage runoff from the Main Granulated Slag Pile to be consistent with the regional storm water management plan.

    - Provide for O&M, and monitoring activities.

4. Control access to prevent exposure to waste materials and potentially contaminated soil, water, and air:

    - PRP will maintain existing ICs to restrict public access and manage future land and water use and shall place future controls on use of property through deed restrictions, restrictive covenants, or conservation easements, as necessary.

    - PRP will continue fencing and security inspections to assure appropriate access and land use.

- ICs will prohibit ground water use for domestic consumption.

- Residual material, including contaminated soils or other non-use materials, remaining after completion of slag production will be sampled and characterized, and a final remediation plan implemented. The remediation plan will be consistent with other waste decisions made on the Anaconda Smelter NPL Site (e.g., flue dust treatment and disposal, waste consolidation and covers) and fully approved by EPA, in concurrence with MDEQ. Final soil and/or waste cleanup action levels will be consistent with the designated land use.

9.4 CONTAMINATED SOILS REMEDIES

The Selected Remedy will address all remaining contaminated soils within the ARWW&S OU not addressed under the OW/EADA ROD or the Community Soils ROD. Areas of contaminated soils are found in all five subareas and are estimated to total >10,000 acres. The Selected Remedy will incorporate an LRES procedure to more accurately determine specific kinds of reclamation to be applied to contaminated soils within each area of concern (Figure 9-5).

9.4.1 REMEDIAL ACTION OBJECTIVES AND GOALS

Remediation of contaminated soils must meet the following Remedial Action Objectives:

- Provide a permanent vegetative cover over contaminated soil material to prevent direct contact with arsenic, thus reducing the potential risk of human exposure to acceptable risk-based levels;

- Provide a permanent vegetative cover over contaminated soil material to minimize transport of COCs to ground water, which cause exceedances of ground water ARARs set forth in Appendix A;

- Provide a permanent vegetative cover over contaminated soil material to minimize surface water erosion and COC transport to surface water in excess of surface water ARARs set forth in Appendix A;

- Provide a permanent vegetative cover over contaminated soil material to minimize wind erosion and movement of contaminated soils onto adjacent lands, thus preventing risk of human and wildlife exposure;

- Reduce surface soil COC levels to allow re-establishment of vegetation, thus reducing risk to upland terrestrial wildlife above risk-based levels and allow re-establishment of wildlife habitat; and

- Remediate contaminated soils to be compatible with the existing and anticipated future land use with minimal future maintenance activities.

9.4.2 REMEDIAL ACTION GOALS

Human health arsenic cleanup action levels for surficial soils at the Anaconda Smelter NPL Site are listed below.

Action Level	Land Use
250 ppm	residential land use
500 ppm	commercial/industrial land use
1,000 ppm	recreational/open space/agricultural land use
2,500 ppm	steep slope/open space

For purposes of the ARWW&S OU lands, EPA and MDEQ have established a 1,000 ppm arsenic action level for recreational/open space/agricultural land use and 2,500 ppm arsenic for steep slope/open space. EPA and MDEQ have determined that it is technically impracticable to apply certain land reclamation techniques to specific steep and rocky slopes and, therefore, cannot achieve the 1,000 ppm arsenic action level. However, other types of reclamation alternatives (e.g., hand planting of trees, shrubs and grass seedlings) are technically practicable and will be implemented in certain areas. Furthermore, because some lands are currently owned by ARCO and specific institutional controls (deed restrictions) and adequate fencing restrict human and wildlife access, the 2,500 ppm arsenic action level is deemed protective for some areas on the site.

9.4.3 REMEDIAL REQUIREMENTS FOR CONTAMINATED SOILS

The following are the remedial requirements for contaminated soils:

1. Reduce arsenic concentrations at the surface to below 1,000 ppm and 2,500 ppm in the Smelter Hill Subarea, as appropriate, using a combination of revegetation treatment techniques and/or engineered covers.

    - Revegetation techniques, which may include deep tilling with lime additions and soil amendments, will reduce surface soil arsenic concentrations to below 1,000 ppm and establish a diverse, effective, and permanent vegetation cover.

    - Engineered covers will be designed to provide an effective and permanent barrier to highly contaminated soils. Soil covers will be stabilized with vegetation that provides a diverse, effective, and permanent cover, and meet the design specifications outlined in the WMAs remedy.

2. Apply revegetation technologies to establish a self-sustaining assemblage of plant species capable of:

    - Stabilizing the soils against erosion and minimizing transport of contaminants to surface and ground water in order to meet water quality standards as set forth in Appendix A;

- Maximizing water usage;
- Re-establishing wildlife habitat; and
- Accelerating successional processes.

3. Apply BMPs for agricultural lands, as appropriate.
    - BMPs currently adopted or to be developed for various individual lands will be reviewed and included in the site-wide ICs Planning Document.
    - For barren/sparsely vegetated areas determined to be a source pathway to surface water, revegetation will accomplish storm water objectives, including implementation of BMPs.
4. Use ICs to maintain the integrity of remedial actions and prevent exposure to contaminated soil.
    - Apply ICs, appropriate for land ownership and land use, capable of maintaining and protecting revegetated lands.
    - Maintain existing ICs (e.g., governmental trespass and zoning regulations) to restrict access, as needed.
    - Use the ADLC DPS process on lands proposed for new land use and which would require additional soil remediation, if necessary.
5. Provide for O&M activities, as necessary.
    - Inspect the conditions of revegetated lands and institutional control remedies.
    - Repair revegetated lands and structures, as needed.
    - Develop specific procedures for O&M during remedial action for final implementation at the time of construction completion of selected areas.

9.4.4 LAND RECLAMATION EVALUATION SYSTEM (LRES) PROCEDURE

The reduction of risk and the protection of human health and ecological systems and compliance with ARARs is to be accomplished through the establishment of self-sustaining assemblages of plant species. To accomplish this objective, EPA and MDEQ will require application of an LRES as the standard operating procedure. (See Appendix C for a more complete description of the LRES.) The purpose of the LRES is to define which areas will receive what type of remedial action. Utilizing the statutory requirements (CERCLA reduction of risk to human health and the environment and compliance with ARARs including selected mine closure reclamation criteria) as a backdrop, field evaluation of each area to be remediated will be required during remedial design. Field evaluation will apply the LRES for delineation of remedial design units. The LRES integrates EPA guidance criteria, a quantitative scoring system of existing vegetation communities and potential for contaminant movement, and modifying parameters. The result is a spatial delineation of areas by general remedial class and an estimation of the level of reclamation for each unit.

The specifications and components of the reclamation alternative chosen are outlined in Table 1, Appendix C. Generally, the alternatives range in intensity, and are applied based on the level of arsenic soil contamination (i.e., the higher the arsenic concentration, the less likely tillage will reduce the concentrations), acid/base accounting, depth of contamination, slope characteristics of the land, potential for COC transport, and presence of existing vegetation. The alternative ranges include monitoring, cover soil, vegetation improvement, low intensity *in situ* reclamation, moderate intensity *in situ* reclamation, high intensity *in situ* reclamation, steep slope reclamation, and rock (industrial) amendment.

The Remedial Design process will further expand and modify the LRES procedures for specific application on the ARWW&S OU.

9.4.5 DESIGN AND PERFORMANCE STANDARDS

Successful reclamation of land contaminated by smelting and ore-processing activities is defined as the establishment of self-perpetuating plant communities capable of stabilizing contaminated soils against wind and water erosion, reducing COCs transport to ground water, reducing the risk to human health and the environment, and compliance with ARARs, in perpetuity. For the alternatives to meet the objectives, the physiochemical characteristics of soils media must meet minimal specifications to allow establishment of vegetation. Design criteria must be specifically linked to the physical characteristics of a particular area targeted for reclamation, along with its land use pattern. Given the size of the potential remedial units, each parcel of land will be evaluated for a specific standard that is linked to land use, depth and level of soil contamination, and the physical conditions of the site (e.g., degree of slope, aspect, rock cover). Furthermore, the physical conditions of the site will influence the percent cover that can be maintained. Design criteria may include, but are not limited to, parameters set for depth of rooting media, texture, pH, metal concentration, organic matter, specific conductance, surface manipulation, and seed mixture. Cover soil design specifications for use in upland positions are listed in Section 9.1.3, Reclamation (Cover Soil) Criteria. Criteria for *in situ* reclamation will be developed during remedial design. The criteria will be developed based on the information known (and contained in the Administrative Record) and knowledge gained after selection of the remedy. Vegetation performance criteria will be established during remedial design for various ecotypes at the site; criteria will be set for the following parameters: erosion, live plant cover, total cover, perennial plant community richness, proving-up period, and plant reproduction. Performance Standards also include compliance with ARARs.

9.5 GROUND WATER REMEDIES

9.5.1 REMEDIAL ACTION OBJECTIVES

The ground water areas of concern are presented in Figure 1-1. EPA and MDEQ expect to return usable ground waters to their beneficial uses wherever practicable through achievement of the remedial action goal, within a time frame that is reasonable given the particular circumstances of the site. When restoration of ground water to beneficial uses is not practicable (within WMAs and TI zones), EPA and MDEQ will prevent further migration of the plume, prevent exposure to the contaminated ground water, and further reduce risk by minimizing transport of COCs to the bedrock and alluvial aquifers.

9.5.2 CONTAMINANTS OF CONCERN AND THE REMEDIAL ACTION GOAL/PERFORMANCE STANDARDS

Remedial action goals for cleanup of contaminants in ground water and protection of ground water resources within the ARWW&S OU are established based on the applicable State of Montana numeric water quality standards set forth in Circular WQB-7. The COCs and their associated standards are listed below.

COC	WQB-7 Standard*
Arsenic	18 μg/L
Beryllium	4 μg/L
Cadmium	5 μg/L
Copper	1,000 μg/L
Lead	15 μg/L
Zinc	5,000 μg/L

*WQB-7 standards for metals in ground water are based on the dissolved metals portion of the sample.

9.5.3 GROUND WATER AREAS OF CONCERN

For the Anaconda Smelter NPL Site, EPA and MDEQ have identified the following ground water areas exceeding one or more of the remedial action goals, shown on Figure 9-6:

- Stucky Ridge TI Zone - bedrock aquifer system on Stucky Ridge;
- Smelter Hill TI Zone - bedrock aquifer system to west and south of Smelter Hill WMA;
- Mount Haggin TI Zone - bedrock aquifer system south and east of Smelter Hill area, covering drainages of Cabbage Gulch, Upper Willow Creek, and an unnamed tributary of Mill Creek;
- Opportunity Ponds WMA - alluvial aquifer under Opportunity Ponds Cells B1, B2, C1, C2, D1 and D2, and South Lime Ditch;

- Smelter Hill WMA - tertiary bedrock aquifer and alluvial aquifer under Disturbed Area, Anaconda Ponds, Main Granulated Slag, and East Anaconda Yards;
- Old Works WMA and alluvial aquifer downgradient of these areas - valley alluvial aquifer under Old Works Golf Course, Floodplain Wastes, Heap Roast Slag, Waste Piles 1-8, Red Sands Main Deposit, and alluvial aquifer downgradient of these areas underneath Red Sands and Arbiter Plant;
- South Opportunity Alluvial Aquifer - in the vicinity of Yellow Ditch (Figure 9-7); and
- Blue Lagoon - alluvial aquifer underneath and downgradient of Lagoon (Figure 9-8).

9.5.4 SELECTED REMEDY

Stucky Ridge, Smelter Hill and Mount Haggin TI Zones

Based on conclusions of the TI evaluation (Appendix D) for the bedrock aquifers in the Smelter Hill, Mount Haggin and Stucky Ridge areas, the area of the shallow bedrock aquifer with arsenic levels above the State of Montana ground water standard for arsenic (18 *ug*/L) may encompass at least 28,600 acres. The depth of ground water contamination in the bedrock aquifer is estimated as high as 250 feet below ground surface. EPA and MDEQ consider it to be technically impracticable to restore ground water quality in the bedrock aquifers to levels below the Montana Ground Water Quality Standard for arsenic, since: ; 1) the primary source of arsenic to ground water is infiltration of precipitation through widespread areas of contaminated soils; and 2) the contaminated zones are dispersed throughout fractured bedrock aquifer systems. As provided under Section 121(d)(4)(c) of CERCLA, the ground water standard for arsenic is waived within the TI zones due to technical impracticability. Documentation is provided in the TI Evaluation in FS Deliverable No. 3A (EPA 1996a) and provided in Appendix D.

The following remedial actions will be taken to minimize on-going transport of COCs to the bedrock aquifers, protect domestic water users, and provide for contingency water systems in the event of newly identified users:

1. *Complete source control measures through waste consolidation and implementation of* in situ *revegetation or soil cover treatments*. Contaminated soils and waste materials are the identified sources of arsenic to the bedrock aquifer plume in the TI zones. EPA and MDEQ require waste consolidation and *in situ* revegetation and/or soil cover of the soil and waste materials as a source control measure (see Sections 9.1 and 9.4). These source control measures will minimize transport of COCs to the ground water, prevent further migration of the plume, and may improve ground water conditions over time. EPA and MDEQ do not expect the ground water plumes to become fully restored to the State of Montana Water Quality Standards.

2. *Implement ICs to monitor and regulate domestic ground water use.* A detailed program to regulate and monitor ground water use within the boundaries of the TI zones at the ARWW&S OU will be formulated. ICs will be achieved through upgrading and enforcing the Anaconda Deer-Lodge County DPS, through implementation of a State of Montana Controlled Ground Water Area (administered through the Montana Department of Natural Resources and Conservation, Water Resources Division), or a combination of both. The PRP will be responsible for developing and implementing the ICs as part of the final site-wide ICs Plan (see Section 9.7).

3. *Establish a long-term monitoring plan.* A long-term monitoring plan will be designed and implemented to evaluate changes in ground water quality in the TI zones as the source control measures and ICs are implemented during remedial design/remedial action. The information will be evaluated during each of EPA's 5-year reviews to ensure that variations in the nature and extent, fate and transport, and changes in land use have not significantly changed EPA's assessment of the exposure of ground water contamination in the TI zones to humans and/or the environment. The PRP will be responsible for developing and implementing the monitoring plan (see Section 9.8).

4. *Complete site characterization to better define lateral and vertical extent of TI zones.* On-going site characterization will further define the nature and extent of the ground water plumes. Specifically, additional monitoring wells will be drilled to evaluate the vertical extent of the contamination, additional springs and seeps will be identified and monitored to better define the lateral extent of the TI boundaries, and newly drilled domestic well data will be added to the existing data base, as it becomes available, to expand the characterization of the TI zones.

5. *Provide for alternative water supplies.* In the event that domestic water users are discovered using contaminated ground water and/or springs surface water with COC concentrations above the State of Montana standards, an alternative water supply for those water users will be implemented. The alternative water supply may consist of newly drilled individual wells, a community-based water supply, individual home treatment systems, or hauled water. The alternative water supply will meet all applicable Federal Safe Drinking Water Act MCLs and Montana Numeric Water Quality Standards.

Opportunity Ponds and Smelter Hill WMAs

EPA and MDEQ have determined that removal of waste material within the WMA boundary is technically impracticable and cost prohibitive. Therefore, waste material will be stabilized in place, and ground water with elevated concentrations of COCs beneath the waste material will not be restored. Ground water contamination within the Opportunity Ponds area covers approximately 2,275 acres with an estimated volume of 4,550 to 11,375 acre-feet and ground water within the Smelter Hill WMA cover approximately 2,076 acres with an estimated volume of 1,980 to 3,960 acre-feet.

The following remedial actions will be taken to minimize on-going transport of COCs to the aquifers, and protect potential water users:

1. *Complete source control actions through implementation of soil covers and/or in situ revegetation treatment.* Contaminated waste materials are the identified sources of arsenic, cadmium and copper to the alluvial and bedrock aquifer plumes underneath WMAs. EPA and MDEQ require *in situ* revegetation and/or soil cover of the waste materials as a source control measure (see Section 9.1). Source control measures will minimize transport of COCs to the ground water, prevent further migration of the plume, and may improve ground water conditions over time. EPA and MDEQ do not expect the ground water plumes to become fully restored to applicable State of Montana Water Quality Standards.

2. *Implement ICs to manage future water use.* EPA and MDEQ will prohibit ground water use for domestic consumption. Ground waters in the WMAs may be treated and/or used for irrigation, agricultural or industrial purposes if determined protective for the use.

3. *Provide for containment of ground water plumes.* Clean up levels must be maintained "at and beyond the edge of the WMA when waste is left in place" (*1990 NCP Preamble at 55 FR 8713*); therefore, EPA and MDEQ have established ground water boundary POCs for each WMA (see Section 9.1.4). In the event a POC boundary is violated, EPA and MDEQ will respond by conducting one or more of the following actions: 1) re-assess containment alternatives for any migrating contaminant plume (e.g., use of slurry walls or extraction wells); or 2) complete a TI evaluation for the aquifer in areas of ground water contamination located outside the compliance boundary.

Old Works WMA and Alluvial Aquifer Cadmium/Copper Plume

The previously selected remedy for the OW/EADA OU left wastes in place within that OU boundary. Wastes were consolidated and graded as necessary to reduce infiltration and control runoff and capped with an engineered cover (Figure 9-9). This remedy was documented in the 1994 ROD for the OU. The wastes-left-in-place included the Red Sands, Floodplain Wastes (Jig Tailings), Heap Roast Slag, and Waste Piles 1-8.

The goal of the ARWW&S OU remedial action is to restore a portion of the ground water at the OW/EADA OU to its beneficial use (the area located downgradient of the Red Sands Main Deposit - see Figure 9-4). The importance of restoring this portion of the valley alluvial aquifer is heightened in light of lost use of ground water resources surrounding the community of Anaconda. Based on information obtained during the ARWW RI and implementation of source controls measures taken under the Arbiter and Old Works Tailings EE/CA removal actions and OW/EADA ROD, EPA and MDEQ believe that the remedy selected in the OW/EADA ROD may be able to restore the aquifer downgradient of the Red Sands POC. The targeted area and volumes for restoration are estimated to be 320 acres with 640 acre-feet of water.

Ground water contamination may be especially persistent in the immediate vicinity of the Red Sands (21 acres) upgradient of the Arbiter Plant, where concentrations of COCs are relatively high. The ability to achieve cleanup goals below the POC and throughout the area of attainment cannot be determined until the final source control remedies are implemented and plume response is monitored over time. If source controls identified in the OW/EADA remedy cannot meet the specified remediation goals at any or all of the monitoring points during implementation and subsequent monitoring, the contingency measures and goals described in this section may replace the selected remedy and goals for a portion of the plume. Such contingency measures are intended to, at a minimum, prevent further migration of the plume and could include a combination of containment technologies and ICs.

The following remedial requirements are applicable to the ground water portion of the OW/EADA OU for the objective of restoring a portion of the alluvial aquifer downgradient of the Red Sands Main Deposit:

1. *Complete OW/EADA OU source control actions through final implementation of consolidation/grading actions and engineered covers.* EPA and MDEQ require final design and implementation of the engineered covers over the Arbiter Plant properties and Drag Strip area, and full implementation of the storm water management plan as described in the OW/EADA ROD.

2. *Implement a monitoring plan to track the progress of attaining remediation goals.* A monitoring plan will be designed and implemented to allow EPA and MDEQ to assess progress toward attaining restoration of a portion of the aquifer.

3. *Maintain existing ICs which prohibit ground water use until attainment of the restoration goals.* As part of the OW/EADA ROD and Prospective Purchasers Agreement (1994), EPA, ARCO, and ADLC agreed to place water development bans within this OU. These controls will remain in place until EPA and MDEQ have determined that the aquifer has met the established restoration goals for a portion of the alluvial aquifer.

If it is determined on the basis of the preceding remedial actions and monitoring data that this portion of the aquifer cannot be restored to its beneficial use, one or more of the following measures involving long-term management may occur for an indefinite period of time as a modification of the existing system:

- Implementation of engineering controls at the Red Sands POC, which may include construction of a slurry wall or installation of pumping wells;

- Cadmium and copper standards will be waived for the cleanup of those portions of the aquifer based on the TI of achieving further contaminant reduction and the POC moved to the OU boundary;

- ICs will be maintained to restrict access to those portions of the aquifer which remain above the remediation goal;

- Continued monitoring of the plume; or
- Periodic re-evaluation of remedial technologies for ground water restoration.

The decision to invoke any or all of these measures may be made during a periodic review of the remedial action.

Yellow Ditch And South Opportunity Alluvial Aquifer Plume

For the South Opportunity area, the aerial extent of arsenic concentrations in ground water in excess of 18 $\mu g/L$ is approximately 1,200 acres, with the volume of affected ground water estimated to be 2,400 acre-feet to 7,200 acre-feet. Elevated arsenic levels have been confined to the uppermost portion of the alluvial aquifer, estimated to range approximately 10 to 30 feet. The final remedy for this area of concern will address the identified sources of arsenic: impacted surface waters used for flood irrigation, regional soils containing arsenic from aerially deposited stack emissions, and berm and sediment material containing arsenic along Yellow Ditch. The remedy will address the historic irrigation practices in which surface water in Willow Creek has been diverted to Yellow Ditch and transported for flood irrigation in the South Opportunity area. The major components of this remedial strategy are provided below:

1. *Minimize flood irrigation practices in the South Opportunity area.* ARCO is in the process of acquiring property and water rights in the South Opportunity area and is implementing a strategy to close the head gates at the diversions to Yellow Ditch. Elimination of flood irrigation is anticipated to improve ground water quality in the South Opportunity area through reduction of:

    - Surface water infiltration;
    - Evaporative concentration effects;
    - Large seasonal fluctuations in the ground water table which will reduce ponding and evaporative concentrations of ground water;
    - Unstable redox conditions associated with ponding of ground water; and
    - Water table interaction with arsenic impacted vadose zone pore water or overlying soils.

2. *Implementation of an engineered soil cover over Yellow Ditch.* Construction of a soil cover over Yellow Ditch would be effective in eliminating metals loading to portions of the underlying alluvial aquifer by reducing the rate of infiltration and eliminating loading of metals from contaminated soils and wastes to surface water used for any remaining irrigation practices.

3. *Rely on natural attenuation and dilution of arsenic in the alluvial aquifer to control the extent and concentration of arsenic and attain the remedial action objective of less than 18 µg/L in the aquifer.* The cessation of flood irrigation is anticipated to disrupt the chain of loading mechanisms and subsequently allow dilution and natural attenuation to decrease the level of dissolved arsenic in the ground water. The estimated remediation time frame necessary to reduce arsenic levels in the shallow alluvial aquifer to less than 18 µg/L ranges from 5½ to 28 years.

4. *Establish ICs to control access to and use of water within the South Opportunity area.* The primary ICs in the South Opportunity area will provide for the establishment of well installation standards requiring all future water supply wells be constructed so that their screened intervals are below the depth of arsenic impacted ground water (approximately 30 feet). In addition, all new water supply wells have to be tested for concentrations of dissolved arsenic prior to final permitting. These ICs will be implemented through amendments to the ADLC DPS and/or use of State of Montana Control Ground Water Use Areas. Through ARCO's acquirement of property and water rights in the South Opportunity area, ARCO has already established covenants that restrict future flood irrigation. These covenants will remain in place for protection of the source control remedy. It may be necessary for ARCO to modify or refine these covenants as part of this remedial action. It is not anticipated that a reduction in flood irrigation will result in negative impacts on the water levels in local domestic wells.

5. *Establish a ground water performance monitoring plan.* The ability of ICs, source controls, and natural attenuation to improve ground water quality of the shallow alluvial aquifer in the area will be evaluated by a ground water and surface water monitoring program. The performance monitoring program will specify the location, frequency, and type of samples and measurements necessary to evaluate remedy performance. The monitoring program will demonstrate if natural attenuation is occurring according to expectations, determine if the plume is expanding (either downgradient, laterally or vertically), ensure no impact occurs to downgradient receptors, demonstrate the efficacy of the ICs program, detect changes in environmental conditions that may reduce the efficacy of the natural attenuation process, and verify attainment of cleanup objectives. Performance monitoring will continue as long as contamination remains above required cleanup levels. An evaluation of the performance of the source control/natural attenuation remedy will be provided during each of the five-year site reviews.

If it is determined, on the basis of the preceding remedial actions and monitoring data, that this aquifer cannot be restored to its beneficial use, all of the following measures involving long-term management may occur, for an indefinite period of time, as a modification of the existing system:

- An analysis of the TI of achieving further contaminant reduction and potential waiver of the arsenic standard;

- ICs will be maintained to restrict access to those portions of the aquifer which remain above the remediation goal;

- Continued monitoring of the plume; and

- Periodic re-evaluation of remedial technologies for ground water restoration.

The decision to invoke any or all of these measures may be made during a periodic review of the remedial action.

Blue Lagoon Alluvial Aquifer Plume

The area of contaminated alluvial aquifer located near the Blue Lagoon is approximately 5 to 10 acres with average depth of ground water contamination estimated to be 10 feet. The remedial action for the Blue Lagoon area will address the primary sources of metals to the alluvial aquifer and surface water of the Blue Lagoon which are leaching from railroad grade material contaminated soils, sediment located at the bottom of the Blue Lagoon into the aquifer, and possibly contaminated material in the outwash located downgradient of the Lagoon. The major components of this remedial strategy are provided below:

1. *Excavation of approximately 5,100 cy of contaminated sediments/waste from the Blue Lagoon and contaminated sediments within the conveyance ditch downstream of the Blue Lagoon.* Waste from the Blue Lagoon will be excavated, removed, and disposed in a WMA. Contaminated sediments within the conveyance ditch downstream of the Blue Lagoon will also be excavated and disposed in a WMA. The lagoon and conveyance ditch will be reconstructed to facilitate use of landowner's water rights.

2. *Install a culvert at the railroad fill base to promote surface drainage upgradient from the Blue Lagoon.* The culvert will convey ponded water within the surface drainage upgradient of the railroad fill through the grade and into the reconstructed lagoon. This culvert will eliminate leaching of metals from the base of the railroad fill by surface water.

3. *Revegetation of outwash.* For the area downgradient of the Blue Lagoon that has been impacted from overland transport of contaminated surface water, a revegetation plan will be developed using the LRES scoring and decision process outlined in the Contaminated Soils Remedies section (Section 9.4) of this ROD.

4. *Natural attenuation processes will be allowed to work.* The above source control measures will not directly remediate the alluvial aquifer at the Blue Lagoon. With the sources of metals loading mitigated, ground water and surface water contamination should naturally attenuate the metals concentrations and achieve applicable state standards within a reasonable time.

5. *Performance monitoring plan.* The ability of source controls and natural attenuation to improve ground water quality of the shallow alluvial aquifer in the area will be evaluated by a ground water and surface water monitoring program. The performance monitoring program will specify the location, frequency, and type of samples and measurements necessary to evaluate remedy performance. The monitoring program will demonstrate whether natural attenuation is occurring according to expectations, determine if the plume is expanding (either downgradient, laterally or vertically), ensure no impact occurs to downgradient receptors, detect changes in environmental conditions that may reduce the efficacy of the natural attenuation process, and verify attainment of cleanup objectives.

9.6 SURFACE WATER REMEDY

Periodic exceedances of water quality standards within the ARWW&S OU are caused by surface water runoff from aerially contaminated soils and from areas of evaporative salts, erosion of fluvially deposited tailings into receiving water bodies, and contaminated ground water discharges into perennial flow drainages. In order to meet the remedial action objectives, EPA and MDEQ will require reclamation of contaminated soils, engineered storm water management options to control overland runoff, and other engineering controls to minimize releases from fluvially deposited tailings.

Specific remedial action objectives of the Selected Remedy will be to achieve the following:

1. Minimize source contamination to surface waters that would result in exceedances of State of Montana water quality standards.

2. Return surface water to its beneficial use by reducing loading sources of COCs.

During the FS, EPA, in consultation with MDEQ, assessed the feasibility of active treatment of surface waters in Yellow Ditch and Cabbage Gulch. The Selected Remedy in this ROD is passive treatment (i.e., source controls through land reclamation, soil covers, and other engineered storm water runoff controls), natural attenuation, and monitoring for these surface water resources. The reader is referred to Sections 9.1 and 9.4 for a description of the remedial requirements. EPA and MDEQ believe these requirements, as well as those mentioned in this section, will lead to attainment of the specific remedial action objectives. The remainder of Section 9.6 describes specific remedial requirements for Warm Springs Creek, Mill Creek and Willow Creek.

9.6.1 CONTAMINANTS OF CONCERN AND THE REMEDIAL ACTION GOALS/PERFORMANCE STANDARDS

Remedial action goals for protection of surface waters within the ARWW&S OU are established based on applicable State of Montana numeric water quality standards set forth in Circular WQB-7 which are protective of human health and aquatic life. The COCs and their associated standards are listed below. Cadmium, copper, lead and zinc are calculated at a hardness of 100 mg/L $CaCO_3$ equivalent. Measurements and compliance of the COCs will be for total recoverable concentrations.

COC	Standard
Arsenic	18 μg/L
Cadmium	1.1 μg/L
Copper	12 μg/L
Iron	300 μg/L
Lead	3.2 μg/L
Zinc	100 μg/L

9.6.2 REMEDIAL ACTION REQUIREMENTS BY AREA OF CONCERN

Warm Springs Creek

Human actions on Warm Springs Creek (e.g., channelization, relocation, historic mine waste disposal, and flow alterations) have resulted in reaches of the channel being unstable with increasing lateral movement and down cutting. Remedial actions are necessary to protect erosion control structures within the OW/EADA OU and to minimize rates of release of COCs found in aerially contaminated riparian soils fluvially deposited tailings. The Selected Remedy for Warm Springs Creek will:

- Minimize erosion of fluvially deposited tailings using selective removal and stream stabilization techniques;

- Remove identified waste material located on the RSN Johnson ranch and consolidate into a WMA;

- Selectively remove other waste materials within the unstable portion of the stream and consolidate into a WMA;

- Replace removed wastes with material of acceptable quality; and

- Employ stream stabilization techniques, such as rechannelization, gradient controls and stream bank re-enforcement to minimize future migration of the stream into adjacent fluvially deposited tailings and to protect waste caps and erosion control structures implemented in the OW/EADA OU, in accordance with ARARs. Waste material outside the unstable portion will be revegetated to reduce runoff.

Mill Creek and Tributaries

Water quality degradation in the Mill Creek drainage is primarily influenced by surface water runoff from aerially contaminated soils and contaminated ground water discharges into perennial flow drainages from the Cabbage Gulch, Aspen Hills, and Clear Creek areas. Minor additions of COCs into Mill Creek may also be contributed from waste materials placed along stream sides for historic railroad grade and bridge abutment use. The following Selected Remedy will be implemented to address potential and known sources of contamination:

- Conduct mass-loading analysis from tributary drainages to determine distribution of loading sources;

- Use non-point source BMPs by employing land reclamation technologies to reduce surface water runoff and transport of COCs to surface water receptors;

- Where BMPs cannot fully minimize non-point source runoff, construct surface controls to manage surface water runoff from Cabbage Gulch, Aspen Hills, and Clear Creek, and throughout the area to minimize discharge to Mill Creek; and

- Use selective removal or other source control measures (capping or soil covers) to prevent release of waste materials from bridge abutments into surface water.

Willow Creek

During the RI/FS investigation of Willow Creek, the stream system was divided into two segments: the upper segment located above Yellow Ditch in which the entire stream was diverted into Yellow Ditch for irrigation practices; and the lower segment beginning down stream from Yellow Ditch, with flows re-established by ground water discharge into the stream channel. Sources of elevated arsenic concentrations in the upper segment of Willow Creek were not identified during the RI/FS; however, based on the Ground Water TI Evaluation Addendum (Appendix D), surface water runoff from aerially contaminated soils and/or discharges from contaminated ground water into the headwaters of Willow Creek may be a source of increased levels of arsenic (concentrations between 20 - 50 *ug/L*). COC source loading for the lower segment of Willow Creek was identified as a thin layer of fluvially deposited tailings in the historic floodplain between Willow Creek and Silver Bow Creek. The following Selected Remedy will be implemented to address potential and known sources of contamination:

- Conduct mass loading analysis from headwater drainages to determine distribution of loading sources;

- If necessary, use non-point source BMPs in the headwaters area of Upper Willow Creek by employing land reclamation technologies to reduce surface water runoff and transport of COCs to surface water receptors; and

- Remove an estimated 96,000 cy of fluvially deposited tailings along the lower segment of Willow Creek and dispose into a WMA, and backfill, grade and revegetate area as necessary to prevent erosion of fluvially deposited tailings into the surface water in accordance with ARARs. (The estimated total tailings along the lower segment of Willow Creek is 157,000 cy; this scenario is considered a partial removal).

9.6.3 SITE-WIDE SURFACE WATER REMEDIAL ACTIONS

1. *Establish a long-term surface water quality monitoring plan.* A water quality monitoring plan will be implemented to assess cleanup and protection of water quality for all surface

water resources in the ARWW&S OU. The elements of a monitoring plan for Mill Creek, Willow Creek and Warm Springs Creek will be consistent with the Upper Clark Fork Basin Long-Term Monitoring Plan, currently implemented by the U.S. Geological Survey.

2. *Finalize and implement site-wide storm water management plan.* Storm water regulations are applicable to the operable unit and particularly to Stucky Ridge, Smelter Hill, Aspen Hills, Clear Creek and Cabbage Gulch areas. These areas received diffuse air borne smelter emissions and exceed State of Montana water quality standards for arsenic in perennial, intermittent and storm water flows.

   EPA and MDEQ require development and implementation of a storm water runoff control plan for the ARWW&S OU. The approach of the plan will be to apply storm water BMPs with an emphasis on revegetation supplemented by engineering controls (e.g., sedimentation basins, storm water detention basins, ditches). This plan will detail all existing storm water management features within the OU, describe engineered improvements to the system, and determine which areas need revegetation for erosion control. The revegetation decisions will be made in conjunction with the Contaminated Soils remedy portion of the ROD (Section 9.4). The overall objective of the plan will be to reduce contaminated runoff into surface water to below Montana water quality standards and to route remaining storm water from Smelter Hill and the Old Works/Stucky Ridge areas to Opportunity Ponds for proper management.

3. *Establish a storm water management performance monitoring program.* The ability of revegetation and engineering controls to improve and protect surface water quality will be evaluated by a storm water performance monitoring program. The performance monitoring program will specify location, frequency, and type of samples and measurements necessary to evaluate remedy performance. Performance monitoring will continue as long as contamination remains above required cleanup levels.

   Prior to construction of the remedies, a mass balance waste load analysis will be conducted within each of the watersheds to assess storm water contaminant contribution to receiving water bodies. An initial three-year monitoring program will begin at construction completion with sample measurements taken at the final downgradient discharge point and within receiving water bodies. An evaluation of the performance of the remedy will be provided during each of the five-year site reviews.

If it is determined, on the basis of the preceding remedial actions and monitoring data, that these water sheds cannot meet applicable water quality standards, one or more of the following measures involving long-term management may occur for an indefinite period of time as a modification of the remedy:

- An analysis of the TI of achieving further contaminant reduction and potential waiver of the water quality standard;

- Re-evaluation of remedial technologies for treatment of surface water; and

- Consideration of additional BMPs.

9.7 INSTITUTIONAL CONTROLS (ICs)

ICs are a necessary supplement to reclamation and engineering controls when waste is left in place or where ground water will continue to exceed standards, as it will with this response action. Therefore, EPA and MDEQ expect ICs to play an integral part in the Selected Remedy to assure future protection of human health and the environment. An ICs program will be developed in conjunction with the selected reclamation and engineering controls to include three basic components: land use restrictions and zoning, ground water controls, and public notices or advisories.

The Selected Remedy, through ICs, will:

- Assure that future land and water use at the site is consistent with EPA's determination of the health and environmental risks posed by contaminants left on site;

- Provide for the preservation and maintenance of Superfund remedial structures on the site, including but not limited to engineered caps, covers, storm water conveyances, waste repositories and reclaimed areas;

- Require that future development at the site employ construction practices that are consistent with the protection of public health and the environment, as determined by Superfund remedial actions;

- As development occurs at the site, implement the remediation of soil arsenic contamination to levels appropriate for the intended use, as determined by Superfund remedial actions;

- Provide for implementation of other laws applicable to development, such as subdivision and floodplain requirements; and

- Provide information and notice to the public (users or potential users of land or ground water) of some existing or impending risk associated with their use of the site.

The following public and private ICs, to be developed in conjunction with EPA and MDEQ, the State of Montana, ADLC, and ARCO, have been identified as likely components of an ICs Program to address the above remedial requirements within the Anaconda Smelter NPL Site. An overall site ICs management plan will be developed during Remedial Design, describing specific lands and/or properties with attached ICs, outlining new ICs that will be implemented, and providing for an annual reporting and tracking system to EPA and MDEQ. The plan will also describe any necessary funding requirements for each element of the plan.

EPA and MDEQ have integrated many ICs components into the final set of engineering and reclamation remedies on this site. The package of ICs approved as part of the ICs Management Plan will be reviewed no less than every five years to assess how the ICs are helping to maintain elements of the remedy and whether the ICs still contribute to protection of human health and the environment. If at any time EPA and MDEQ determine that ICs are failing to protect an engineered remedy or fail protection of human health and the environment, EPA and MDEQ will re-assess the overall protectiveness of the remedy and may require additional site cleanup.

9.7.1 ADLC COMPREHENSIVE MASTER PLAN AND DPS

ADLC has adopted a Master Plan and DPS to provide an over-arching land use plan as well as specific land use regulations which: 1) assure that land use is consistent with the Superfund remedies implemented within the county and are consistent and current with designated land uses; and 2) protect human health and the environment from any remaining unacceptable risks posed by waste-left-in-place. These restriction apply to all public and private property at the Anaconda Smelter Site. These governmental restrictions have been integrated with land use restrictions placed on titles to individual properties through conservation easements and restrictive covenants as well as other community programs.

The Master Plan identifies each of the NPL sites and OUs within ADLC and establishes a Superfund Study Area. Within the Superfund Study Area, the Master Plan land use policy is supportive of Superfund remediation that is protective of human health and the environment and levels of cleanup that would allow use of soils and water commensurate with proposed land and water uses. The Plan creates a Superfund Planning Area Overlay Development District, the principal tool for establishment of ICs, that requires all development within the Superfund sites to occur on lands only after the level of contamination poses no significant health risk. This overlay also controls access to potentially contaminated ground water and protects the integrity of remedial measures by regulating development.

The DPS implements the Master Plan by requiring a permit for any subdivision of land, clearing, grading, excavation, construction, reconstruction, or any development or building activity, with certain exceptions. Development must be consistent with the DPS requirements and approved by the County Administrator. DPS requirements, or performance standards, have been identified by development district for the permitted or special permitted uses of that district. The DPS generally requires a grading plan, an erosion and runoff control plan, and requires a remediation plan: 1) where remedial structures are in place; or 2) in unremediated areas or areas remediated to a previous land use that would now exceed the following arsenic trigger levels: residential use - 250 ppm; commercial/industrial use - 500 ppm; and recreational use - 1,000 ppm.

Because of the integral nature of ICs to this final site-wide remedy, this ROD calls for a stable, long-term funding source to ADLC. Funding will cover adequate resources for legal, administrative, organizational, planning, engineering, mapping, and support services, including staff and supplies. .

9.7.2 LAND OR PROPERTY USE RESTRICTIONS

Private property law provides a variety of tools that can be used to restrict or affect the use of property. These include restrictive covenants, conservation easements, dedicated developments, and other property conveyances restricting future land use or prohibiting activities that may compromise specific engineering remedies implemented at the site. Permanent land use restrictions will be used in areas where waste is left in place and/or where an engineering control has been constructed. These restrictions may limit the type of use (e.g., residential), activities (e.g., excavation) and/or provide for access control or the maintenance of engineered controls.

Other land use restrictions may permanently or temporarily limit activities to "Best Management Practices" (i.e., grazing or irrigation restrictions, weed control) in reclaimed areas to such a time as no longer warranted. The following are examples of land use restrictions that are currently applied on portions of the Anaconda Smelter Site.

Restrictive Covenants

Restrictive covenants are written restrictions or requirements placed on the title to real property that bind current and future owners of the property. ARCO has placed restrictive covenants on a number of properties within the Anaconda Smelter Site. Restrictions are used to prohibit or restrict land uses, construction activities, access, and ground water uses such as well drilling. Although important, these are the least preferred land use tool since enforcement relies primarily on private entities and notice is solely available though a deed search.

Dedicated Developments

Dedicated development is the construction of improvements on land and the dedication of the improved land to a governmental or other agency for the use of the public. A dedicated development may include restrictions on the property in the form of restrictive covenants, negative easements, or other mechanisms which restrict the use of the property to accomplish a specific purpose. Examples include: parks, trails, golf course, airport, railroad, etc. Land dedicated to a public entity has a greater likelihood of maintaining the permanence of ICs.

Conservation Easements

Federal, state, and local governments and agencies, and qualified private organizations can be provided conservation easements for the purpose of preserving open space or natural characteristics under state law. The easements bind subsequent landowners and may be granted in perpetuity or on renewable terms of not less than 15 years. The easements would prohibit subdivision of the property and prohibit construction activities, but allow public access for recreational purposes. Conservation easements held by the Montana Fish, Wildlife & Parks Commission in the North and South Opportunity Subareas are examples of these restrictions.

Conveyances

ARCO has indicated that it will only convey lands to other parties for development if the transferee agrees to specific restrictions and obligations on the use and development of the property. These restrictions and obligations will be set forth in the deeds and conveyance agreements designed to ensure that future obligations in support of the remedy are fulfilled.

9.7.3 GROUND WATER USE CONTROLS

Ground water use controls (restrictions/management areas) are directed at limiting or prohibiting certain uses of ground water where ground water may remain contaminated for an extended period. Ground water restrictions will be used in areas where waste is left in place (WMAs) and may include prohibitions or limitations on certain uses of ground water, capping or closing of wells, and limitations on the drilling of new wells. Ground water management areas will be established in the TI zones and may include a permitting program to require water quality testing, licensing of well drillers, prohibitions on the drilling of new wells in areas of contamination, or requirements and controls on the construction and use of wells (i.e., well depths, consumption uses).

Ground Water Restrictions

Ground water use at the Anaconda Smelter Site is presently controlled largely by the restrictive covenants which have been placed on the ARCO-owned property as well as other conveyed property. Restrictive covenants, easements, conveyances, or dedicated developments in most instances provide that no ground water wells will be drilled for potable use. Other ground water controls may also be established, such as controlled ground water areas; or through appropriate agreements with individual landowners.

Ground Water Management Areas

Controls on drilling wells for ground water exist in the ADLC though its DPS. The ADLC DPS sets out specific requirements for use of ground water by any person within the Superfund Study Area. The DPS requires the county engineer to issue a permit before a well is drilled. Further, prior to issuance of a certificate of completion for a well, the water must be sampled according to protocol which specifies testing requirements for coliform bacteria, arsenic, cadmium, other metals, and nitrate. Other legal mechanisms for dealing with restrictions on water wells, including the 35 gpm or less wells, that can be effective ICs, include:

- Controlled Ground Water Areas - The Montana Department of Natural Resource and Conservation (DNRC) has the authority to grant applications to establish a Controlled Ground Water Area where withdrawals will cause contaminant migration and subsequent degradation of ground water. Establishment of a Controlled Ground Water Area would prevent the drilling of any additional new wells, regardless of production rate, into the ground water in the area designated by the DNRC.

- Local Water Districts - Local governments may form local water quality districts for the purpose of preserving and protecting water quality. Once formed, a district is empowered to enact and enforce water control ordinances.

9.7.4 COMMUNITY PROTECTIVE MEASURES

Efforts to provide better public information about risks from contamination are a form of institutional control. These include private property transactions, deed notices, or other land recording systems that would alert anyone searching the records to important information about the property. Other means of alerting the public to the presence of contamination can be developed that focus less on giving notice to purchasers and more on informing the general public. These include setting up records on contaminated property, easily identifiable by locality, at a local office (or local government), and their existence generally publicized so that community members, or potential purchasers, will know how to find them.

Community Protection Measures Program

The Community Protective Measures Program (CPMP) is an element of the selected remedy for the Community Soils OU and is applicable to the ARWW&S OU. The CPMP is intended to provide regulatory and educational support to residents within the Superfund Study Area. Educational materials will discuss the potential risks associated with exposure to elevated arsenic levels in the environment and suggest methods for reducing exposure. The administrator in charge of the CPMP will be responsible for responding to residents who are concerned about arsenic exposure on their property. In accordance with defined procedures and upon request from a property owner or resident, the CPMP administrator will perform sampling and provide assistance, including remediation as necessary, to reduce unacceptable exposure. As part of this program, information regarding the current status of exposure (i.e., arsenic levels, cleanup status, future requirements) will be maintained on a Geographical Informational System, which will display information for specific locations and be made available to the public. The program may develop other types of informational material, such as maintenance of remedies (e.g., protection of caps) and a developers' package.

9.8 RD/RA MANAGEMENT

9.8.1 SITE MANAGEMENT PLAN

The ARWW&S OU is a very large site, with Remedial Action slated for approximately 20,000 acres (Figure 1-1). The size of the site and the focus on land reclamation as the key remedy leads project management toward a specific structure to address the multiple elements of the final cleanup and long-term management of large areas of waste-left-in-place. The SMP will be a planning and strategy document with the purpose to set forth a rational process for addressing the various elements of RD/RA in a manner that is efficient, as well as sensitive to public health, the environment and the community. Definition of such a process entails the designation of Remedial Design Units (RDUs), and a plan for identification of their interrelationships and priorities. In addition, the SMP will address priorities of the individual work elements associated with the RDUs, and an order in which to address them. The rationale used to determine the priority shall be clearly defined.

Developing remedial actions at each RDU will involve undertaking and accomplishing individual tasks. Data and information must be obtained, analyses performed, treatment technologies renewed, and remedial action implemented. Some tasks must follow a particular sequence, others may occur in parallel. Individual work tasks range from data collection, to implementation of treatability studies and ICs, and design and implementation of the remedial technologies. Data analyses and treatment technology refinement will utilize regional and site-wide information as much as possible to streamline the RD/RA process.

Elements of the SMP are as follows:

Objectives

The SMP will provide a framework for future RD/RA activities for the ARWW&S OU. The SMP will incorporate RDU designations and sequencing criteria for the RD/RA actions. This will be accomplished by:

- Identifying and describing RDUs for the ARWW&S OU;
- Describing the inter-relationships between the RDUs;
- Determining the remedial action priority for the RDUs (and providing the rationale for the prioritization); and
- Providing projected schedules for the various activities associated with implementing remedies and O&M.

The SMP will be a planning and strategy document. As such, it will establish a flexible framework for coordinating and performing the various activities associated with the ARWW&S RD/RA. The SMP may change over time to meet the goals of the ARWW&S RD/RA as additional information is gathered and priorities shift. Annual reports and/or updates may be presented within the SMP structure.

RDU Sequencing and Interaction

The RD/RA SMP will identify sequencing criteria to consider in prioritizing and scheduling remedial action at the ARWW&S OU. The sequencing criteria will be based on the current or potential for human and/or environmental exposure. The criteria will also take into consideration ADLC land use planning and coordination with Natural Resource Damage restoration.

A phased approach to remedial action will accelerate risk reduction and provide additional technical site information on which to base future remedial action sequencing decisions. EPA, in consultation with the State, will periodically review the application of sequencing criteria and the respective schedule. Lower priority RDUs may be addressed prior to the time frame suggested, if it can be shown that the earlier performance of the action for the RDU will contribute to a more cost-effective remedy or will better enhance the protectiveness of the remedy.

9.8.2 CULTURAL AND HISTORIC MITIGATION AND PRESERVATION

Valuable historic resources have been identified and inventoried on the Anaconda Smelter NPL Site. Historic preservation and mitigation at the Site will continue to be managed through implementation of the Regional Historic Preservation Programmatic Agreement. The second programmatic agreement was approved and signed by all applicable federal, state and local agencies, consulting agencies, and ARCO in 1994.

The programmatic agreement outlines three specific types of actions: 1) historic properties where no impact is expected (Washoe Reduction Works/Stack, Slag Piles, Anaconda Ponds, Mill Creek Community, Opportunity Ponds); 2) historic properties that will receive on-site mitigation and be subject to the processes outlined in the agreement (Upper and Lower Works at Old Works Golf Course and Red Sands area); and 3) historic properties that may be impacted, and if so, will be included in the off-site mitigation package (all areas listed in #1 and #2).

The specified off-site historic mitigation obligations for the Site have been implemented through preservation of the flue areas and structures located at the Old Works, construction of the Upper and Lower Old Works/Red Sands Trails, installation of interpretation signage along the trails and funding of a housing inventory in the city of Anaconda and an archives project for the community of Anaconda. No further historic preservation within the Anaconda Smelter NPL Site is anticipated. For remaining areas noted in the programmatic agreement, remedial action will be conducted to avoid impacts to the historic landscape and structures to the maximum extent possible.

The Confederated Salish and Kootenai Tribes (CSKT) are recognized as Natural Resource Trustees in the Upper Clark Fork River Basin based upon reserved treaty rights from the Hellgate Treaty of 1855. The CSKT have also established cultural and historical use of the area, based upon a record of archeological, historic and oral tradition records. The CSKT were not a party to the 1994 Regional Historic Preservation Programmatic Agreement, and because this agreement does not provide for appropriate consultation with the Tribes on historic preservation issues, EPA and MDEQ will require appropriate consultation with the tribes and other compliance with applicable historic preservations.

9.8.3 WETLANDS MITIGATION

EPA and MDEQ have determined that the substantive requirements of Section 404 of the Clean Water Act, regulating the discharge of dredge or fill materials into aquatic ecosystems, and Executive Order 11990, which established a national policy of minimizing losses of and adverse impacts to wetlands, are applicable to the ARWW&S OU. To meet these regulatory requirements, it is necessary to determine where jurisdictional wetlands occur on the site and what functional values such wetlands have. The information is used to develop an accounting of losses and gains of wetland functional value from pre- to post-remediation conditions.

EPA and MDEQ have approved a four step process to determine application of the national no-net loss of wetlands policy for the Upper Clark Fork Basin Superfund sites. These steps are: 1) wetland delineation and functional evaluation; 2) preliminary analysis of impacts to wetlands from potential response action; 3) detailed analysis of impacts from a chosen response action; and 4) confirmation of response action impacts.

Due to the large area of investigation during the RI/FS, wetland delineation and functional evaluation analyses and preliminary analysis of impacts to wetlands from potential response actions were conducted using a broad-based approach in Anaconda. With this ROD, area-specific wetlands delineation and functional evaluations will be conducted as needed and a more detailed analysis of potential impacts from construction activities will be submitted during the design phase. General information regarding wetlands impacts and tracking of site-wide mitigation will be presented during the annual reports on the Site Management Plan. Project specific mitigation plans, which address the substantive ARAR requirements for protection of wetlands and associated aquatic habitat, will propose mitigation measures following the guidelines set forth at 40 CFR 230, Subpart H. The Mitigation Plan will be submitted to the agencies for review as part of the ARARs report submitted as part of each design package. These efforts may be coordinated with wetland restoration efforts.

There is potential that a proposed final remedial action design may be modified during construction. For sites where such changes are made, a final analysis of impacts following construction will be prepared. The final analysis will be submitted at the completion of remedial action for each individual project prior to Certification of Construction Completion. A final accounting of acreage totals and conclusions presented in the previous analyses regarding anticipated changes in the wetland values and functions would be revised to conform with the as-built design of the Selected Remedy.

9.8.4 OPERATIONS AND MAINTENANCE (O&M)/MONITORING PLANS

This ROD outlines numerous remedial actions to be taken to address remaining waste materials, contaminated soils, ground water and surface water throughout the ARWW&S OU. As part of the long-term management of this site, an O&M/Monitoring Plan will be developed. This plan will describe the level of monitoring and O&M that will be required as part of the final decision for remedial activities and will be applied to each area of concern within the OU.

The purpose of the document is to:

- Describe the objectives, specific locations and procedures for monitoring ground water, and for any contingency actions, describe operating and maintenance activities for ground water remediation;

- Describe the objectives, specific locations and procedures for monitoring surface water;

- Describe the objectives, specific locations and procedures for monitoring and maintaining the storm water control structures;

- Describe the objectives and specific procedures for monitoring and maintaining the function and integrity of the engineered and soil/vegetative covers and the vegetation on *in situ* reclaimed areas;

- Describe the objectives and specific procedures for terrestrial and aquatic biological monitoring;

- Describe the analytical and reporting requirements for all samples and data; and

- Specify how site security will be maintained.

Where applicable, the document will incorporate previously approved OW/EADA and Flue Dust monitoring and maintenance activities as outlined in the *OW/EADA Remedial Action Work Plan and Operation and Monitoring Plan* (ARCO 1994) and the *Smelter Hill Repository Complex Interim Post-Closure Operation and Monitoring Plan* (ARCO 1996d).

9.9 ESTIMATED REMEDY COSTS

The total present worth cost of the remedy was estimated in the feasibility study to be $178,963,000.00. This was based on generally conservative assumptions. Capital costs were calculated for direct implementation of the action (e.g., mobilization, site preparation, materials, temporary roads, storm water management, construction monitoring) and indirect costs (e.g., supervision, inspections, contractor bonds, design). These combined capital costs were spread over the time for implementation of the alternative. Operation and maintenance costs for each alternative were then calculated for a 30-year estimate and included activities such as inspections, vegetation repair work, surface and ground water monitoring, ongoing storm water management and site reviews. O&M costs were also calculated for all No Further Action alternatives, reflecting the fact that large areas containing contaminated soils would be left in place without further action.

Based on site-specific information received separately from ARCO and MDEQ during the Proposed Plan Public Comment Period, EPA revised costing assumptions used for calculating cover soil and *in situ* revegetation alternatives. These revised assumptions and costs are presented in Appendix E and are summarized in Table 9-1. Furthermore, EPA has chosen to represent a range of cost for all areas of concern which will require reclamation. The revised total present worth cost of the remedy is now estimated between $89,973,000.00 and $162,555,000.00.

9.9.1 COST UNCERTAINTIES

Due to the size of the site and variable terrain, many generic cost assumptions were applied in the FS and the revised cost sheets found in Appendix E. Remedial design will play a critical role in determining final costs. Some primary factors which will determine final costs of the remedies are:

- Actual acreages and level of reclamation chosen for the contaminated soils areas of concern;

- The quantity and quality of cover soil material meeting design specifications for the cover soil alternatives on wastes; and

- Availability of large quantities of low-cost lime for moderate and high-intensity *in situ* reclamation options.

The agencies believe that use of the LRES evaluation on the site will narrow and focus the scope of the remedies, leading to better costing analyses during preliminary design. Furthermore, through improved knowledge on the effective implementation of the reclamation strategies, efficiencies will be gained and cost savings realized.

10.0 STATUTORY DETERMINATIONS

Under CERCLA Section 121, EPA and MDEQ must select a remedy that is protective of human health and the environment, 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 following sections discuss how the Selected Remedy meets these statutory requirements.

10.1 PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The Selected Remedy protects human health and the environment through the following:

- Prevention of human ingestion of, inhalation of dust from, or direct contact with high arsenic soils and waste sources where such ingestion or contact would pose an unacceptable health risk for the designated or reasonably anticipated land use by the use of selective removal, reclamation, or engineered cover;

- Risk reduction for protection of ecological and agricultural systems by stabilization of soil against wind and surface water erosion, and reducing surface soil COC levels to allow re-establishment of vegetation, thus reducing risk to upland terrestrial wildlife and allowing re-establishment of wildlife habitat through selective removal, reclamation, or engineered cover;

- Restoration of ground water to its beneficial use through source control by selective removal and engineered cover, and natural attenuation;

- For areas in which the ground water ARAR is waived or not met underneath WMAs, protection of human health through minimization of COC transport to ground water, prevention of expansion of the plume, and implementation of ICs to prevent consumption of ground water with arsenic above the state ground water standard; and

- Prevention of release of contaminated material to surface waters and protection of aquatic resources by implementing source control measures through removal, reclamation, or soil cover, and use of engineered storm water control structures.

There are no short-term threats associated with the Selected Remedy that cannot be readily controlled through applicable health and safety requirements, monitoring, and standard construction practices.

10.2 COMPLIANCE WITH ARARs

The final determination of ARARs by EPA and MDEQ are listed in Appendix A of this ROD. The selected combination of remedies is expected to meet Federal and State requirements that are legally applicable or relevant and appropriate. A waiver of certain standards is necessary based on the determination that compliance with these standards is either technically impracticable from an engineering stand point or the remedial action called for in this plan is equally protective of human health and/or the environment. Some significant ARARs compliance issues are discussed below. Full ARARs are described in Appendix A.

10.2.1 CONTAMINANT-SPECIFIC ARARs

For ground water, the contaminant-specific ARARs for these remedial actions are the standards specified in the State of Montana Circular WQB-7. For large areas of bedrock aquifer contamination (approximately 28,600 acres) the ground water standard for arsenic is waived due to a TI from an engineering perspective. Accordingly, EPA, in consultation with MDEQ, invokes the ARAR waiver provided by CERCLA Section 121(d)(4)(D), 42 U.S.C. § 9621(d)(4)(D). The justification for a finding of technical impracticability waiver from an engineering prospective is documented in FS Deliverable No. 3A (EPA 1996a) and presented in Appendix D. For areas in which large volumes of waste material will be left-in-place, and in accordance with the preamble to the NCP, EPA and MDEQ have set the compliance boundary for ground water standards at the edge of the waste-left-in-place. Ground water will not be restored in the alluvial aquifers underneath the Opportunity Ponds, Smelter Hill and Old Works WMAs. For ground water downgradient of WMAs which exceed the State standards, and the shallow alluvial aquifer contaminant plumes in the South Opportunity area (Yellow Ditch and Blue Lagoon), the Selected Remedy will address source areas of contamination to ground water sufficiently to allow natural attenuation of ground water to attain the ground water standards in these areas within a reasonable time, consistent with the NCP.

In addition, the remedy will attain the federal and state surface water quality standards listed in Appendix A, throughout the OU. In Mill Creek, Willow Creek, and Warm Springs Creek, this is expected to be accomplished through implementation of source control measures and storm water BMPs. Due to the wide-spread and diffuse nature of the aerially contaminated soils, there is a moderate level of uncertainty about consistently achieving water quality standards 100% of the time in all surface water receptors across the site. The remedy is expected to achieve significant reduction of COC movement into surface water and therefore will meet the primary remediation goals of protecting the aquatic resources across the site. A determination will be made following implementation of the remedy whether the State standards can be met through source reduction and storm water BMPs or whether additional actions are necessary (new BMPs or point source water treatment). If it is found to be technically impracticable from an engineering perspective to achieve the State standards, an ARAR waiver will be applied.

10.2.2 LOCATION-SPECIFIC ARARs

The final remedy will attain compliance with all historic and cultural resource preservation and mitigation requirements through final implementation of the Regional Historic Preservation Programmatic Agreement and through additional agreements with the CSKT.

Remedial actions for Warm Springs Creek, Mill Creek and Willow Creek will take place within the 100-year floodplain for each of these streams. Remedial actions are required within the 100-

year floodplain due to source pathways from fluvially deposited tailings found within the stream banks on Warm Springs and Willow Creeks and waste material historically used as bank material for railroad and bridge crossings on Mill Creek and Willow Creek into surface water receptors. The remedy calls for selective removal of these fluvially-deposited tailings based on a remedial design analysis of unstable and erodible stream banks and soil cover and stabilization on portions of the transportation abutments. Removed material will be disposed of in WMAs outside the 100 year flood plain. The affected floodplain will be backfilled with clean material, stabilized and revegetated to minimize harm to the floodplain and wetlands environments found in the removal areas in accordance with ARARs. This proposed action may improve the beneficial values of the floodplain through removal of contaminated material and stabilization of the creek systems, therefore meeting the goals of the Floodplain Management Act, 40 CFR § 6.302(b), Executive Order No. 11988, and Montana Floodplain and Flood Way Management Act and Regulations.

The remedial action plan also provides for the use of *in situ* reclamation techniques as treatment for tailings in the floodplain in portions of Warm Springs Creek. Because this will constitute "disposal" of solid waste in the flood plain, this action will not comply with Montana Solid Waste Regulations location-specific ARARs (ARM § 17.50.505(1) and (2)) and an ARAR waiver is necessary. EPA and MDEQ have determined that *in situ* reclamation treatment, together with O&M and monitoring actions, will attain a standard of performance that is equivalent to that required by floodplain and solid waste regulations through use of another method or approach. Accordingly, the agencies invoke the ARAR waiver provided by CERCLA Section 121(d)(4)(D), 42 U.S.C. § 9621(d)(4)(D). Further analysis and justification for this waiver is contained in the Administrative Record for the Streamside Tailings OU of the Silver Bow Creek/Butte Area NPL Site.

As noted in Section 9.8, RD/RA Management and Appendix A of this ROD, compliance with the wetlands mitigation requirements of 40 CFR Part 6, Appendix C, and Executive Order No. 11990 will require development of a detailed wetlands mitigation plan as part of each specific, applicable remedial design plan. This is necessitated by the large study area and the patchiness of wetland and non-wetland areas, the need to determine the precise boundaries of impacted wetlands, and the need to develop location-specific remedial plans in order to determine any wetlands impacts. More detail about the process of developing wetlands mitigation plans is presented in Section 9.8, RD/RA Management, of the ROD.

Threatened and Endangered Species Act Mitigation

A review of the threatened and endangered species lists at the Anaconda Smelter Site indicates that no federally-listed threatened or endangered plant species occur at the site. For wildlife species, the Bald Eagle, Peregrine Falcon, and Gray Wolf are federally listed as endangered, and the Bull Trout is listed as threatened. To date, no specific breeding or nesting places have been located in the areas slated for revegetation. During remedial design, site reviews will be conducted, areas in which Bald Eagle, Peregrine Falcon, or Gray Wolves are noted will be identified, the U.S. Fish and Wildlife Service (USFWS) will be notified, and appropriate mitigation plans developed and approved by EPA, in consultation with USFWS. To date, Bull Trout have been found in the upper reaches of Warm Springs Creek, outside the areas of concern for CERCLA action. During remedial design for selective removal and stream bank stabilization on Warm Springs Creek. the agencies will use data collected during the 1998 stream habitat survey to develop appropriate mitigation plans, as necessary, and in consultation with USFWS.

10.2.3 ACTION-SPECIFIC ARARs

Action-specific ARARs generally provide guidelines for the manner in which specific activities must be implemented. Thus, compliance with any action-specific requirements must be ensured through appropriate design and implementation of the remedy.

There are several action-specific ARARs that are important to the ARWW&S OU. These requirements guide final closure and management of the waste material to be left-in-place at the designated WMAs. The regulations include the Federal and State RCRA Subtitle D and Solid Waste Requirements, the Federal Surface Mining Control and Reclamation Act, the Montana Strip and Underground Mine Reclamation and Montana Hardrock Mining Acts, and selected requirements of the Montana Metal Mining Act. EPA and MDEQ have determined that these regulations are applicable or relevant and appropriate for meeting the primary objective of closing the waste disposal sites in a protective manner that is also consistent with surrounding land use through revegetation, excavation, storm water management, and erosion controls requirements. The ARARs compliance section of each RD plan will need to list the pertinent reclamation ARAR and describe how the plan will attain these requirements, including reclamation requirements. Portions of the mine closure regulations which deal with ground water protection, specifically requiring use of liners or capping specifications, are not listed as relevant and appropriate for the WMAs. The reason that these requirements were deemed not relevant is due to the contaminated ground water underneath the wastes-left-in-place which will not be restored. However, through engineered controls and revegetation, the final remedy will attain the primary goal of minimizing transport of COC to ground water resources from the WMAs.

The action-specific requirements which regulate water quality will be met on all areas on the site. The substantive requirements of the Clean Water Act Point Source Discharge program, National and Montana Pollution Discharge Elimination System Permit requirements, technology-based treatments, and other State of Montana water quality regulations will be met through the OU but are not applied to the WMAs because there are not any defined State surface waters within the WMAs, and EPA and MDEQ believe that any surface water discharge to ground water will have minimal to negligible effect on the contaminated ground water underneath wastes-left-in-place. Furthermore, EPA and MDEQ believe the remedy required in this ROD (reclamation of contaminated soils, closure and revegetation of WMAs, and a site-wide storm water management plan) meets the primary objective of attaining water quality standards in State surface waters and ground waters outside WMAs, and minimizes transport of COCs to ground water within WMAs. Additionally, EPA and MDEQ have provided for containment and treatment of ground waters that may migrate outside a WMA through defined contingencies in the ROD as well as contingencies if surface water standards are not met.

10.2.4 PERFORMANCE STANDARDS AND COMPLIANCE POINTS

Performance standards and some compliance points are defined in Section 9.0. Final Performance Standards and compliance points for specific ARARs will be determined in remedial design.

10.3 COST EFFECTIVENESS

EPA and MDEQ have determined that the Selected Remedy is cost effective in mitigating the principal risks posed by contaminated wastes and soils. 40 CFR § 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 Remedy meets the criteria and provides for overall effectiveness in proportion to its cost. The estimated costs for the remedy have been revised and are expected to range between $88,000,000.00 and $150,000,000.00 (see Appendix E).

To the extent that the estimated cost of the Selected Remedy for subareas exceeds the cost for other alternatives, the difference in cost is reasonable when related to the greater overall effectiveness achieved by the Selected Remedy. For most of the areas of concern, however, EPA and MDEQ have chosen the most cost effective alternative, i.e., revegetation was chosen over removal or capping. The agencies also believe that use of the RD/RA management strategies (Site Management Plan, ICs Management Plan, O&M Plan) will further add to the cost-effectiveness of the remedy by focusing the initial designs and actions in those areas deemed of highest priorities and addressing other less significant sites in the near future. Furthermore, on-going evaluation of the reclamation strategies across landscapes and terrain not assessed during the RI/FS will help maximize implementation of the technologies during RD/RA.

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

EPA and MDEQ have determined that the Selected Remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a cost effective manner at the ARWW&S OU. Of those alternatives that are protective of human health and the environment and comply with ARARs, EPA and MDEQ have determined that the Selected Remedy provides the best balance of trade-offs in terms of long-term effectiveness and permanence, reduction in toxicity, mobility, or volume achieved through treatment, short-term effectiveness, implementability, and cost, while also considering the statutory preference for treatment as a principal element and considering state and community acceptance.

The Selected Remedies include treatment of contaminated soils which will permanently and significantly reduce the toxicity and mobility of contaminants contained in the soil. Engineered covers will permanently prevent contact with waste materials that pose a principal threat and provide stable and permanent rooting material to enable the re-establishment of vegetation. Both the *in situ* land reclamation and soil cover remedies meet the ARARs for permanently closing historic mine waste disposal facilities.

Principal human health threat wastes on the Anaconda Smelter NPL Site have been addressed under prior RODs (Flue Dust, OW/EADA, and Community Soils). The final remedies selected for the ARWW&S OU are directed primarily at the remaining wide-spread arsenic and metals in surface soils, in tailings impoundments, ground water, and surface water. The remedies call for waste consolidation where necessary to minimize long-term management of the lands, reduction of surface metals and arsenic levels in soils, permanent closure of historic mine waste disposal facilities, containment of contaminated ground water, minimization of transport of COCs to surface and ground water, long-term management of WMAs, and support of local community land use planning to direct cleanups.

11.0 DOCUMENTATION OF SIGNIFICANT CHANGES

Two specific changes are made from the Proposed Plan with this ROD. These changes are noted below.

11.1 GROUND WATER TI ZONES

At the time of the release of EPA's Proposed Plan in October 1997, EPA was updating the characterization of ground water contamination in the bedrock aquifers in the TI zones at the ARWW&S OU as a result of information collected at the ARWW&S OU during field investigations of TI zones in summer 1997. An initial identification of TI zones in the bedrock aquifers was presented by EPA in the *Draft Feasibility Study Deliverable 3A Ground Water Technical Impracticability Evaluation for the Anaconda Smelter NPL Site Anaconda-Deer Lodge County, Montana Anaconda Regional Water, Waste, and Soils Operable Unit* (EPA 1996a). The result of the TI evaluations identified two regions of the shallow bedrock aquifer, estimated to cover approximately 11,000 acres, in which restoration of ground water to levels of dissolved arsenic below Montana Ground Water Quality Standards is considered to be technically impracticable by EPA. The two areas identified for a TI waiver were Smelter Hill TI Zone and Stucky Ridge TI Zone.

As a result of the updated characterization of the TI zones, EPA has determined there is a significantly larger area in which restoration of ground water to levels of dissolved arsenic below Montana Ground Water Quality Standards is technically impracticable. The area of the shallow bedrock aquifer with arsenic levels above the State of Montana ground water standard for arsenic (18 μg/L) may encompass approximately 28,600 acres (Figure 9-6) (see Appendix D, *Addendum to TI Evaluations at the ARWW&S OU*, August 1998.) To better define the areas of concern, EPA has re-defined the aquifers into three separate areas: Stucky Ridge, Smelter Hill and Mount Haggin (Figure 1-1). The increase in area coverage is mostly in the Mount Haggin area and covers most of the northern half of the Mount Haggin Wildlife Management Area, property owned and managed by the State of Montana for elk habitat.

The implication of increasing the area in which the ground water standard will be waived because there is no technically practicable solution is to expand the area for application of ICs. The remedy calls for further characterization of the TI zones to better define vertical and lateral extent of the contamination, on-going monitoring of ground water quality in these areas, implementation of ICs for protection of domestic water users, and communications with various land owners in the TI zones.

11.2 CELL A, OPPORTUNITY PONDS

Throughout the FS and Proposed Plan on ARWW&S, EPA used the current ADLC Master Plan to guide understanding of land use and determine appropriate proposed remedies. The 1992 Master Plan identified Cell A, Opportunity Ponds, as a future mine waste disposal facility for permitted county use. Comments received on the Proposed Plan by the County noted that the revised drafts of the 1997 Master Plan called for movement of the proposed mine waste disposal facility from Cell A to Cell B2 of the Opportunity Ponds. The final remedy outlined in this ROD calls for closure and reclamation of Cell A to be consistent with the new designated land use.

11.3 WARM SPRINGS CREEK

CERCLA site investigations along Warm Springs Creek were conducted from 1992 through 1994. Field reconnaissance and data results from the ARCO studies of regionally contaminated soils identified a limited amount of exposed stream side tailings located in Section 23 on RSN Johnson Ranch property. EPA determined that this tailings deposit was a likely contributor of total and dissolved copper concentrations which exceed the State of Montana water quality standards and were measured in the water column of Warm Springs Creek. An estimated 1,200 cy of tailings were proposed for removal in EPA's October 1997 Proposed Plan.

The Montana Department of Fish, Wildlife and Parks (MDFWP) initiated a stream renaturalization project along Warm Springs Creek in October 1997 to address stream migration and creek bank erosion concerns upgradient of EPA's area of concern for stream side tailings. Significant quantities of mine tailings were discovered within an abandoned creek channel. The MDFWP notified EPA about the tailings and terminated the project until financial assistance could be procured to remove and dispose of the tailings.

Based on the results of MDFWP project, it is apparent that a higher volume of tailings remains within the floodplain of Warm Springs Creek than originally identified during the RI/FS process. These tailings have the potential for re-entrainment into the aquatic environment of Warm Springs Creek, resulting in potential exceedances of water quality standards and risk to aquatic organisms. EPA and MDEQ agreed that further site characterization is needed as part of the pre-design remediation efforts, a coordinated plan to address stream stabilization is necessary among MDFWP, EPA, and MDEQ with input from local land owners, and additional selective removal of tailings material may be conducted under CERCLA actions within the creek corridor.

11.4 HUMAN HEALTH RISK ASSESSMENT/TRESPASSER'S SCENARIO AND STEEP SLOPE/OPEN SPACE ACTION LEVEL

EPA's Proposed Plan call for establishment of a final site-wide soils and tailings clean up action level for arsenic of 1,000 ppm. EPA received comments from ARCO on calculations of risk and reviewed the site specific data as it would apply to areas on the site in which it would be technically difficult to remediate aerially contaminated soils to below the 1,000 ppm action level. EPA determined that a 2,500 ppm arsenic action level would be protective under very specific circumstances. These circumstances apply only to steep and rocky topography and on limited access property. The addition of the action level falls within EPA's established risk range for protection of human health (10^{-5}) and is consistent with the clean up action levels established for other land uses within the Anaconda Smelter NPL Site.

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TABLES

TABLE 5-1

Surface Water Exceedance Summary
ARWW&S OU

Analyte	Standard	Number of Exceedances/Number of Samples							
		Lost Creek		Warm Springs Creek		Mill Creek		Willow Creek	
		Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower
Total Arsenic	Montana: 18 μg/L	3/14	4/12	0/51	1/42	12/15	21/21	10/10	24/25
Dissolved Arsenic	Montana: 18 μg/L	1/14	3/12	0/51	0/42	9/15	21/21	9/10	25/29
Total Arsenic	MCL: 50 μg/L	0/14	0/11	0/51	0/42	2/15	7/21	0/9	19/26
Dissolved Arsenic	MCL: 50 μg/L	0/14	0/11	0/51	0/42	1/15	6/21	0/9	18/28
Total Cadmium	AQWC^1: Acute	0/12	0/11	0/51	0/42	2/15	0/31	1/9	3/25
Dissolved Cadmium	AQWC^1: Acute	0/12	0/11	0/51	0/42	1/15	0/31	1/9	3/29
Total Cadmium	AQWC^1: Chronic	0/12	0/11	0/51	0/42	2/15	1/31	2/9	5/25
Dissolved Cadmium	AQWC^1: Chronic	0/12	0/11	0/51	1/42	1/15	1/31	1/9	6/29
Total Copper	AQWC^1: Acute	2/12	0/11	5/51	6/42	3/15	6/31	2/9	8/25
Dissolved Copper	AQWC^1: Acute	0/12	0/11	0/51	2/42	2/15	5/31	3/9	8/29
Total Copper	AQWC^1: Chronic	2/12	0/11	6/51	8/42	6/15	11/31	4/9	12/25
Dissolved Copper	AQWC^1: Chronic	0/12	0/11	1/51	2/42	2/15	8/31	2/9	12/29
Total Lead	AQWC^1: Acute	0/12	0/11	0/51	0/42	0/15	0/31	0/9	0/25
Dissolved Lead	AQWC^1: Acute	0/12	0/11	0/51	0/41	0/15	0/31	0/9	0/29
Total Lead	AQWC^1: Chronic	0/12	0/11	9/51	8/42	4/15	11/31	5/9	4/25
Dissolved Lead	AQWC^1: Chronic	0/12	0/11	1/51	0/41	1/15	6/31	2/9	2/29
Total Zinc	AQWC^1: Acute	0/12	0/11	0/51	0/42	0/15	0/31	0/9	0/25
Dissolved Zinc	AQWC^1: Acute	0/12	0/11	0/51	0/41	0/15	0/31	0/9	0/29
Total Zinc	AQWC^1: Chronic	0/12	0/11	0/51	1/42	0/15	0/31	0/9	0/25
Dissolved Zinc	AQWC^1: Chronic	0/12	0/11	0/51	0/41	0/15	0/31	0/9	0/29

Source: ESE 1996

Reach delineations:
Upper Lost Creek: LC-1, LC-2, LC-3
Upper Warm Springs Creek: WS-1, WS-2, WS-3
Upper Mill Creek: MC-7, MC7a
Lower Willow Creek: WC-13
Lower Lost Creek: LC-4, LC-5, LC-6
Lower Warm Springs Creek: WS-4, WS-5, WS-6
Lower Mill Creek: MC-8, MC-10a
Lower Willow Creek: WC-12, WC-14, WC-15

Note: Concentrations of constituents in surface water that are greater than the chronic AQWC and SSWQC are not necessarily exceedances. Samples cited are instantaneous, not for a continuous 96-hour period.

TABLE 5-2

Summary of Areas of Concern in the ARWW&S OU

Subarea	Area of Concern	Area (acres)	Volume
Opportunity Ponds	Opportunity Ponds	3,600[b] *	129,300,000 cy[b]
	Toe Area Wastes	26	60,000 cy[b]
	S. Lime Ditch	490[b] *	1,700,000 cy[b]
	Triangle Wastes	300[b] *	1,400,000 cy[b]
	Contaminated Soils/Barren or Poor Vegetation Condition	1,095[a] **	NR
	Groundwater Contamination (alluvial aquifer)	2,275[c] ∘	4,550 to 11,375 ac-ft
North Opportunity	Contaminated Soils/Barren or Poor Vegetation Condition	1,105[a] **	NR
	Streamside Tailings - Warm Springs Creek	0.4 *	1116 cy[b]
South Opportunity	Contaminated Soils/Barren or Poor Vegetation Condition	500[a] **	NR
	Streamside Tailings - Willow Creek	65[b] *	157,000 cy[b]
	Yellow Ditch	9[b] *	120,000 cy[b]
	Blue Lagoon (including RR grade and contaminated Blue Lagoon sediment)	NR	71,000 cy[b]
	Groundwater Contamination (alluvial aquifer)	1,200[c] ∘	2,400 to 7,200 ac-ft
Old Works/ Stucky Ridge	Contaminated Soils/Barren or Poor Vegetation Condition	6,625 **	NR
	Groundwater Contamination (alluvial aquifer)	320[c] ∘	640 ac-ft
	Groundwater Contamination (bedrock aquifer)	4,771[d] ∘∘	9,542 to 54,867 ac-ft
Smelter Hill	Proposed Waste Left in Place Areas (Disturbed Area, Main Slag Pits, Anaconda Ponds)	1,492 *	124,900,000 cy
	West Stack Slag	5.2 *	56,000 cy
	Contaminated Soils/Barren or Poor Vegetation Condition (includes Nazer Gulch debris)	3,700[a] **	NR
	East Anaconda Yard Wastes	171 *	480,000 cy
	Cabbage Gulch Surface Water Contamination	NR	NR
	Groundwater Contamination (alluvial aquifer)	990 ∘	1,980 to 3,960 ac-ft
	Groundwater Contamination (bedrock aquifer)	23,830[d] ∘∘	47,660 to 274,045 ac-ft

[a] CDM Federal, 1996
[b] ARCO, 1996a
[c] ARCO, 1996b
[d] TI Addendum (Appendix D)

* wastes
** soils
∘ alluvial ground water
∘∘ bedrock ground water

cy = cubic yards
ac-ft = acre-feet
NR = Not Reported

TABLE 5-3

Physical Composition of Tailings in Opportunity Ponds
ARWW&S OU

Parameter	Tailings Thickness (feet)	Grain Size Distribution (%)			
		Gravel	Sand	Silt	Clay
Maximum	48.3	59.5	91.2	88.2	55
Minimum	15	0.0	0.1	1.7	2.1
Arithmetic Mean	28.5	2.2	37.7	44.2	16.7
Standard Deviation	11	8.7	26.6	20.4	11
Geometric Mean	26.7	NR	26.1	36.7	13.3
Number of Samples	16	136	136	136	136

NR = not reported
Source: ESE 1996

TABLE 5-4

Statistical Comparison of Chemical Analyses for Opportunity Ponds Tailings and Alluvium ARWW&S OU

	Statistical Parameter	Slurry pH (S.U.)	Total Sulfur (%)	Pyritic Sulfur (%)	Leachable Sulfur (%)	Carbonate (%)	Arsenic (mg/kg)	Cadmium (mg/kg)	Copper (mg/kg)	Iron (mg/kg)	Lead (mg/kg)	Manganese (mg/kg)	Zinc (mg/kg)
Top of Tailings (0-3 feet)	Number of Samples	19	9	9	9	19	19	19	19	19	19	19	19
	Maximum	7.45	5.09	4	1.37	2.26	505	9.7	3,130	58,100	1,730	2,600	1,230
	Minimum	2	0.9	0.01	0.04	0.01	35	2	164	12,500	20	105	60
	Arithmetic Mean	4.57	2.02	0.77	0.67	0.33	193	3.7	897	32,086	627	779	448
	Standard Deviation	2.08	1.29	1.47	0.52	0.57	113	2	794	10,454	411	778	316
	Geometric Mean	4.1	1.75	0.06	0.44	0.15	161	3.3	659	30,410	462	455	350
Base of Tailings (interval from 0-3 inches above the tailings/alluvium interface and represents the lowermost tailings sample collected in each borehole)	Number of Samples	16	6	6	6	16	16	16	16	16	16	16	16
	Maximum	7.4	10.23	4.43	0.26	7.27	860	13	5,920	71,500	888	9,020	2,740
	Minimum	4.4	0.5	0.01	0.01	0.06	71	2	1,010	9,440	39	315	125
	Arithmetic Mean	5.8	4.44	1.43	0.12	0.8	338	7.1	2,531	37,346	367	3,106	1,417
	Standard Deviation	0.9	3.58	1.99	0.09	1.77	215	3.3	1,128	19,766	231	2,595	725
	Geometric Mean	5.73	2.87	0.21	0.08	0.31	277	6.2	2,336	31,468	296	2,165	1,166
Top of Alluvium (represents the uppermost alluvial core sample and the top 1-3 feet of alluvial material)	Number of Samples	16	6	6	6	16	16	16	16	16	16	16	16
	Maximum	7.3	3.4	2.23	0.38	35.2	1,600	30	6,830	78,100	658	3,610	7,730
	Minimum	3.5	0.14	0.01	0.01	0.01	23	2	128	3,850	16	314	44
	Arithmetic Mean	6.18	1.53	0.41	0.11	8.07	508	10.3	2,453	28,959	235	1,433	2,242
	Standard Deviation	0.96	1.22	0.89	0.14	10.74	504	8.9	2,156	23,153	200	1,156	2,148
	Geometric Mean	6.1	0.97	0.06	0.06	1.43	280	6.8	1,430	21,334	151	1,048	1,149
Alluvium Beneath Tailings/Alluvium Interface (represents all alluvial samples collected from 3-21 feet below the tailings/alluvium interface)	Number of Samples	39	17	17	18	36	36	36	36	36	36	36	36
	Maximum	8.3	1.57	1.08	0.1	32.6	370	7.7	1,420	60,300	300	2,270	4,260
	Minimum	4.9	0.1	0.01	0.01	0.15	2	0.4	5	7,726	2	154	19
	Arithmetic Mean	7.34	0.38	0.11	0.03	7.19	57	2	267	14,578	50	560	381
	Standard Deviation	0.74	0.49	0.26	0.03	7.5	83	1.6	345	10,412	66	563	719
	Geometric Mean	7.3	0.21	0.04	0.02	3.79	27	1.5	123	12,871	26	397	167
Alluvium Downgradient of the Tailings	Number of Samples	122	22	22	22	22	22	22	22	22	22	22	22
	Maximum	8.6	0.1	0.13	0.23	32.1	20	1	38	26,300	31	3,334	85
	Minimum	6.6	0.1	0.01	0.01	0.15	2	0.4	6	3,255	2	32	17
	Arithmetic Mean	7.78	0.1	0.05	0.02	4.2	6	0.4	22	11,966	12	569	40
	Standard Deviation	0.32	0	0.04	0.05	7.18	4	0.1	9	5,382	8	714	21
	Geometric Mean	7.77	0.1	0.04	0.02	0.98	5	0.4	20	10,884	10	318	36

mg/kg = milligrams per kilogram
S.U. = Standard Units

TABLE 5-5

Geochemical Zones as Determined from Lithologic Color Descriptions and Chemical Analyses for Borehole 88 in Cell C-1 of Opportunity Ponds
ARWW&S OU

Sample Number	Depth Interval (feet)	Description	Color	Slurry pH (S.U.)	Carbonate (%)	Arsenic (mg/kg)	Cadmium (mg/kg)	Copper (mg/kg)	Iron (mg/kg)	Lead (mg/kg)	Manganese (mg/kg)	Zinc (mg/kg)	Geochemical Zone
TL- 146	0-3	Tailings	white and yellow	5.35	0.26	160	2.5	513	32,600	812	2,040	592	oxidized
TL- 149	4-7	Tailings	yellow, brown, olive, and gray	4.75	0.42	310	7.0	2,720	61,400	498	3,480	2,390	transition
TL-151	7-10	Tailings	gray and brown	5.90	0.79	170	3.9	1,900	66,000	335	3,960	2,320	reduced
TL-153	10-13	Tailings	gray and brown	6.70	0.73	160	3.7	1,610	63,000	294	3,680	1,610	reduced
TL-155	16-19	Tailings	gray and brown	7.20	0.29	200	2.2	1,560	65,900	214	2,200	420	reduced
TL-157	16-19	Tailings	gray and brown	6.80	0.57	250	4.8	2,810	52,400	303	3,930	1,310	reduced
TL-159	19.3-20.5	Tailings	gray and black	7.05	27.50	540	19.0	6,830	16,400	127	3,240	2,910	---
TL- 161	21-22.5	Tailings	gray and black	7.10	20.10	91	<2.0	273	11,900	105	1,760	860	---

mg/kg = milligrams per kilogram
S.U. = Standard Units
Source: ESE 1996

TABLE 5-6

Summary of Lysimeter Data for Opportunity Ponds
ARWW&S OU

Lysimeter	Date	Depth (feet)	pH (S.U.)	Slurry pH (S.U.)	Dissolved Oxygen (mg/L)	Eh (mV)	Arsenic (μg/L)	Cadmium (μg/L)	Copper (μg/L)	Iron (μg/L)	Manganese (μg/L)	Lead (μg/L)	Zinc (μg/L)	Sulfate (mg/L)
Summary of Tetra Tech (1985) Lysimeter Data														
A Cell (near well 95) Shallow	6/12/85	5	---	3-7.5	---	---	49.0	680	58,000	4,600	32,000	50.0	49,000	1,640
	8/8/85	5	4.6	3.4	5.1	+350	9.0	810	120,000	2,100	40,000	80.0	65,000	---
	9/19/85	5	3.4	---	5.5	+450	24.0	1,600	339,000	1,400	64,000	76.0	94,000	---
	10/19/85	5	3.2	---	4.5	---	14.0	820	195,000	1,600	33,000	98.0	51,000	3,330
A Cell (near well 95) Deep	6/12/85	9	---	7.5-10.5	---	---	26.0	1,000	58,000	200	143,000	80.0	192,000	2,260
	8/8/85	9	5.8	5.1	4	+350	17.0	990	51,000	140	149,000	70.0	201,000	---
	9/19/85	9	5	---	6.4	+310	---	---	---	---	---	---	---	---
	10/19/85	9	5.1	---	3.2	---	8.0	640	24,500	24.5	96,000	60.0	109,000	2,320
C2 Cell (near well 85) Deep	6/12/85	4.8	---	•	---	---	31.0	130	1,700	1,000	111,000	50.0	16,000	---
	8/8/85	4.8	---	---	---	---	---	---	---	---	---	---	---	---
	9/19/85	---	---	---	3.8	+250	20.0	190	1,900	1,300	200,000	15.0	26,000	---
	10/19/85	4.8	6	---	6	---	---	---	---	---	---	---	---	---
C2 Cell (near well 85)	6/12/85	7.5	---	•	---	---	34.0	110	1,300	200	144,000	50.0	12,000	---
	8/8/85	7.5	---	---	---	---	---	---	---	---	---	---	---	---
	9/19/85	7.5	6.5	---	2.6	+230	28.0	100	890	1,200	127,000	15.0	13,000	---
	10/19/85	7.5	6.6	---	3.4	+260	15.0	60.0	400	100	64,000	54.0	6,500	---
Summary of ESE (1993) Lysimeter Data														
D2 Cell (near well 84)														
R4 No.3	9/3/93	2.5	---	---	---	---	---	---	---	---	---	---	---	---
	9/23/93	2.5	1.16	---	---	---	---	---	---	---	---	---	---	---
R4 No.7	9/3/93	6	3.66	---	---	---	9,470	801	2,390,000	309,000	2,940,000	4,070	419,000	26,300
	9/23/93	6	2.74	---	---	---	133	813	1,670,000	3,150,000	2,320,000	40.1	392,000	19,840
R4 No.6	9/3/93	10	5.19	---	---	---	917	64.0	8,580	205,000	300,000	344	49,000	3,280
	9/23/93	10	3.97	---	---	---	3.8	38.0	2,780	721,000	259,000	26.3	35,000	2,500
C2 Cell (near well 89)														
R5 No.2	9/3/93	2	2.26	---	---	---	2,010	109	64,000	11,300,000	25,800	89,800	78,700	52,700
	9/23/93	2	1.77	---	---	---	11,500	25.7	57,100	12,100,000	182,000	754	87,800	---
R5 No.5	9/3/93	5	3.25	---	---	---	---	---	---	---	---	---	---	---
	9/23/93	5	2.71	---	---	---	---	---	---	---	---	---	---	---

--- = insufficient sample quality for chemical analysis
S.U. = Standard Units
μg/L = micrograms per liter

• = ground water monitoring well MW-86 had a pH ranging from 3.1 to 4.6 during 1985
mV = millivolts
mg/L = milligrams per liter

TABLE 5-7

Concentrations of Arsenic and Metals in Sediments from Triangle Waste Area
ARWW&S OU

Analyte	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)	Geometric Mean Concentration (mg/kg)
Arsenic	<5.8	3,370	160
Cadmium	<3.8	78.6	5.5
Copper	17	49,800	779
Manganese	145	3,250	382
Zinc	43	19,100	612

< = less than detection limit
mg/kg = milligrams per kilogram
Source: ESE 1996

TABLE 5-8

Concentrations of Arsenic and Metals in Soils of the South Lime Ditch Area
ARWW&S OU

Analyte	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)	Geometric Mean Concentration (mg/kg)
Arsenic	<5.8	2,190	39
Cadmium	<3.8	35.7	4.3
Copper	<13.4	25,800	167
Manganese	103	28,200	409
Zinc	22.2	7,690	167.2

< = less than detection limit
Source: ESE 1996

TABLE 5-9

Summary Statistics for Network Wells in Opportunity Ponds Subarea During the Anaconda Regional Water and Waste Remedial Investigation ARWW&S OU

Well Number	Analyte	Maximum	Minimum	Mean	Standard Deviation	Median	Geometric Mean	Number of Samples
MW-76	Arsenic	3.20	0.50	1.61	0.98	1.28	1.30	8
	Cadmium	2.50	0.11	1.37	0.66	1.40	1.07	8
MW-78	Arsenic	4.00	0.50	1.64	1.28	1.25	1.19	8
	Cadmium	1.95	0.11	1.26	0.52	1.40	1.02	8
MW-78	Arsenic	4.10	0.50	1.71	1.26	1.43	1.29	8
	Cadmium	**5.30**	0.11	1.74	1.44	1.40	1.19	8
MW-81	Arsenic	3.20	0.50	1.35	1.08	0.75	1.00	8
	Cadmium	3.90	0.11	1.51	1.01	1.40	1.11	8
MW-90	Arsenic	**302**	**254**	**280**	15.9	**285**	**279**	8
	Cadmium	4.00	0.10	1.48	1.20	1.30	0.85	8
MW-212	Arsenic	1.90	0.65	1.36	0.44	1.30	1.28	6
	Cadmium	1.95	0.11	1.27	0.58	1.40	0.96	6
MW-214	Arsenic	2.70	0.65	1.53	0.69	1.50	1.37	6
	Cadmium	3.50	0.17	1.61	1.01	1.48	1.18	6
MW-215	Arsenic	**22.3**	2.60	12.62	6.08	13.70	10.53	6
	Cadmium	**12.5**	0.11	3.66	4.23	1.63	1.64	6
MW-216	Arsenic	13.20	1.70	6.02	3.94	5.70	4.83	5
	Cadmium	2.00	1.10	1.57	0.35	1.50	1.53	5
MW-217D	Arsenic	1.50	0.50	1.00	0.41	1.00	0.91	6
	Cadmium	2.50	0.04	1.40	0.76	1.40	0.86	6
MW-217S	Arsenic	**352**	**228**	**282**	**48**	**274**	**278**	6
	Cadmium	3.00	0.11	1.49	0.87	1.40	1.06	6
MW-219	Arsenic	3.10	0.50	2.02	0.89	1.95	1.74	6
	Cadmium	2.00	0.12	1.28	0.59	1.40	0.97	6
MW-221	Arsenic	14.40	4.10	8.83	3.34	8.90	8.16	6
	Cadmium	1.95	0.04	1.26	0.61	1.40	0.81	6
MW-222	Arsenic	3.30	0.49	1.81	1.14	1.83	1.37	6
	Cadmium	4.00	0.05	1.60	1.19	1.40	0.94	6
MW-223	Arsenic	4.80	1.75	3.21	1.03	3.40	3.03	6
	Cadmium	1.95	0.08	1.26	0.59	1.40	0.91	6
MW-224	Arsenic	1.90	0.50	1.18	0.53	1.20	1.04	6
	Cadmium	1.95	0.04	1.26	0.61	1.40	0.81	6
MW-230	Arsenic	2.40	0.65	1.49	0.64	1.40	1.34	5
	Cadmium	1.95	0.05	1.21	0.65	1.30	0.75	5
MW-234D	Arsenic	2.70	0.85	1.75	0.64	1.70	1.62	5
	Cadmium	1.95	0.04	1.21	0.65	1.30	0.71	5
WSP1D	Arsenic	5.40	1.00	3.07	1.20	3.15	2.79	8
	Cadmium	2.60	0.04	1.42	0.78	1.58	0.93	8
WSP6S	Arsenic	5.80	2.10	3.69	1.01	3.70	3.55	8
	Cadmium	2.00	0.11	1.26	0.63	1.40	0.97	8
WSP9	Arsenic	9.30	3.80	6.66	1.94	6.50	6.35	8
	Cadmium	4.00	0.04	1.44	1.10	1.40	0.89	8

All units in micrograms per liter (μg/L).
For values reported at less than instrument detection limit, one-half the reported value was used in statistical evaluations.
Exceedances of the State of Montana Ground Water Quality Standard for arsenic (18μg/L) and cadmium (5μg/L) are shown in bold.
Source: ESE 1996

TABLE 5-10

Analytical Results for Non-Network Wells and Well Points in Opportunity Ponds Subarea ARWW&S OU

Location	Well ID	Sample Date	Arsenic ($\mu g/L$)	Cadmium ($\mu g/L$)
Triangle Waste	10	2Q'95	<1	<0.1
	69	2Q'95	<1	<0.1
	212	3Q'95	2.0	<0.1
	243	4Q'95	<1	<0.1
Opportunity Ponds	26s	3Q'95	<1	<0.1
	26m	3Q'95	<1	<0.1
	28s	3Q'95	4.0	<0.1
	28m	3Q'95	<1	<0.1
	31s	3Q'95	<1	<0.1
	31m	3Q'95	3.0	<0.1
	76	3Q'93	<2	<2.6
	77	2Q'93	4.4	<0.1
	78	3Q'93	<1.7	<2.6
	79	3Q'93	<3.5	<2.6
	81	3Q'93	<1.7	<2.6
	90	3Q'93	**284.0**	<0.2
	214	3Q'93	<1.7	<2.6
	215	3Q'93	13.3	<2.6
	219	3Q'93	<6	<2.6
	230	3Q'93	1.0	<2.6
	GPB	4Q'94	**427.0**	0.1
	GPC	4Q'94	2.0	<0.1
	GPD	4Q'94	3.0	0.1
	GPE	4Q'94	6.0	0.1
Anaconda Ponds	36S	4Q'95	<1	<0.1
	36D	4Q'95	<1	0.3
	75	2Q'93	<0.98	**7.9**
	218d	3Q'93	<6.4	<2.6
	218s	3Q'93	**38.5**	<9.9
Old Works	207	3Q'93	<1	<0.1
	208	3Q'93	<1	<1
	209	3Q'93	<1	**5.9**
	240	4Q'95	—	0.2
	242	4Q'95	—	0.3
South Lime Ditch	216	3Q'93	13.2	<2.6
	217d	3Q'93	<2.7	<2.6
	217s	3Q'93	**339.0**	<2.6
	HP-6	4Q'95	6.0	1.2
	HP-7	4Q'95	<1	0.2
	HP-8	4Q'95	2.0	**9.0**
Warm Springs Ponds	221	3Q'93	5.9	<2.6
	222	3Q'93	<1	<2.6
	223	3Q'93	3.8	<2.6
	234D	3Q'93	<1.7	<2.6
	CFR-3	3Q'93	<1.6	<2.6
Airport	224	3Q'93	<1.7	<2.6
Silver Bow Creek	WSP-1D	3Q'93	2.3	2.6
	WSP-6S	3Q'93	5.8	<2.6
	WSP-9	3Q'93	6.0	<2.6
East of Opportunity Ponds	GPA	4Q'94	2.0	<0.1

< = less than detection limit

Exceedances of the State of Montana Ground Water Quality Standard for arsenic (18$\mu g/L$) and cadmium (5$\mu g/L$) are shown in bold.

Source: ESE 1996

TABLE 5-11

Summary of Soil and Sediment Sampling Results from Yellow Ditch
ARWW&S OU

Solid Matrix Screening Study (CDM 1987)

Station	Depth Interval (inches)	Arsenic (mg/kg)	Cadmium (mg/kg)	Copper (mg/kg)	Lead mg/kg)	Zinc (mg/kg)
SS-002 sediment in ditch	0-3	<75	---	576	722	827
	3-6	<75	---	1,170	1,130	1,340
	6-12	<75	---	1,020	947	1,190
	12-20	<75	---	725	964	1,190
SS-003 berm material	0-3	<75	---	678	1,030	1,180
	3-6	<75	---	985	985	647
	6-12	<75	---	430	569	660
	12-20	<75	---	1,240	213	394

Phase I and II Anaconda Soils Investigation Along Yellow Ditch (PTI 1992, 1993b)

Analyte	Depth Interval (inches)	Number of Samples	Minimum (mg/kg)	Maximum (mg/kg)	Mean (mg/kg)	Geometric Mean (mg/kg)
Arsenic	0-2	28	<29	846.0	215.7	158.5
Cadmium	0-2	28	0.8	9.4	3.5	2.5
Copper	0-2	28	37.0	1,490	462.2	316.2
Lead	0-2	28	<23	829.0	212.9	125.9
Zinc	0-2	28	61.0	560.0	445.0	316.2
Arsenic	2-10	28	<29	1,170.0	174.7	100.0
Cadmium	2-10	28	0.2	10.8	1.9	1.0
Copper	2-10	28	27.0	7,240.0	610.8	154.9
Lead	2-10	28	23.0	641.0	141.8	70.8
Zinc	2-10	28	34.0	2,210.0	381.8	177.8

ARWW 3rd Quarter 1993 Waste Characterization (ESE 1994)

Station	Depth Interval (feet)	Arsenic (mg/kg)	Cadmium (mg/kg)	Copper (mg/kg)	Lead mg/kg)	Zinc (mg/kg)
SBL-3 sediment in ditch	0-2	115.0	<3.8	577.0	91.3	295.0
	2-4	93.8	<3.8	137.0	187.0	212.0
	4-6	305.0	<3.8	257.0	116.0	197.0
	6-8	9.6	12.6	2,190.0	29.4	2,990.0

TABLE 5-11 (Continued)

Summary of Soil and Sediment Sampling Results from Yellow Ditch ARWW&S OU

Phase I and II ARWW&S OU Feasibility Study Soil Sample Results Along Yellow Ditch (ARCO 1996c)

Berm Material (Depth Interval)	Number of Samples	Arsenic (mg/kg)	Cadmium (mg/kg)	Copper (mg/kg)	Lead mg/kg)	Zinc (mg/kg)
Red (0-2 inches)	3	184-255	2.27-3.02	406-645	172-237	361-572
Red (2-10 inches)	2	21.9-273	0.98-3.96	105-496	26.8-201	155-511
Red (10-24 inches)	2	<5.68-202	1.52-5.79	58.1-756	25.7-174	73.6-1,010
Yellow (0-2 inches)	2	153-349	1.68-5.85	254-640	106-206	108-218
Yellow (2-10 inches)	2	46-125	1.66-2.73	103-1,520	19.7-116	83.8-233
Yellow (10-24 inches)	2	63.7-224	1.75-4.68	77.7-2,410	19.7-120	95.9-352
Native (0-2 inches)	3	38-83.7	1.68-3.95	75.4-114	28-36.3	91.1-158
Native (2-10 inches)	2	35.8-54.7	<0.59	14.8-23	8.58-10.4	29.3-35.8
Native (10-24 inches)	2	18.5-38.7	<0.6	11.7-98	9.24-24.6	25.8-94.2

Anaconda Soils Investigation, Phase I, South Opportunity Area (PTI 1992)

Analyte	Depth Interval (inches)	Number of Samples	Minimum (mg/kg)	Maximum (mg/kg)	Mean (mg/kg)	Geometric Mean (mg/kg)
Arsenic	0-2	14	55.0	488	201.9	163.8
Cadmium	0-2	14	1.8	48.0	9.1	6.3
Copper	0-2	14	114	1,880	573.9	411.8
Lead	0-2	14	66.0	769	191.7	151.5
Zinc	0-2	14	149.0	1,650	509.6	374.5

--- = not analyzed
< = less than detection limit
mg/kg = milligrams per kilogram

TABLE 5-12

Summary of Arsenic and Metals Concentrations in Soil and Waste Samples in the Vicinity of the Blue Lagoon ARWW&S OU

Sample ID	Number of Samples	Location	Depth Interval (feet)	Arsenic (mg/kg)	Cadmium (mg/kg)	Copper (mg/kg)	Lead mg/kg)	Zinc (mg/kg)	Reference
SS-002	4	Yellow Ditch sediments	0-1.6	<75	---	576-1,170	722-1,130	827-1,340	CDM 1987
SBL-3	4	Yellow Ditch sediments	0-8	9.6-305	<3.8-12.6	137-2,190	29.4-187	197-2,990	ESE 1994
SS-003	4	Yellow Ditch berm material	0-1.6	<75	---	430-1,240	213-1,030	394-1,180	CDM 1987
RTYD5	4	Yellow Ditch berm material	0-0.83	<29-266	<0.2-4.8	32-440	<23-89	80-203	ESE 1994
SL-001	1	Near railroad bed	0-0.25	<75	---	44	242	642	CDM 1987
SBL-5	2	Near railroad bed	0-6	38.1-346	<3.8-4.2	850-1,200	16.8-222	1,080-1,680	ESE 1994
YD-RR-01	1	Railroad bed	0-0.17	391	8.27	4,170	360	4,700	ARCO 1996c
YD-RR-02	1	Railroad bed	0.17-0.83	353	3.3	3,310	327	2,410	ARCO 1996c
YD-RR-03	1	Railroad bed	0.83-2	36.4	2.51	9,090	34.7	1,620	ARCO 1996c
YD-RR-04	1	Railroad bed	0-0.17	305	6.07	5,660	264	2,970	ARCO 1996c
YD-RR-05	1	Railroad bed	0.17-0.83	297	3.91	3,370	244	1,190	ARCO 1996c
YD-RR-06	1	Railroad bed	0.83-2	26.5	0.685	2,540	18.8	1,200	ARCO 1996c
RTYD5	1	Area of reported spill	0-0.17	237	2.6	88,700	---	2,010	PTI 1992, 1993
YD5	10	Area of reported spill	0-3.0	52-448	---	142-139,000	---	347-3,290	PTI 1992, 1993
SBL-1	6	Outside outwash area	0-8	<5.8-89.9	<3.8	13.4-111	9.4-17.1	88.3-339	ESE 1994
SBL-6	3	Outside outwash area	0-10	9.3-84.5	<3.8	24.7-1,930	<8.3-44.1	72.7-1,220	ESE 1994
SBL-7	3	Outside outwash area	0-7	<5.8-39.7	<3.8	<13.4-57.9	<8.3-23.6	76.2-98.9	ESE 1994
SBL-2	6	Outwash area	0-7.5	10.6-113	<3.8-9	1,830-11,300	<8.3-57.9	797-3,850	ESE 1994
SBL-4	4	Outwash area	0-12	<5.8-118	<3.8-10	32.6-2,030	11.5-69.7	358-2,970	ESE 1994
SBL-8	3	Outwash area	0-8	<5.8-39.7	<3.8	16.1-699	11-26.1	1,490-1,890	ESE 1994
MW-235	3	Outwash area	0-6	8.4-56.8	3.9-10.6	2,200-3,430	10.9-30.7	1,490-1,890	ESE 1994
SL-005	1	Outwash area	0-0.25	<75	---	>3,000	272	1,190	CDM 1987

— = not analyzed
< = less than detection limit
mg/kg = milligrams per kilogram

TABLE 5-13

Summary of Arsenic and Metals Concentrations in Soils and Tailings in the MW-225 Area ARWW&S OU

Sample Location	Sample Number	Depth (feet)	Arsenic (mg/kg)	Cadmium (mg/kg)	Copper (mg/kg)	Lead mg/kg)	Zinc (mg/kg)
Within defined area of tailings	SBW-2	0.0-0.4	614	13.2	3,210	1,200	4,000
		0.0-2.5	29.3	<3.8	98.3	42.5	193
	SBW-3	0.0-1.0	539	3.8	5,020	267	2,410
	SBW-5	0.0-1.5	746	10.2	2,110	1,680	4,680
	SBW-6	0.0-0.75	725	13.1	2,610	1,550	4,430
		0.75-2.0	53.5	25.7	1,340	71.8	5,330
	SBW-7	0.0-1.0	615	10	2,080	1,340	2,790
		1.0-2.0	93.9	13.6	1,850	942	3,380
		2.0-2.5	23	<3.8	264	111	912
Outside defined area of tailings	SBW-1	0.0-3.0	166	<3.8	566	169	560
	SBW-4	0.0-3.0	35.8	<3.8	100	36.9	137
	SBW-8	0.0-2.0	78.9	<3.8	152	45.3	143
	SBW-9	0.0-2.5	109	<3.8	96.7	30.8	114
	SBW-10	0.0-2.0	35.5	<3.8	182	24.9	143

< = less than detection limit
mg/kg = milligrams per kilogram
Source: ESE 1996

TABLE 5-14

Arsenic Concentrations in Ground Water in the South Opportunity Subarea
ARWW&S OU

Sample Number	Sample Date	Arsenic (μg/L)
Springs/Seeps		
SS-T1	August 1995	5.0
SS-T2	August 1995	**78.0**
SS-T17	October 1995	**80.0**
SS-T18	October 1995	**23.0**
Hydro-Punch		
HP-1	September 1995	7.0
HP-2	September 1995	**24.0**
HP-4	October 1995	5.0
HP-5	October 1995	2.0
HP-9	October 1995	10.0
HP-11	October 1995	**249.0**
ARWW Wells		
MW-225	July 1995	10.0
MW-231	July 1995	4.0
MW-232	July 1995	**120.0**
MW-235	July 1995	<1
Rural Wells		
DW-SO2	August 1995	2.0
DW-SO16	August 1995	3.0
GW-SO46	August 1995	**29.0**
GW-SO57	August 1995	<1
DW-SO58	August 1995	4.0

μg/L = micrograms per liter
< = less than instrument detection limit
Exceedances of the State of Montana Ground Water Quality Standard for arsenic (18 μg/L) are shown in bold.
Source: ESE 1996

TABLE 5-15

Arsenic Concentrations in Ground Water in the MW-232 Area
ARWW&S OU

Sample Location	Sample Date	Arsenic (μg/L)
MW-232	3Q'93	**262**
Domestic wells at Willow Glen Ranch		
R1107	3Q'93	1
R1108	3Q'93	<1
R1110	3Q'93	7.9
Well Points		
SA-1	3Q'93	**24**
SA-2	3Q'93	13
SA-3	3Q'93	7
SA-4	3Q'93	7.4
SA-5	3Q'93	**245**
SA-6	3Q'93	**80.1**
SA-7	3Q'93	**84.6**

μg/L - micrograms per liter
Exceedances of the State of Montana Ground Water Quality Standard for arsenic (18 μg/L) are shown in bold.
Source: ESE 1996

TABLE 5-16

Cadmium, Copper, and Zinc Concentrations in Ground Water of the Blue Lagoon Area ARWW&S OU

Sample Location	Sample Date	Cadmium (μg/L)	Copper (μg/L)	Zinc (μg/L)
MW-235	3Q'93	---	**3,550**	**15,800**
SBL-2	3Q'93	**14**	459	**9,120**
SBL-5	3Q'93	**51.9**	**108,000**	**46,400**

Exceedances of the Preliminary Remedial Action Goals for cadmium (5μg/L), copper (1,000 μg/L), and zinc (5,000 μ/L) are shown in bold.

--- = no analysis

Source: ESE 1996

TABLE 5-17

Physical Characteristics of Waste and Solids in the Old Works/Stucky Ridge Subarea
ARWW&S OU

Disposal Area	Type	Area (acres)	Thickness (feet)	Volume (cubic yards)	Material Classification	Geometric Mean Concentration of Metals (mg/kg)				
						Arsenic	Cadmium	Copper	Lead	Zinc
Upper Works Structural Areas	Demolition and flue debris	3.94	2-14	32,000	Variable	508	5.6	4,540	189	889
Lower Works Structural Area	Demolition and flue debris	0.19	2-14	4,000	Variable	773	5.6	3,570	299	614
Railroad Beds	Waste aggregate	---	---	---	---	1,060	3.4	4,150	392	645
"Heap Roast" Slag Piles	Slag	22	2-14	298,000	Coarse sand	578	2	4,720	354	5,170
Warm Springs Creek Floodplain Area	Jig tailings and other debris	78	1-6	300,000	Clay, silt, sand, debris	1,010	5.7	1,480	328	441
Red Sands	Jig tailings	120	2-40	606,000	Sand and silt	1,200	2.1	2,920	437	3,640
Miscellaneous Waste Piles 1-8	Miscellaneous debris and waste	4.1	---	32,000	Variable	934	1.9	6,250	209	517

mg/kg = milligrams per kilogram
--- = data not available
Source: ESE 1996

TABLE 5-18

Summary of Springs and Seep Sample Results for Stucky Ridge Subarea ARWW&S OU

Station	Date	Basis	Arsenic (μg/L)	Q
SP97-1	16-May-97	DIS	40.7	
SP97-2	16-May-97	DIS	42.9	
SP97-3	16-May-97	DIS	13.4	
SP97-4	19-May-97	DIS	17.3	
SP97-5	19-May-97	DIS	18.2	
SP97-6	19-May-97	DIS	2.5	
SP97-7	20-May-97	DIS	8.7	
SP97-8	20-May-97	DIS	19.6	
SP97-20	9-Jun-97	DIS	95.4	
SP-1	Jul-91	DIS	10.6	
SP-2	Jul-91	DIS	63.9	
SP-3	Jul-91	DIS	88	
OWS-1	29-Oct-92	DIS	16.2	
OWS-2	29-Oct-92	DIS	40.5	
OWS-4	29-Oct-92	DIS	12.2	
SS-T-03	2-Aug-95	WET	4	
SS-T-04	16-Aug-95	WET	7	
SS-T-14	16-Aug-95	WET	104	
SS-T-15	16-Aug-95	WET	25	
SS-T-16	19-Sep-95	WET	39	
SS-T-28	9-Oct-96	DIS	1	U
Areawide Statistics				
Number of Samples			21	
Number of Detects			20	
Geometric Mean of All at SQL (μg/L)*			18.5	
Geometric Mean of detects (μg/L)			21.4	
Maximum Detect (μg/L)			104	
Minimum Detect (μg/L)			2.5	
ARAR (μg/L)			18	
Samples exceeding ARAR			11	
Percent of Samples Exceeding ARAR			52	

* Includes nondetects converted to sample quantitation limit (SQL)
ARAR = Applicable or Relevant and Appropriate Requirement
U = nondetect
μg/L = micrograms per liter

TABLE 5-19

Lysimeter Data for Red Sands and Old Works Tailings
ARWW&S OU

Location	Sample Depth (feet)	Date	Concentration of Metals (μg/L)				
			Arsenic	Cadmium	Copper	Lead	Zinc
Red Sands (RSLY)	7[1]	6/26/92	5.3	28.5	5,300	<1.0	12,100
		9/4/92	6	75.8	39,800	3	35,100
		11/18/92	8.5	322	267,000	1.1	180,000
Old Works Tailings Ponds (TPLY)	4.5[2]	6/26/92	54.8	67.8	82,900	<1.0	19,000
		9/4/92	21.6	58.5	58,500	<1.0	17,100

[1] RSLY was installed 7 feet below ground surface and 2 feet below the waste/soil interface

[2] TPLY was installed 4.5 feet below ground surface and 3 feet below the waste/soil interface

μg/L = micrograms per liter
< = less than detection limit
Source: ESE 1996

TABLE 5-20

Summary of Cadmium, Copper, and Zinc Concentrations in Ground Water in the Old Works/Red Sands Area
ARWW&S OU

Well I.D.	Geometric Mean*			Percent of Samples Exceeding ARAR		
	Cadmium	Copper	Zinc	Cadmium	Copper	Zinc
MW-72	3.3	126.2	534.2	13	0	0
MW-200	1.5	2.4	3.5	0	0	0
MW-202	1.8	132.4	216.7	0	0	0
MW-203	10.2	641.6	4075.8	100	22	33
MW-204	2.2	297.0	518.9	25	0	0
MW-205	2.3	21.0	94.2	11	0	0
MW-206	18.6	176.7	2128.2	100	0	0
MW-207	0.9	2.9	4.6	0	0	0
MW-208	1.2	3.0	5.7	0	0	0
MW-209	5.7	3.2	571.3	63	0	0
MW-213	7.1	869.5	2542.6	67	33	33
MW-240	0.1	4.2	11.6	0	0	0
MW-241	1.2	30.9	313.1	0	0	0
MW-242	2.6	26.0	387.8	50	0	0
LF-4	3.0	37.8	292.8	13	0	0
T1A	2.5	365.1	200.5	13	0	0
T1D	1.1	3.0	4.6	0	0	0
T2B	1.8	43.0	36.9	13	0	0
T2D	1.2	20.6	83.1	14	0	0

Area-Wide Statistics	Cadmium	Copper	Zinc
Number of Samples	137	137	137
Number of Detects	63	94	108
Geometric Mean of All at SQL (μg/L)*	2.62	46.29	148.54
Geometric Mean of detects (μg/L)	2.99	123.24	304.12
Maximum Detect (μg/L)	66.6	17300	33200
Minimum Detect (μg/L)	0.1	2	3.4
ARAR (μg/L)	5	1000	5000
Samples exceeding ARAR	36	4	5
Percent of Samples Exceeding ARAR	26	3	4
Number of Wells	19	19	19
Wells exceeding ARAR	12	2	2
Percent of Wells Exceeding ARAR	63	11	11

* Includes nondetects converted to sample quantitation limit (SQL)
ARAR = Applicable or Relevant and Appropriate Requirement
μg/L = micrograms per liter

TABLE 5-21

Statistical Summary of Arsenic and Metals Concentrations in Soil Samples from the Undisturbed Area of the Smelter Hill Subarea

ARWW&S OU

	Depth Interval	Number of Samples	Minimum	Maximum	Arithmetic Mean	Standard Deviation	Median	Geometric Mean
Arsenic	0-2 inches	126	43.6	**27,200**	**1,390**	2,460	976	870
Cadmium		85	1.1	964	53.2	107	29.9	29.5
Copper		126	47.3	72,400	3,230	6,760	1,870	1,820
Lead		126	26.3	6,430	755	861	535	460
Zinc		126	82.7	30,400	1,760	3,210	981	1,030
Conductivity		126	11.9	2,700	203	293	130	135
pH		126	3.8	8.2	6.0	1.1	6.2	
Arsenic	2-10 inches	125	26.2	**2,440**	476	408	384	342
Cadmium		84	0.2	126	13.0	17.2	8.5	6.0
Copper		125	6.2	5,100	620	888	270	252
Lead		125	6.0	1,550	153	241	57	67
Zinc		125	35.1	3,500	588	510	453	431
Conductivity		125	7.5	2,280	139	227	93.7	94.3
pH		125	4.0	8.2	6.2	1.0	6.1	
Arsenic	10-24 inches	107	0.6	**1,250**	216	219	150	121
Cadmium		106	0.2	32.0	2.1	5.8	0.3	0.5
Copper		107	3.5	4,150	153	542	18.6	27.8
Lead		107	3.8	587	38.3	96.3	13.8	16.5
Zinc		107	18.4	1,600	147	264	56.3	74.3
Conductivity		84	23.2	2,020	140	292	72.5	82.5
pH		107	5.4	10.3	7.2	1.0	7.0	
Arsenic	24-48 inches	23	0.6	780	129	173	110	51.0
Cadmium		23	0.2	17.5	1.1	3.6	0.3	0.4
Copper		23	3.5	808	53.2	165	15.7	18.6
Lead		23	5.5	305	25.5	61.1	13.2	13.7
Zinc		23	18.4	700	80.3	138	45.7	53.1
Conductivity		23	40.2	2,260	197	453	96.0	106
pH		23	5.9	10.3	7.4	1.2	7.0	

Values greater than or equal to 10 are reported in 3 significant figures, and values less than 10 are reported in 2 significant figures.
All concentrations are reported in mg/kg (milligrams per kilogram), except for pH, which is in Standard Units.
Exceedances of the Preliminary Remedial Action Goal for recreational use (1,000 parts per million arsenic) are shown in bold.
Source: ESE 1996

TABLE 5-22

Volumes of Soil with Arsenic Concentrations Greater than 1,000 mg/kg in the Smelter Hill Subarea
ARWW&S OU

Area	Total Volume (cubic yards)	Volume of Waste		
		Arsenic >1,000 mg/kg but ≤5,000 mg/kg (cubic yards)	Arsenic >5,000 mg/kg but ≤10,000 mg/kg (cubic yards)	Arsenic >10,000 mg/kg (cubic yards)
Reclaimed disturbed	280,864	217,593 (18%)	1,543 (0.1%)	61,728 (5%)
Non-reclaimed disturbed	393,162	340,100 (14%)	16,373 (1%)	36,698 (2%)
Reclaimed HPS	58,665	54,105 (34%)	2,353 (2%)	2,207 (1%)
Non-reclaimed HPS	62,916	55,748 (26%)	3,102 (2%)	4,066 (2%)
Stack	23,942	12,523 (24%)	3,387 (6%)	8,032 (15%)

Values in parentheses are the percentage of the total volume that is waste.
mg/kg = milligrams per kilogram
Source: ESE 1996

TABLE 5-23

Results of Chemical Analysis for Slag Samples
ARWW&S OU

Parameter[1]	Detection Limit[2]	Main Slag Pile[3]	SPT-1[4]	SPT-2	SPT-3	SPT-4	SPT-5	SPS-1[5]	SPS-2	SPS-3	SPS-4	SPS-5	Maximum	Minimum	Arithmetic Mean	Geometric Mean	Standard Deviation
Aluminum			21,000	21,000	21,800	17,500	20,200	20,500	22,600	24,400	30,700	17,100	30,700	17,100	21,690	21,413	3,639
Antimony			67	162	115	57	129	219	129	98	42	96	219	42	111.4	100	50
Arsenic		2,690	1,470	3,070	1,690	1,340	2,270	3,190	2,170	2,160	498	1,920	3,190	498	1,978	1,787	759
Barium			1,170	1,340	463	1,690	1,450	3,190	980	266	485	766	3,190	266	1,180	942	803
Beryllium	2.5		2.5	2.7	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.7	2.5	2.5	2.5	0.1
Boron	8		17	170	27	15	22	9.7	22	8	27	14	170	8	33.17	21	46
Cadmium		23.3	21	29	26	11	25	44	30	19	4.4	19	44	4.4	22.8	19.8	10.3
Chromium			354	115	436	297	342	217	323	205	45	278	436	45	261	224	111
Cobalt			90	82	517	118	73	42	267	99	28	101	517	28	141.7	100	139
Copper		5,550	5,590	4,740	9,760	6,680	6,760	5,210	7,710	5,660	3,140	7,460	9,760	3,140	6,271	6,017	1,737
Iron			300,000	316,000	334,000	341,000	288,000	325,000	320,000	377,000	188,000	326,000	377,000	188,000	311,500	307,146	46,998
Lead		2,730	954	2,590	4,190	1,000	926	4,310	2,830	2,200	364	1,080	4,310	364	2,044	1,587	1,340
Manganese			832	8,280	864	710	961	1,470	1,750	17,200	754	908	17,200	710	3,373	1,618	5,100
Mercury	0.04		0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.08	0.08	0.04	0.04	0.04	0.01
Molybdenum	3		57	82	670	67	57	3.2	485	14	3	74	670	3	151.22	47	219
Nickel	20		40	22	291	54	23	20	129	36	20	73	291	20	70.8	46	80
Selenium	50		50	50	50	50	50	50	50	85	50	50	85	50	53.5	53	11
Silver	5		5	7.8	5.8	5.8	5.4	9.5	6.1	88	17	9	88	5	15.94	9	24
Tin	20		41	20	220	99	126	67	118	129	20	172	220	20	101	78	62
Vanadium			118	229	213	93	190	192	184	127	83	132	229	83	156.1	148	49
Zinc		23,300	38,800	25,800	36,300	21,200	34,700	23,400	29,900	23,800	8,380	23,700	38,800	8,380	26,598	24,811	8,412
Total Sulfur[6]			1.36	0.95	0.95	1.29	1.15	0.99	1.36	1.16	0.51	1.28	1.36	0.51	1.1	1.06	0.25
Pyritic Sulfur[6]	0.01		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0
Slurry pH[7]			6.6	7.5	7.0	6.4	6.8	7.2	6.9	8.9	6.5	7.1	8.9	6.4	7.1	7.1	0.7

[1] Acid extractable metals (mg/kg dry weight basis)
[2] Instrument detection limit reported for undetected values and used in the statistical calculations at the detection limits
[3] Composite slag samples collected from the main slag pile during 3rd Quarter 1993 (ESE)
[4] SPT indicates sample collected from top of slag pile
[5] SPS indicates sample collected from side slope of slag pile
[6] Percent sulfur on a dry weight basis
[7] 1:1 slurry mix
All units are in μg/L (micrograms per liter), except for pH, which is in Standard Units
Source: ESE 1996

TABLE 5-24

XRF-Metals Data Obtained from Slag Piles: Landfill, West Stack, and Main Granulated Slag Piles
ARWW&S OU

Location	Arsenic	Cadmium	Copper	Lead	Iron[1]	Manganese	Mercury	Selenium	Silver	Zinc
Landfill	337	<4.0	5,418	681	22.2	565	<8.0	17.4	9.9	10,100
West Stack[2]	1,870	39.6	21,600	1,470	8.99	484	<8.0	11.8	28.1	19,400
West Stack[3]	5,500	52.9	11,600	3,250	27.8	1,310	<8.0	<10.0	15.5	68,000

[1] Iron is measured on a percentage basis. All other units are in mg/kg (milligrams per kilogram).

[2] coarse slag from 1 inch to 3 feet in diameter

[3] composited from two piles, less coarse ½ to 1 inch in diameter

Source: ESE 1996

TABLE 5-25

Statistical Summary of Metals Concentrations in Non-Reclaimed Soil Samples in the Disturbed Area of the Smelter Hill Subarea
ARWW&S OU

	Depth Interval	Number of Samples	Minimum	Maximum	Arithmetic Mean	Standard Deviation	Median	Geometric Mean
Arsenic	0-2 inches	56	20.6	29,300	2,260	4,160	1,220	830
Cadmium		56	0.6	482	48.6	96.6	9.9	18.6
Copper		56	42.3	160,000	9,070	22,500	2,180	2,130
Lead		56	8.2	16,400	1,500	2,620	546	428
Zinc		56	42.6	61,600	6,740	10,600	2,410	2,220
Conductivity		56	69	11,500	1,230	1,930	457	614
pH		56	2.3	8.3	6.5	1.2	7.0	
Arsenic	2-10 inches	53	12.8	21,900	1,060	3,030	362	385
Cadmium		53	0.6	584	24.8	82.8	4.4	7.5
Copper		53	10.3	122,000	4,080	1,700	618	556
Lead		53	3.1	12,100	535	1,703	115	115
Zinc		53	16.3	16,500	2,070	3,450	725	715
Conductivity		53	57.6	5,940	869	1,120	470	498
pH		53	2.3	8.3	6.6	1.2	6.9	
Arsenic	10-24 inches	53	8.9	8,700	798	1,700	174	214
Cadmium		53	0.6	494	21.2	77.8	1.0	3.7
Copper		53	7.3	39,800	2,660	7,290	177	253
Lead		53	2.8	5,940	366	940	46.3	64.1
Zinc		53	13.8	64,900	2,560	9,240	269	323
Conductivity		53	72.3	22,100	1,500	3,130	780	745
pH		53	2.3	59.4	7.6	7.4	7.0	
Arsenic	24-48 inches	38	4.6	25,600	1,400	4,660	109	126
Cadmium		38	0.6	187	8.7	30.7	1.0	1.9
Copper		38	5.9	29,500	2,110	6,220	152	174
Lead		38	1.1	2,890	270	622	29.7	38.4
Zinc		38	6.9	17,900	1,960	4,580	223	212
Conductivity		38	95.3	5,780	1,100	1,200	769	705
pH		38	2.0	7.1	5.1	1.2	4.9	
Arsenic	Greater than 48 inches	31	4.9	28,300	1,400	5,210	68	105
Cadmium		31	0.6	95	5.0	17.6	0.6	1.2
Copper		31	3.3	65,700	4,190	13,700	31.9	90.3
Lead		31	2.4	2,950	319	779	9.6	24.9
Zinc		31	8.3	16,600	1,700	4,370	59	124
Conductivity		31	193	7,980	1,090	1,430	659	729
pH		31	3.6	9.5	7.1	1.1	7.2	

Values greater than or equal to 10 are reported in 3 significant figures, and values less than 10 are reported in 2 significant figures.
All concentrations are reported in mg/kg (milligrams per kilogram), except for pH, which is in Standard Units.
Source: ESE 1996

TABLE 5-26

Statistical Summary of Physical Parameters for Tailings in the Anaconda Ponds
ARWW&S OU

Parameter	Tailings Thickness (feet)	Moisture (%)	Grain Size Distribution (%)			
			Gravel	Sand	Silt	Clay
Number of Samples	2	27	27	27	27	27
Maximum	90.0	25.9	17.6	89.2	60.1	57.0
Minimum	89.0	0.0	0.0	2.9	8.6	2.1
Arithmetic Mean	89.5	6.8	1.99	56.53	28.50	13.44
Standard Deviation	0.5	9.3	4.43	28.58	16.57	15.62
Geometric Mean	89.5	NA	NA	43.64	23.27	7.99

NA = not available
Source: ESE 1996

TABLE 5-27

Statistical Summary of Chemical Parameters for Tailings in Anaconda Ponds
ARWW&S OU

Parameter	Slurry pH (S.U.)	Total Sulfur (%)	Pyritic Sulfur (%)	Leachable Sulfate (%)	Carbonate (%)	Arsenic (mg/kg)	Cadmium (mg/kg)	Copper (mg/kg)	Iron (mg/kg)	Lead (mg/kg)	Manganese (mg/kg)	Zinc (mg/kg)
Number of Samples	27	27	27	27	27	27	27	27	27	27	27	27
Maximum	7.40	7.13	6.67	0.86	12.80	367	42.0	4,770	74,800	1,190	17,000	12,400
Minimum	2.40	0.86	0.36	0.01	0.01	71	2.0	1,030	8,340	59	128	201
Arithmetic Mean	6.00	4.22	3.46	0.23	1.80	152	7.6	2,186	42,790	418	2,243	2,131
Standard Deviation	1.50	1.81	1.82	0.20	3.35	76	10.1	964	17,571	347	3,509	3,055
Geometric Mean	5.70	3.74	2.86	0.16	0.52	137	4.4	2,005	38,437	293	1,057	1,096

S.U. = Standard Units
mg/kg = milligrams per kilogram
Source: ESE 1996

TABLE 5-28

Statistical Summary of Metals Concentrations in Soil Samples
from the HPS Area of East Anaconda Yard
ARWW&S OU

	Depth Interval	Number of Samples	Minimum	Maximum	Arithmetic Mean	Standard Deviation	Geometric Mean
Arsenic	0-2 inches	56	43.0	190	105.6	45.3	94.0
Copper		56	46.5	286	101.6	65.1	84.2
Lead		56	61.0	61	61.0	0.0	61.0
Zinc		56	323.5	958	402.3	183.8	374.8
pH		56	5.0	8.2	7.2	0.6	
Arsenic	2-10 inches	50	43.0	305	111.2	64.7	92.2
Copper		50	46.5	4,110	194.2	573.0	86.8
Lead		50	61.0	455	68.9	55.2	63.5
Zinc		50	323.5	1,520	429.7	273.9	383.8
pH		50	5.8	8.3	7.4	0.5	
Arsenic	10-24 inches	77	43.0	4,480	425.0	699.3	209.1
Copper		77	46.5	50,300	2,450.1	6,330.4	635.6
Lead		77	61.0	12,200	1,231.7	2,270.0	265.9
Zinc		77	242.0	4,500	1,053.2	956.7	717.6
pH		77	5.6	8.5	7.2	0.6	
Arsenic	24-48 inches	107	43.0	6,460	921.8	1,252.3	393.6
Copper		107	46.5	65,900	4,612.2	9,908.6	1,242.4
Lead		107	61.0	60,000	2,273.0	6,085.3	627.1
Zinc		107	242.0	16,400	2,522.8	3,609.5	1,228.2
pH		107	5.7	8.8	7.1	0.6	
Arsenic	Greater than 48 inches	32	43.0	6,260	1,147.5	1,587.1	360.8
Copper		32	86.0	6,810	1,756.1	2,031.8	879.4
Lead		32	61.0	30,200	2,785.4	6,902.3	538.1
Zinc		32	242.0	18,300	3,766.3	5,660.9	1,334.1
pH		31	3.7	8.0	7.0	0.8	
Arsenic	All data	322	43.0	6,460	557.6	1,019.2	208.7
Copper		322	46.5	65,900	2,340.9	6,782.9	423.7
Lead		322	61.0	60,000	1,348.0	4,394.0	236.8
Zinc		322	242.0	18,300	1,601.2	3,005.6	739.6
pH		321	3.7	8.8	7.2	0.6	

Values greater than or equal to 10 are reported in 3 significant figures, and values less than 10 are reported in 2 significant figures.
All concentrations are reported in mg/kg (milligrams per kilogram), except for pH, which is in Standard Units.
Source: ESE 1996

TABLE 5-29

Statistical Summary of Metals Concentrations in Soil Samples from the Disturbed Area of East Anaconda Yard
ARWW&S OU

	Depth Interval	Number of Samples	Minimum	Maximum	Arithmetic Mean	Standard Deviation	Geometric Mean
Arsenic	0-2 inches	33	19	2,090	124	363	45
Cadmium		33	0.4	126.0	6.9	21.7	1.6
Copper		33	34	16,100	864	2,910	127
Lead		33	11	1,590	93	278	30
Arsenic	2-10 inches	33	11	1,510	124	291	43
Cadmium		33	0.4	148.0	6.6	25.3	1.2
Copper		33	9	8,660	458	1,538	62
Lead		33	9	4,400	217	789	26
Arsenic	10-24 inches	42	7	2,150	480	653	167
Cadmium		42	0.6	66.2	8.6	12.4	3.9
Copper		42	16	91,600	3,668	13,910	497
Lead		42	9	22,400	822	3,406	95
Arsenic	24-48 inches	11	10	1,770	531	594	185
Cadmium		11	1.3	37.9	11.5	10.6	7.9
Copper		11	29	4,710	1,205	1,327	535
Lead		11	7	1,220	311	417	92
Arsenic	Greater than 48 inches	13	11	9,480	1,182	2,497	248
Cadmium		13	0.7	181.0	29.1	48.1	9.0
Copper		13	34	7,800	1,754	2,062	740
Lead		13	7	3,030	407	804	97
Arsenic	All data	132	7.4	9,480	376	966	90
Cadmium		132	0.4	181.0	9.9	24.6	2.7
Copper		132	8.7	91,600	1,771	8,164	219
Lead		132	6.7	22,400	405	2,008	51

Values greater than or equal to 10 are reported in 3 significant figures, and values less than 10 are reported in 2 significant figures.
All concentrations are reported in mg/kg (milligrams per kilogram).
Source: ESE 1996

TABLE 5-30

Statistical Summary of Metals Concentrations in Non-Reclaimed Soil Samples in the Primary HPS Area of the Smelter Hill Subarea
ARWW&S OU

	Depth Interval	Number of Samples	Minimum	Maximum	Arithmetic Mean	Standard Deviation	Median	Geometric Mean
Arsenic	0-2 inches	333	16	25,600	1,714	2,458	950	815
Copper		333	44	138,000	7,295	12,763	3,693	2,913
Lead		333	17	8,580	946	1,206	524	445
Zinc		333	99	36,900	6,441	7,893	3,320	2,877
Conductivity		333	0.34	4,100	982	864	690	572
pH		333	2.8	9.8	7.3	0.9	7.4	
Arsenic	2-10 inches	376	13	65,300	2,072	5,053	752	640
Copper		376	18	130,000	8,732	14,528	3,845	2,399
Lead		376	9.5	12,100	843	1,247	384	308
Zinc		376	28	60,900	5,307	8,587	2,155	1,634
Conductivity		395	1.8	7,400	1,077	1,048	720	626
pH		395	2.1	12.8	7.4	1.3	7.4	
Arsenic	10-24 inches	71	13	11,300	1,125	1,664	463	434
Copper		71	18	21,200	4,243	4,530	2,590	1,603
Lead		71	9.5	8,230	560	1,066	239	216
Zinc		71	28	65,800	4,696	9,841	1,410	1,199
Conductivity		459	0	8,980	1,214	988	1,020	798
pH		459	2.3	12.5	7.2	1.2	7.3	
Arsenic	24-48 inches	195	4	33,000	1,552	3,705	455	350
Copper		195	21	90,900	7,981	15,074	2,380	1,674
Lead		195	13	8,010	584	1,113	185	179
Zinc		195	18	44,100	3,909	7,359	1,180	1,049
Conductivity		539	14	7,300	1,224	990	891	830
pH		539	2.3	12.5	7.2	1.3	7.3	
Arsenic	Greater than 48 inches	178	16	12,200	691	1,685	38	90
Copper		178	21	70,600	3,348	9,274	280	343
Lead		178	13	28,900	520	2,293	27	67
Zinc		178	31	50,300	2,871	7,607	207	361
Conductivity		306	10	6,583	1,024	1,010	550	656
pH		306	1.6	12.5	7.3	1.4	7.4	

Values greater than or equal to 10 are reported in 3 significant figures, and values less than 10 are reported in 2 significant figures.
All concentrations are reported in mg/kg (milligrams per kilogram), except for pH, which is Standard Units..
Source: ESE 1996

TABLE 5-31

Statistical Summary of Metals Concentrations in Soil Samples in the Stack Area of the Smelter Hill Subarea

ARWW&S OU

	Depth Interval	Number of Samples	Minimum	Maximum	Arithmetic Mean	Standard Deviation	Median	Geometric Mean
Arsenic	0-2 inches	115	16	31,600	2,995	5,918	772	728
Copper		115	21	15,600	1,448	2,785	417	441
Lead		115	14	4,040	447	808	144	163
Zinc		115	39	5,030	933	1,104	502	486
Conductivity		115	27	7,060	705	1,033	217	308
pH		115	4.4	12.6	6.8	1.2	6.9	
Arsenic	2-10 inches	127	16	52,200	5,165	9,531	866	939
Copper		127	21	25,600	2,429	4,321	448	502
Lead		127	13	8,460	870	1,657	122	181
Zinc		127	22	10,000	1,536	2,145	472	571
Conductivity		127	30	4,230	831	984	233	343
pH		127	2.9	11.2	6.5	1.3	6.6	
Arsenic	10-24 inches	74	16	143,000	8,995	19,967	2,045	1,245
Copper		74	21	31,100	3,885	6,198	1,445	680
Lead		74	16	29,000	1,867	4,666	241	219
Zinc		74	24	13,700	2,238	2,630	1,085	715
Conductivity		148	33	11,700	1,152	1,452	488	517
pH		148	1.6	9.4	6.3	1.5	6.5	
Arsenic	24-48 inches	55	16	25,000	4,060	6,266	634	829
Copper		55	21	12,900	2,252	3,529	404	487
Lead		55	14	4,180	554	1,047	66	116
Zinc		55	26	9,420	1,666	2,452	407	512
Conductivity		121	51	8,960	1,135	1,367	492	599
pH		121	1.6	9.4	6.2	1.5	6.4	
Arsenic	Greater than 48 inches	53	16	44,800	4,013	9,356	200	336
Copper		53	21	14,200	1,866	3,800	74	177
Lead		53	13	8,970	780	1,939	25	60
Zinc		53	23	15,500	1,558	3,083	113	261
Conductivity		92	81	11,200	893	1,450	421	521
pH		92	3.2	10.8	6.7	1.4	6.8	

Values greater than or equal to 10 are reported in 3 significant figures, and values less than 10 are reported in 2 significant figures.
All concentrations are reported in mg/kg (milligrams per kilogram), except for pH, which is Standard Units..
Source: ESE 1996

TABLE 5-32

Statistical Summary and Metals Concentrations in Soil Samples in the Loop Track Railroad Beds of the Smelter Hill Subarea
ARWW&S OU

	Depth Interval	Number of Samples	Minimum	Maximum	Arithmetic Mean	Standard Deviation	Median	Geometric Mean
Arsenic	0-2 inches	10	770	7,489	3,700	1,885	3,812	3,131
Copper		10	3,939	9,880	6,212	1,685	6,324	6,021
Lead		10	1,056	2,389	1,522	362	1,412	1,488
Zinc		10	3,329	8,064	5,242	1,490	5,041	5,059
Conductivity		20	253	2,928	1,124	814	893	849
pH		20	4.3	7.6	6.4	1.0	6.6	
Arsenic	2-10 inches	3	6,720	13,100	10640	3,431	12,100	10,209
Copper		3	8,410	11,100	9,970	1,396	10,400	9,897
Lead		3	2,240	3,260	2,867	549	3,100	2,830
Zinc		3	5,510	8,350	7,280	1,544	7,980	7,158
Conductivity		6	627	1,770	1,107	389	1,105	1,052
pH		6	4.2	6.5	5.3	0.87	5.4	
Arsenic	10-24 inches	4	502	4,660	2048	1,834	1,515	1,495
Copper		4	802	14,100	7,698	6,408	7,945	4,774
Lead		4	128	1,770	842	707	735	577
Zinc		4	596	13,700	7,359	5,571	7,570	4,578
Conductivity		8	169	2,060	952	648	849	740
pH		8	4.4	7.6	5.9	1.2	6.1	

Values greater than or equal to 10 are reported in 3 significant figures, and values less than 10 are reported in 2 significant figures.
All concentrations are reported in mg/kg (milligrams per kilogram), except for pH, which is Standard Units..
Source: ESE 1996

TABLE 5-33

Statistical Summary of Metals Concentrations in Reclaimed Soil Samples in the Disturbed Area of the Smelter Hill Subarea
ARWW&S OU

	Depth Interval	Number of Samples	Minimum	Maximum	Arithmetic Mean	Standard Deviation	Median	Geometric Mean
Arsenic	0-2 inches	28	19.0	3,960	235	735	61.2	82.7
Cadmium		28	0.6	234	11.6	44.0	1.7	2.5
Copper		28	22.2	14,800	733	2,770	131	165
Lead		28	10.7	2,580	147	482	37.8	46.0
Zinc		28	52.1	26,300	1,300	4,910	242	308
Conductivity		28	130	3,020	470	674	228	295
pH		28	5.3	12.5	7.5	1.2	7.6	
Arsenic	2-10 inches	28	4.8	524	78.0	101	46.5	50.1
Cadmium		28	0.6	21.0	2.4	4.3	0.8	1.4
Copper		28	14.5	1,100	129	205	82.7	81.9
Lead		28	9.9	248	38.3	46.7	26.0	27.8
Zinc		28	36.6	1,940	292	383	167	184
Conductivity		28	90.0	2,460	494	557	292	336
pH		28	4.0	8.7	7.5	1.0	7.8	
Arsenic	10-24 inches	28	21.9	2,410	635	739	299	264
Cadmium		28	0.6	230	18.7	44.0	5.4	6.2
Copper		28	45.5	7,370	1,850	2,090	997	652
Lead		28	11.8	1,790	453	552	246	169
Zinc		28	89.5	18,200	4,080	5,950	841	120
Conductivity		28	0.0	2,580	1,020	822	860	703
pH		28	5.0	16.7	8.0	2.4	7.5	
Arsenic	24-48 inches	11	8.4	3,640	778	1,300	193	190
Cadmium		11	0.6	133	22.4	43.8	3.9	5.3
Copper		11	20.9	24,200	3,560	7,330	451	470
Lead		11	7.9	2,890	449	833	233	121
Zinc		11	33.8	19,400	2,570	5,720	623	505
Conductivity		11	300	5,100	1,860	1,400	1,480	1,400
pH		11	2.5	6.6	5.2	1.5	5.5	
Arsenic	Greater than 48 inches	10	15.5	19,000	2,440	5,860	308	377
Cadmium		10	0.6	208	32.9	63.4	9.9	9.6
Copper		10	23.6	31,000	4,230	9,540	693	811
Lead		10	5.1	2,000	554	611	374	236
Zinc		10	33.3	10,100	3,400	3,790	2,010	1,130
Conductivity		10	186	9,280	2,200	3,650	1,620	1,300
pH		10	2.7	8.5	5.6	2.0	5.8	

Values greater than or equal to 10 are reported in 3 significant figures, and values less than 10 are reported in 2 significant figures.
All concentrations are reported in mg/kg (milligrams per kilogram), except for pH, which is in Standard Units.
Source: ESE 1996

TABLE 5-34

Statistical Summary of Metals Concentrations in Reclaimed Soil Samples in the Primary HPS Area of the Smelter Hill Subarea ARWW&S OU

	Depth Interval	Number of Samples	Minimum	Maximum	Arithmetic Mean	Standard Deviation	Median	Geometric Mean
Arsenic	0-2 inches	245	16	8,180	518	1,031	162	186
Copper		245	34	49,100	1,539	4,356	189	314
Lead		245	13	4,790	312	675	49	85
Zinc		245	36	37,000	2,950	6,901	382	592
Conductivity		252	10	18,200	586	1,620	240	264
pH		252	3.2	10.5	7.5	1.0	7.5	
Arsenic	2-10 inches	249	16	11,700	434	1,093	119	129
Copper		249	21	24,700	1,550	3,784	94	190
Lead		249	13	4,900	237	606	29	54
Zinc		249	31	41,600	1,910	5,368	175	322
Conductivity		284	10	10,600	620	906	275	338
pH		284	2.3	10.5	7.4	1.1	7.4	
Arsenic	10-24 inches	19	16	6,490	1,715	1,825	986	735
Copper		19	18	54,900	8,993	14,237	4,140	2,375
Lead		19	18	3,150	1,036	1,003	774	419
Zinc		19	56	36,533	8,719	11,056	4,240	2,408
Conductivity		366	20	11,000	1,251	1,177	830	726
pH		366	2.2	12.7	7.2	1.4	7.1	
Arsenic	24-48 inches	104	4	140,000	3,312	14,267	672	388
Copper		104	21	173,000	7,349	18,498	3,525	1,482
Lead		104	10	16,800	1,169	2,109	312	262
Zinc		104	37	60,500	8,411	12,816	2,235	1,626
Conductivity		403	20	8,800	1,450	1,310	1,190	888
pH		404	1.4	12.7	7.1	1.7	7.0	
Arsenic	Greater than 48 inches	163	3	567,000	5,654	44,656	297	269
Copper		163	13	67,800	4,599	10,181	1,120	815
Lead		163	10	35,100	1,056	3,459	132	167
Zinc		163	37	39,200	6,187	10,245	1,340	1,321
Conductivity		314	10	8,113	1,241	1,238	801	734
pH		314	2.6	12.5	7.3	1.8	7.2	

Values greater than or equal to 10 are reported in 3 significant figures, and values less than 10 are reported in 2 significant figures.
All concentrations are reported in mg/kg (milligrams per kilogram), except for pH, which is Standard Units.
Source: ESE 1996

TABLE 5-35

Lysimeter Results for the Smelter Hill Subarea
ARWW&S OU

Location	Sample	Date	Depth	Arsenic	Cadmium	Copper	Lead	Iron	Zinc	SO_4	Conductivity	pH
R6 Anaconda Ponds		9/2/93	4	—	—	—	—	—	—	—	—	—
		9/22/93	4	—	—	—	—	—	—	—	—	2.24
		9/2/93	8.5	—	—	—	—	—	—	—	—	—
		9/22/93	8.5	—	—	—	—	—	—	—	—	—
		9/2/93	12.5	—	—	—	—	—	—	—	—	—
	PW016	9/22/93	12.5	2.2	0.62	55	0.7	50,400	30	1,420	3.1	5.71
R7 Smelter Hill Stack Area		9/2/93	2.5	—	—	—	—	—	—	—	3.02	5.05
		9/22/93	2.5	—	—	—	—	—	—	—	—	—
	PW001	9/2/93	6.5	1,120	44,100	149,000	5.5	39	787,000	4,410	4.68	5.33
	PW011	9/22/93	6.5	901	38,200	256,000	3.6	142	864,000	3,870	4.9	4.67
		9/2/93	10.5	—	—	—	—	—	—	—	—	6.35
		9/22/93	10.5	—	—	—	—	—	—	—	2.56	6.31
		9/2/93	14.5	—	—	—	—	—	—	—	3.27	7.75
	PW013	9/22/93	14.5	10,400	139	100	1	42.1	872	2,080	3.41	6.58
R8 Smelter Hill Iron Pond	PW002	9/2/93	2.5	2.6	95.9	3,270	5.5	381	15,800	1,970	2.85	4.99
	PW015	9/22/93	2.5	2.3	123	5,470	1.6	1,070	22,200	1,740	2.98	3.67
		9/2/93	6.5	—	—	—	—	—	—	—	—	—
		9/22/93	6.5	—	—	—	—	—	—	—	—	—
		9/2/93	11	—	—	—	—	—	—	—	—	—
		9/22/93	11	—	—	—	—	—	—	—	—	—
	PW004	9/2/93	15.5	39.5	1.3	2.9	5.5	3.9	5.7	1,550	2.63	6.65
	PW014	9/22/93	15.5	50.2	1.7	14.6	1.6	26.9	52.1	1,320	2.4	6.4
R9 Reposi-tory Bench		9/2/93	3	—	—	—	—	—	—	—	—	—
	PW019	9/22/93	3	10,400	2	31.9	1.9	319	24	2,710	4.93	6.97
		9/2/93	7	—	—	—	—	—	—	—	2.96	3.59
	PW018	9/22/93	7	159	1.5	10.7	1.6	21.5	32.1	1,500	2.72	7.02
		9/2/93	11	—	—	—	—	—	—	—	—	—
		9/22/93	11	—	—	—	—	—	—	—	2.59	7.27
		9/2/93	15	—	—	—	—	—	—	—	3.06	4.34
	PW017	9/22/93	15	131	2.2	15.4	1.6	21.5	46.9	1,490	2.87	6.82

Concentrations are in μg/L (micrograms per liter) except sulfate, which is in mg/L (milligrams per liter).
Conductivity in millimhos per centimeter (mmhos/cm).
pH in Standard Units.
— = no sample analyzed
Source: ESE 1996

TABLE 5-36

Summary of Analytical Results for Lysimeters in the Main Slag Pile
ARWW&S OU

Lysimeter	Date/Time	Depth (feet)	pH (S.U.)	Arsenic (μg/L)	Cadmium (μg/L)	Sulfate (mg/L)
SLAG-LY-1[1]	7/24/95 16:31	78'6" - 78'8"	6.4	12	87.6	1,620
SLAG-LY-1	7/25/95 11:30	78'6" - 78'8"	---	11	90.1	1,700
SLAG-LY-2D[2]	7/24/95 17:14	97'5.4" - 97'7.4"	7.53	80	0.9	2,020
SLAG-LY-2D	7/25/95 12:19	97'5.4" - 97'7.4"	---	80	0.9	2,070
SLAG-LY-2S[3]	8/16/95 14:12	74' - 74'2"	---	15	<0.1	503
SLAG-LY-2S	8/17/95 16:28	74' - 74'2"	---	18	0.2	659

[1] located in the black slag immediately above the slag/alluvium interface

[2] located beneath the slag at the slag/alluvium interface

[3] shallow lysimeter placed in the SLAG-LY-2 boring

--- = no analysis

S.U. = Standard Units

μg/L = micrograms per liter

mg/L = milligrams per liter

TABLE 5-37

Statistical Summary of Sample Results from Network Wells in the Smelter Hill Subarea During the Anaconda Regional Water and Waste Remedial Investigation ARWW&S OU

Well ID	Location	Zone Monitored	Analyte	Number of Samples	Maximum	Minimum	Mean	Standard Deviation	Median	Geometric Mean
A1BR2	Stack Area	Bedrock	Arsenic	8	**8,470**	**2,510**	**5,337.5**	1,669.9	**5,080.0**	**5,064.0**
			Cadmium	8	**5.8**	0.2	1.6	1.7	1.2	1.0
A1BR3	Stack Area	Bedrock	Arsenic	6	**33.4**	7.8	**19.0**	8.1	16.9	17.2
			Cadmium	6	2.0	0.1	1.0	0.6	1.2	0.7
A2BR	East Anaconda Yard	Bedrock	Arsenic	8	**2,410**	**843**	**1,225.8**	475.1	**1,090.0**	**1,158.1**
			Cadmium	8	2.0	0.1	1.0	0.7	1.3	0.6
B4BR	Primary HPS Area	Bedrock	Arsenic	8	**1,660**	**1,120**	**1,272.5**	163.1	**1,215.0**	**1,263.1**
			Cadmium	8	**56.3**	**38.0**	**45.4**	5.6	**44.9**	**45.1**
C2AL	Iron Ponds	Bedrock	Arsenic	8	**2,450**	**2,010**	**2,306.3**	155.2	**2,375.0**	**2,300.8**
			Cadmium	8	**6.2**	0.3	2.2	2.3	1.3	1.3
C2BR	Iron Ponds	Bedrock	Arsenic	6	**1,240**	**979**	**1,134.8**	107.3	**1,175.0**	**1,129.6**
			Cadmium	6	2.0	0.1	1.0	0.7	1.2	0.6
F2BR	South Mill Creek	Bedrock	Arsenic	8	14.6	0.5	3.1	4.4	1.4	1.7
			Cadmium	8	2.0	0.0	1.1	0.6	1.2	0.7
D3AL1	Northeast Smelter Hill	Alluvium	Arsenic	8	**101**	**38.4**	**62.5**	17.7	**63.7**	**60.1**
			Cadmium	8	**5.1**	0.1	1.9	1.7	1.2	1.0
E2AL1	Mill Creek	Alluvium	Arsenic	8	5.3	0.5	1.9	1.7	1.3	1.3
			Cadmium	8	2.0	0.0	1.0	0.6	1.1	0.6
MW-207	Old Works	Alluvium	Arsenic	9	2.6	0.5	1.2	0.7	1.0	1.0
			Cadmium	9	2.0	0.0	1.2	0.7	1.5	0.6
MW-210	East Anaconda Yard	Alluvium	Arsenic	6	**102**	**47.0**	**81.6**	18.1	**88.2**	**79.2**
			Cadmium	6	2.2	0.2	1.3	0.7	1.4	1.0
MW-211	Anaconda Ponds	Alluvium	Arsenic	6	**61.6**	**40.9**	**49.8**	8.5	**47.6**	**49.1**
			Cadmium	5	2.0	1.1	1.5	0.3	1.5	1.5
MW-218D	Anaconda Ponds	Alluvium	Arsenic	6	3.2	0.5	1.6	0.9	1.6	1.4
			Cadmium	6	2.0	0.6	1.2	0.5	1.2	1.1
MW-218S	Anaconda Ponds	Alluvium	Arsenic	6	**45.8**	**31.6**	**38.8**	4.8	**37.6**	**38.5**
			Cadmium	6	**9.0**	5.0	**6.7**	1.5	**6.9**	**6.6**
MW-219	Anaconda Ponds	Alluvium	Arsenic	6	3.1	0.5	2.0	0.9	2.0	1.7
			Cadmium	6	2.0	0.1	1.3	0.6	1.4	1.0
MW-220	Anaconda Ponds	Alluvium	Arsenic	6	3.0	0.9	1.9	0.7	2.0	1.7
			Cadmium	6	2.0	0.0	1.3	0.6	1.4	0.8
MW-227	East Anaconda Yard	Alluvium	Arsenic	5	**125**	**47.3**	**64.6**	30.2	**49.3**	**59.6**
			Cadmium	5	2.0	0.1	0.7	0.7	0.2	0.3
MW-233	Mill Creek	Alluvium	Arsenic	5	3.6	1.4	2.5	0.9	2.1	2.3
			Cadmium	5	2.0	0.0	0.9	0.7	1.1	0.5

All units in μg/L (micrograms per liter).
For values reported at less than the instrument detection limit, one-half of the reported value was used in the statistical evaluations.
Exceedances of the Preliminary Remedial Action Goals for arsenic (18μg/L) and cadmium (5μg/L) are shown in bold.
Source: ESE 1996

TABLE 5-38

Average Sample Results from Non-Network Wells in the Smelter Hill Subarea
ARWW&S OU

Well I.D.	Location	Zone Monitored	Number of Samples	Arithmetic Average	
				Arsenic (μg/L) Dissolved	Cadmium (μg/L) Dissolved
D2-BR	Repository Area	Alluvium	2	41.7	2.1
MW-244	East Anaconda Yard	Alluvium	1	7	<.01
MW-35	Anaconda Ponds	Alluvium	3	41	<2
MW-36d	Anaconda Ponds	Alluvium	1	<1	0.3
MW-36s	Anaconda Ponds	Alluvium	3	20	<4
MW-37	Anaconda Ponds	Alluvium	3	<3	<2
MW-38	Anaconda Ponds	Alluvium	1	<5	<5
MW-39	Anaconda Ponds	Alluvium	3	<3	<2
MW-55	Iron Ponds Area	Alluvium	165	5123	16 t
MW-56	Iron Ponds Area	Alluvium	168	26901	10206 t
MW-57	Iron Ponds Area	Alluvium	169	1873	12 t
MW-58	Iron Ponds Area	Alluvium	168	62t	11 t
MW-63	Repository Area	Alluvium	22	7	1
MW-64	Repository Area	Alluvium	22	3	2
MW-65	Repository Area	Alluvium	23	5.4	1
MW-75	Anaconda Ponds	Alluvium	3	3.4	25.9
MW-3	Repository Area	Alluvium?	2	13	5
MW-4	Repository Area	Alluvium?	2	2	5
MW-66	Lower Mill Creek	Alluvium?	1	5	5
MW-66A	Lower Mill Creek	Alluvium?	6	2	0.1
MW-67	Repository Area	Alluvium?	21	10	1
MW-68	Repository Area	Alluvium?	23	5.9	1.3
MW-245s	Smelter Hill	Bedrock	1	1170	---
MW-247	East Anaconda Yard	Bedrock	1	<1.1	---
MW-53	Iron Ponds Area	Bedrock	150	3486	11 t
MW-54	Iron Ponds Area	Bedrock	165	1868	39 t
MW-96	Stack Area	Bedrock	3	2840	11.3
MW-97	Stack Area	Bedrock	2	230	87.5
MW-97R	Stack Area	Bedrock	1	3300	29
MW-98	Stack Area	Bedrock	2	480	461
NGP-1	Smelter Hill	Bedrock	2	171.5	0.06
WGP-2	Smelter Hill	Bedrock	1	3.3	---
MW-43	Anaconda Ponds	Tailings	40	3489	27 t
MW-73	Anaconda Ponds	Tailings	2	1455	13.6

t = total metals analysis for arsenic and cadmium
--- = not analyzed
< = less than instrument detection limit
ID = identification
μg/L = micrograms per liter

TABLE 5-39

Seep and Spring Sample Results for the Smelter Hill Subarea
ARWW&S OU

Station	Location	Date Sampled	Dissolved Arsenic (μg/L)
SH-1	Walker Gulch	4Q'92	394.0
SH-2	Walker Gulch	4Q'92	917.0
SH-3	Walker Gulch	4Q'92	39.3
SH-4	South Side of Smelter Hill	4Q'92	1450.0
SH-5	Southeast side of Smelter Hill	4Q'92	15.2
SHSN-1	Northeast Side of Smelter Hill	4Q'92	5.1
SHSS-1	Northeast Side of Smelter Hill	4Q'92	4.3
SP97-10	Aspen Hills	2Q'97	277.0
SP97-11	Aspen Hills	2Q'97	608.0
SP97-12	Aspen Hills	2Q'97	482.0
SP97-13	Aspen Hills	2Q'97	37.4
SP97-14	Clear Creek	2Q'97	3.6
SP97-15	Clear Creek	2Q'97	5.7
SP97-16	Clear Creek	2Q'97	1.1
SP97-17	Upper Mill Creek	2Q'97	112.0
SP97-18	Upper Mill Creek	2Q'97	87.4
SP97-19	West of Naser Gulch	2Q'97	2.5
SP97-21	Clear Creek	2Q'97	147.0
SP97-22	Cabbage Gulch	2Q'97	223.0
SP97-23	Cabbage Gulch	2Q'97	42.3
SP97-24	Aspen Hills	2Q'97	269.0
SP97-25	Aspen Hills	2Q'97	710.0
SP97-26	Upper Willow Creek	2Q'97	60.4
SP97-27	Upper Willow Creek	2Q'97	34.8
SP97-28	Upper Willow Creek	2Q'97	50.9
SP97-29	Upper Willow Creek	2Q'97	260.0
SP97-30	Upper Willow Creek	2Q'97	33.8
SP97-31	Upper Willow Creek	2Q'97	74.8
SP97-32	Mount Haggin	2Q'97	73.1
SP97-33	Mount Haggin	3Q'97	189.0
SP97-34	Mount Haggin	3Q'97	42.9
SP97-35	Mount Haggin	3Q'97	29.3
SP97-36	Mount Haggin	3Q'97	32.3
SP97-37	Mount Haggin	3Q'97	17.4
SP97-38	Mount Haggin	3Q'97	42.7
SP97-39	Upper Mill Creek	3Q'97	45.9
SP97-40	Upper Mill Creek	3Q'97	20.1
SP97-9	South Side of Smelter Hill	2Q'97	1990.0

TABLE 5-39 (Continued)

Seep and Spring Sample Results for the Smelter Hill Subarea
ARWW&S OU

Station	Location	Date Sampled	Dissolved Arsenic (µg/L)
SS-T-07	Aspen Hills	3Q'95	172.0 t
SS-T-08	Clear Creek	3Q'95	22.0 t
SS-T-09	Clear Creek	3Q'95	23.0 t
SS-T-10	Clear Creek	3Q'95	5.0 t
SS-T-13	Cabbage Gulch	3Q'95	129.0 t
SS-T-19	Cabbage Gulch	4Q'96	57.0
SS-T-20	Cabbage Gulch	4Q'96	94.0
SS-T-21	Cabbage Gulch	4Q'96	61.0
SS-T-22	Cabbage Gulch	4Q'96	52.0
SS-T-23	Cabbage Gulch	4Q'96	54.0
SS-T-24	Cabbage Gulch	4Q'96	46.0
SS-T-25	Cabbage Gulch	4Q'96	210.0
SS-T-26	Cabbage Gulch	4Q'96	36.0
SS-T-27	Cabbage Gulch	4Q'96	76.0
SS-T-30	Naser Gulch	2Q'97	245.0
SS-T-31	Naser Gulch	2Q'97	324.0
SS-T-32	Southest of Naser Gulch	2Q'97	146.0
SS-T-33	South of Stack	2Q'97	708.0
SS-T-34	South of Stack	2Q'97	777.0

t = total metals analysis
µg/L = micrograms per liter

TABLE 5-40

Statistical Summary of Metals in Regional Surface and Subsurface Soil
ARWW&S OU

	Depth Interval	Number of Samples	Maximum	Minimum	Arithmetic Mean	Geometric Mean
Arsenic	0-2 inches	791	3,960	16	457	234
Cadmium		581	85.9	0.2	9.7	5.2
Copper		508	10,185	29	1308	632
Lead		707	1,910	9	252	137
Zinc		510	6,890	32	721	425
Arsenic	2-10 inches	388	2,440	2.3	237	122
Cadmium		325	126	0.2	4.9	2.4
Copper		354	18,133	6.2	509	156
Lead		370	1,550	6	88	40
Zinc		354	3,500	28	339	200
Arsenic	Greater than 10 inches	189	1,250	0.6	145	56
Cadmium		175	32	0.2	2.4	0.8
Copper		186	7,590	3.5	299	44
Lead		184	587	3.8	32	16
Zinc		186	3,850	18.4	242	92

Source: ESE 1996

TABLE 6-1

Exposure Parameters for the Residential Scenario
Anaconda Smelter Site HHRA

Symbol	Units	Definition	Value	Source
SL	(mg arsenic/ kg soil)	risk-based screening level	-	-
TR	(unitless)	target risk	-	-
AT	(days)	averaging time	Carcinogens = 25,550 Noncarcinogens RME = 10,950 CTE = 3,285	EPA 1989a
CF	(kg/mg)	conversion factor	.000001	EPA 1989a
EF	(days/year)	exposure frequency	350	EPA 1989a
SF_0	$(mg/kg\text{-}day)^{-1}$	oral slope factor for arsenic	1.5	EPA 1995b
IR_{child}	(mg/day)	soil ingestion rate for children	RME = 200 CTE = 100	EPA 1993 EPA 1993
ED_{child}	(years)	exposure duration for children	RME = 6 CTE = 2	EPA 1993 EPA 1993
BW_{child}	(kg)	average body weight for children	15	EPA 1989a
IR_{adult}	(mg/day)	soil ingestion rate for adults	RME = 100 CTE = 50	EPA 1993 EPA 1993
ED_{adult}	(years)	exposure duration for adults	RME = 24 CTE = 7	EPA 1993 EPA 1993
BW_{adult}	(kg)	average body weight for adults	70	EPA 1989a
FS	(unitless)	fraction of soil ingested	0.45	Professional Judgement
BAFs	(unitless)	bioavailability of soil	0.183	EPA 1995a
C	(unitless)	contribution of soil arsenic to arsenic in dust	0.43	Calculated
FD	(unitless)	fraction of dust ingested	0.55	Professional Judgement
BAF_0	(unitless)	bioavailability of interior dust	0.258	EPA 1995a
SL	(mg arsenic/ kg soil)	risk-based screening level	-	-
TR	(unitless)	target risk	-	-
AT	(days)	averaging time	25550	EPA 1989a
BW	(kg)	body weight	70	EPA 1989a
EF	(days/year)	exposure frequency	RME = 140 CTE = 84	Site-specific Site-specific
ED	(year)	exposure duration	RME = 30 CTE = 9	EPA 1989a EPA 1989a
IRs	(mg/day)	soil ingestion rate	RME = 480 mg/day for 14 days, 100 mg/day for 126 days CTE = 100 mg/day for 14 days, 50 mg/day for 70 days	EPA 1993 Professional Judgement
CFs	(kg/mg)	conversion factor for soil	0.000001	EPA 1989a

TABLE 6-1 (Continued)

Symbol	Units	Definition	Value	Source
SF_0	$(mg/kg\text{-}day)^{-1}$	oral slope factor for arsenic	1.5	EPA 1995b
BAFs	(unitless)	bioavailability of soil	0.183	EPA 1995a
IR	$(m^3/hour)$	inhalation rate	2.5	EPA 1989b
SFi	$(mg/kg\text{-}day)^{-1}$	slope factor for inhalation	15	EPA 1995b
DL	(kg/m^3)	dust loading factor	RME = 1.5×10^{-7} kg/m^3 for 14 days, 2.2×10^{-10} kg/m^3 for 126 days CTE = 1.5×10^{-7} kg/m^3 for 14 days, 2.2×10^{-10} kg/m^3 for 70 days	Professional Judgement
ET	(hours/day)	exposure time	8	Site-specific
SL	(mg arsenic/ kg soil)	risk-based screening level	-	-
TR	(unitless)	target risk	-	-
AT	(days)	averaging time	Carcinogens = 25,550 Noncarcinogens RME = 9,125 CTE = 2,555	EPA 1989a
BW	(kg)	body weight	70	EPA 1989a
EF	(days/year)	exposure frequency	RME = 250 CTE = 234	EPA 1993 EPA 1993
ED	(years)	exposure duration	RME = 25 CTE = 7	EPA 1989a Professional Judgement
IRs	(mg/day)	soil ingestion rate	RME = 100 CTE = 50	EPA 1993 EPA 1993
CFs	(kg/mg)	conversion factor for soil	0.000001	EPA 1989a
SF_0	$(mg/kg\text{-}day)^{-1}$	oral slope factor for arsenic	1.5	EPA 1995b
BAFs	(unitless)	bioavailability factor for soil	0.183	EPA 1995a
FS	(unitless)	fraction of soil ingested	0.45	Professional Judgement
C	(unitless)	contribution of soil arsenic to arsenic in dust	0.43	Calculated
FD	(unitless)	fraction of dust ingested	0.55	Professional Judgement
BAF_0	(unitless)	bioavailability of interior dust	0.258	EPA 1995a
SL	(mg arsenic/L surface water)	risk-based screening level	-	-
TR	(unitless)	target risk	-	-
AT	(days)	averaging time	Carcinogens = 25,550 Noncarcinogens = 2,920	EPA 1989a
BW	(kg)	body weight	27	EPA 1989b
EF	(days/year)	exposure frequency	RME = 40 CTE = 10	Site-specific Site-specific
ED	(years)	exposure duration	8	Site-specific
IRsw	(ml/hour)	surface water ingestion rate	25	Site-specific
CFsw	(L/ml)	conversion factor	0.001	EPA 1989a

TABLE 6-1 (Continued)

Symbol	Units	Definition	Value	Source
SF_0	(mg/kg-day)$^{-1}$	oral slope factor for arsenic	1.5	EPA 1995b
SA	(cm^2)	skin surface area available for contact	10,500	EPA 1989b
PC	(cm/hr)	dermal permeability constant	0.001	EPA 1992
ET	(hours/day)	exposure time	2	Site-specific
CF	(L/cm^3)	volumetric conversion factor	0.001	EPA 1989a
SL	(mg arsenic/kg soil)	risk-based screening level	-	-
TR	(unitless)	target risk	-	-
AT	(days)	averaging time	25550	EPA 1989a
BW	(kg)	body weight	70	EPA 1989a
EF	(days/year)	exposure frequency	RME = 26 CTE = 13	Life Systems 1993 Life Systems 1993
ED	(year)	exposure duration	RME = 30 CTE = 9	EPA 1989a EPA 1989a
IRs	(mg/day)	soil ingestion rate	RME = 100 CTE = 50	Professional Judgement
CFs	(kg/mg)	conversion factor for soil	0.000001	EPA 1989a
SF_0	(mg/kg-day)$^{-1}$	oral slope factor for arsenic	1.5	EPA 1995b
BAFs	(unitless)	bioavailability of soil	0.183	EPA 1995a
IR	(m^3/hour)	inhalation rate	RME = 2.5 CTE = 1.3	EPA 1989b EPA 1989b
SFi	(mg/kg-day)$^{-1}$	slope factor for inhalation	15	EPA 1995b
DL	(kg/m^3)	dust loading factor	3.8×10^{-7}	Professional Judgement
ET	(hours/day)	exposure time	RME = 5 CTE = 2	Life Systems 1993 Life Systems 1993

TABLE 6-2

Exposure Variables for the Old Works/East Anaconda Development Area

Medium	Pathway	Parameter	Dirt-Bike Rider		Commercial Worker	
			CTE	RME	CTE	RME
All	General	Body Weight (kg)	70[a]	70[a]	70[a]	70[a]
All	General	Exposure Duration (ED)(yr)	9[a]	30[a]	7[d]	25[c]
All	General	Averaging time (noncancer) (days)	EF x ED[a]	EF x ED[a]	EF x ED[a]	EF x ED[a]
All	General	Averaging time (cancer) (days)	25550[a]	25550[a]	25550[a]	25550[a]
Tailings, soils	Ingestion	Intake rate (mg/day)	50[d]	100[d]	25[d,f]	50[c,f]
Tailings, soils	Ingestion	Exposure frequency (EF) (days/year)	13[e]	26[e]	250[c]	250[c]
Waste piles, hillside flues	Ingestion	Ingestion rate (mg/event)	50[d]	100[d]	-	-
Waste piles, hillside flues	Ingestion	Exposure frequency (EF) (events/year)	13[e]	26[e]	-	-
Waste piles, hillside flues	PM10 Inhalation	Inhalation rate (cubic meters/hour)	0.8[b]	2.5[b]	-	-
Waste piles, hillside flues	PM10 Inhalation	Exposure time (hours/day)	2[e]	5[e]	-	-
Drinking water	Ingestion	Ingestion rate (L/day)	-	-	0.5[d]	1.0 (c)
Drinking water	Ingestion	Exposure frequency (days/year)	-	-	250[c]	250 (c)

[a] Default value recommended in EPA 1989a

[b] Default value recommended in EPA 1989b

[c] Default value recommended in EPA 1991a

[d] Value based on professional judgment

[e] Based on responses to survey of activity patterns of residents in Anaconda

[f] Total intake from soil plus dust. Assumed to be 50% soil, 50% dust

TABLE 6-3

RME Exposure Variables Used to Calculate Arsenic Screening Levels for Trespassers

Symbol	Units	Definition	Value	Source
SL	mg arsenic/ kg soil	risk-based screening level	to be calculated	---
TR	(unitless)	target risk	Cancer: 1E-04 to 1E-06 Noncancer: 1	EPA 1991a
AT	days	averaging time	25550	EPA 1989a
BW	kg	body weight	70	EPA 1989a
EF	days/year	exposure frequency	26	Life Systems 1993
ED	year	exposure duration	30	EPA 1989a
IR_s	mg/visit	soil ingestion rate	50	Griffin, 1998
CF	kg/mg	conversion factor for soil	1E-06	EPA 1989a
SF_o	$(mg/kg\text{-}day)^{-1}$	oral slope factor for arsenic	1.5	EPA 1998
RFD_o	mg/kg-day	arsenic oral reference dose	3.0E-04	EPA 1998
BAF_s	(unitless)	arsenic bioavailability factor in soil	0.183	EPA 1995a

kg=kilogram
mg=milligram

TABLE 6-4

Risk-based Screening Levels for Arsenic for the Anaconda Smelter NPL Site

Screening Level Based on Risk	Soil								Surface Water	
	Residential Scenario (mg/kg)		Agricultural Scenario (mg/kg)		Commercial Worker Scenario (mg/kg)		Recreational Dirt Biker Scenario (mg/kg)		Recreational Youth/Swimmer (mg/L)	
Carcinogenic Risk	RME	CTE	RME	CTE	RME	CTE	RME	CTE	RME	CTE
1.00E-07	0.3	1.85	1	10	1.33	10.2	2.32	53.5	0.002	0.008
1.00E-06	2.97	18.5	10	100.4	13.3	101.5	23.2	535.5	0.02	0.081
1.00E-05	29.7	185.2	100.3	1003	133	1015	232.3	5355	0.2	0.81
1.00E-04	297	1852	1003	10038	1331	10155	2323	53551	2	8.1
1.00E-03	2970	18516	10033	100385	13307	101546	23231	535517	20.2	81
Noncarcinogenic Risk	RME	CTE	RME	CTE	RME	CTE	RME	CTE	RME	CTE
Hazard Quotient = 1	573	1071	NC	NC	2139	4570	NC	NC	1.04	4.16

NC = not calculated. Risk-based screening levels for these exposure scenarios are based on inhalation and ingestion exposures. A reference concentration for arsenic for inhalation is not available; screening levels based on noncarcinogenic effects can therefore not be calculated for these exposure scenarios.

TABLE 6-5

Risk-based Screening Levels for Arsenic for the Old Works/East Anaconda Development Area

Screening Level Based on Risk	Ground Water (commercial scenario) (mg/L)		Commercial Worker Scenario (mg/kg)		Dirt-Bike Rider Scenario (mg/kg)	
Carcinogenic Risk	RME	CTE	RME	CTE	RME	CTE
1E-06	0.15	1	(a)	7	14	270
1E-05	1.5	11	34	620	140	2700
1E-04	15	110	890	6800	1400	27000
1E-03	150	1100	9500	68000	14000	270000
Screening Level Based on Non-carcinogenic Effects (HI = 1)[a]	29	58	1700	3500	5600	22000

[a] The risk from the "background" level of 40 mg/kg in dust exceeds a risk level of 1E

TABLE 6-6

Risk-Based Screening Levels for Arsenic for the Trespasser Scenario
ARWW&S OU

Screening Level Based on Risk (unitless)	Trespasser Scenario (mg/kg)
Carcinogenic Risk	RME
1E-04	16,706
1E-05	1,670
1E-06	167
Systemic Risk	RME
1	32,219

TABLE 6-7

Concentration of COCs in Wastes and Mixed Wastes and Soils

	Mean Arsenic (mg/kg)	**Mean Cadmium (mg/kg)**	**Mean Copper (mg/kg)**	**Mean Lead (mg/kg)**	**Mean Zinc (mg/kg)**
Ore Processing Wastes					
Opportunity Tailings Ponds	210	4.9	1,930	384	1,340
Anaconda Tailings Ponds	152	7.6	2,186	418	2,131
Main Slag Pile	1,978	22.8	6,271	2,044	26,598
West Stack Course Slag	1,870	39.6	21,600	1,470	19,400
West Stack Fine Slag	5,500	52.9	11,600	3,250	68,000
Yellow Ditch	216	3.5	462	213	445
Railroad Fill at Blue Lagoon	NR	NR	NR	NR	NR
Willow Creek SST	319	3.2	3,467	471	794[2]
South Lime Ditch	124	1.8	1,445	99.7	869
Triangle Wastes	717	5.4	1,665	287	491
Red Sands	1,390	3.3	3,350	540	4,460
Heap Roast Slag	841	NR	5,950	450	6,840
Mixed Wastes and Soil					
Disturbed Area of Smelter Hill	1,142	21.4	2,862	544	2,817
Railroad yard in East Anaconda Yards	1,220	NR	7,170	833	8,440
Upper Works Structural Area	735	NR	7,500	386	5,540
Lower Works Structural Area	1,060	NR	4,560	453	810
East Anaconda Yards	376	9.9	1,771	405	NR
Old Works Flood Plain Tailing	1,290	NR	2,336	457	970
Blue Lagoon	110	4.2	2,527	64	848

Source: Anaconda Regional Water, Waste, & Soils Baseline Ecological Risk Assessment, October 1997
NR = Not Reported
mg/kg = milligrams per kilogram

TABLE 6-8

Concentrations of COCs in Contaminated Soils

	Mean Arsenic (mg/kg)	**Mean Cadmium (mg/kg)**	**Mean Copper (mg/kg)**	**Mean Lead (mg/kg)**	**Mean Zinc (mg/kg)**
Contaminated Soils Wastes					
Mean	548	8.9	1284	281	710
Standard Deviation	369	10.2	1400	198	625
Range	123 - 1340	1 - 46	170 - 5060	63 - 700	126 - 2160

Source: Anaconda Regional Water, Waste, & Soils Baseline Ecological Risk Assessment, October 1997

TABLE 6-9

Regional Background Soil Metal Concentrations (mg/kg) for Montana Communities

	Arsenic	**Cadmium**	**Copper**	**Lead**	**Zinc**
Sample Size	19	19	12	19	13
Geometric Mean	9.3	0.9	22.4	35.7	66.1
Geometric Standard Deviation	2.88	2.64	1.5	4.1	1.3
Lower 95% Confidence Limit	5.6	0.5	17.2	18.1	56
Upper 95% Confidence Limit	15.5	1.4	29.1	70.4	78

Source: Anaconda Regional Water, Waste, & Soils Baseline Ecological Risk Assessment, October 1997
mg/kg = milligrams per kilogram

TABLE 6-10

Soils Effects Concentrations[1] (i.e., Phytotoxicity Values)

	Arsenic (mg/kg)	Cadmium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Zinc (mg/kg)
pH < 6.5					
High	315	20	750	250	240
Low	136	5.1	236	94	196
pH >6.5					
High	315	40	1636	250	500
Low	224	8.6	1062	179	379

[1] Low phytotoxicity values were derived from the terrestrial NRDA (RCG/Hagler, Bailly 1995), and used in the Phase I Screening Level Ecological Assessment (CDM Federal 1994c).
High phytotoxicity values were derived from either the State investigation (RCG/Hagler, Bailly 1995) or the East Helena studies (CH2M Hill 1987a & b).
Source: Anaconda Regional Water, Waste, & Soils Baseline Ecological Risk Assessment, October 1997

TABLE 6-11

Land Area Within the Phytotoxicity Zones[1]

Subarea	Total Acreage	Zone 1		Zone 2		Zone 3		Zone 4	
		Acreage	Percent of Total	Acreage	Percent of Total	Acreage	Percent of Total	Acreage	Percent of Total
Smelter Hill & Surrounding Areas	5,372	5,320	99	5,320	99	5,335	99	1,710	32
Stucky Ridge	3,605	3,605	100	2,748	76	865	24	0	0
North Hills	10,814	9,395	87	6,091	56	506	5	0	0
East Hills	2,149	2,104	98	791	37	3	<1	0	0
South Hills	8,095	8,063	99	5,335	66	4,729	58	308	4
Northern Lowland Area	6,618	6,256	95	5,401	82	1,268	19	0	0
Southern Lowland Area	7,173	5,917	82	5,419	76	2,254	31	70	1
Areas Adjacent to Waste Management Areas	6,812	6,089	89	5,895	87	3,733	55	67	1
Total Acreages for All Subareas	50,638	46,749	92	37,000	73	18,693	37	2,155	4
Land Outside the Subareas	186,808	93,153	50	36,963	20	8,957	5	288	<1

[1] Zone 1: at least one exceedence of the low phytotoxic criteria for As, Cd, Cu, or Pb
Zone 2: at least one exceedence of the high phytotoxic criteria for As, Cd, Cu, or Pb
Zone 3: area exceeds the low phytotoxic criteria for As, Cd, Cu, and Pb
Zone 4: area exceeds the high phytotoxic criteria for As, Cd, Cu, and Pb

Source: Anaconda Regional Water, Waste, & Soils Baseline Ecological Risk Assessment, October 1997

Table 6-12

Number of Samples Exceeding the White-tailed Deer Forage NOAELs and LOAELs

Subarea	Number of Forage Samples (and percent of total) Where the Concentration of at Least One of the COCs Exceeded the NOAEL and LOAEL[1]			
	Total	<NOAEL	>NOAEL and <LOAEL	>LOAEL
Smelter Hill and Surrounding Areas	20	16 (80)	4 (20)	2 (10)
North Hills	20	16 (80)	4 (20)	4 (20)
East Hills	10	7 (70)	3 (30)	1 (10)
South Hills	10	9 (90)	1 (10)	10 (10)
Northern Lowland Area	10	6 (60)	4 (40)	2 (20)
Southern Lowland Area	20	12 (60)	8 (40)	4 (20)
Areas Adjacent to Waste Management Areas	65	38 (58)	27 (42)	17 (26)
TOTALS	155	104 (67)	51 (33)	31 (20)

[1] Forage COC concentrations between the NOAEL and the LOAEL are referred to as presenting a "potential" risk. Concentrations greater than the LOAEL are referred to as presenting a "likely" risk.

Source: Anaconda Regional Water, Waste, & Soils Baseline Ecological Risk Assessment, October 1997

Table 6-13

Exceedances of Wildlife Drinking Water Effects Concentrations at the Anaconda Smelter Site[1]

Subarea	Water Body/ Station	COC	Result (µg/L)	Receptor	NOAEL - LOAEL (µg/L)	Risk Level[2]
Creeks						
South Opportunity	Cabbage Gulch/ CG-1 and 2	As	311	Deer Mice	210 - 630	Potential
				Red Fox	120 - 240	Likely
	Willow Creek/ WC-12	As	148	Red Fox	120 - 240	Potential
Seeps and Springs						
Smelter Hill	SH-1	As	394	Deer Mice	210 - 630	Potential
				Red Fox	120 - 240	Likely
	SH-2	As	917	Deer Mice	210 - 630	Likely
				Red Fox	120 - 240	Likely
	SH-4	As	1450	Deer Mice	210 - 630	Likely
				Red Fox	120 - 240	Likely
	T-7	As	583	Deer Mice	210 - 630	Potential
				Red Fox	120 - 240	Likely
	Nazar Gulch/ NG-01	As	330	Deer Mice	210 - 630	Potential
				Red Fox	120 - 240	Likely
	Nazar Gulch/ NG-02	As	367	Deer Mice	210 - 630	Potential
				Red Fox	120 - 240	Likely
	Slag Gulch/ SG-01	As	718	Deer Mice	210 - 630	Likely
				Red Fox	120 - 240	Likely
	Slag Gulch/ SG-02	As	384	Deer Mice	210 - 630	Potential
				Red Fox	120 - 240	Likely
	SP97-9	As	1990	White-tailed Deer	1,890 - 5,760	Potential
				Deer Mice	210 - 630	Likely
				Red Fox	120 - 240	Likely
	SP97-10	As	277	Deer Mice	210 - 630	Potential
				Red Fox	120 - 240	Likely
	SP97-11	As	608	Deer Mice	210 - 630	Potential
				Red Fox	120 - 240	Likely
	SP97-12	As	482	Deer Mice	210 - 630	Potential
				Red Fox	120 - 240	Likely
	SP97-21	As	147	Red Fox	120 - 240	Potential
	SP97-24	As	269	Deer Mice	210 - 630	Potential
				Red Fox	120 - 240	Likely
	SP97-25	As	710	Deer Mice	210 - 630	Likely
				Red Fox	120 - 240	Likely

Table 6-13 (Continued)

Exceedances of Wildlife Drinking Water Effects Concentrations at the Anaconda Smelter Site[1]

Subarea	Water Body/ Station	COC	Result (μg/L)	Receptor	NOAEL - LOAEL (μg/L)	Risk Level[2]
South Hills	T-13	As	414	Deer Mice	210 - 630	Potential
				Red Fox	120 - 240	Likely
	T-25	As	210	Red Fox	120 - 240	Potential
	SP97-22	As	233	Deer Mice	210 - 630	Potential
				Red Fox	120 - 240	Potential
	SP97-29	As	260	Deer Mice	210 - 630	Potential
				Red Fox	120 - 240	Likely
Ditches and Ponds						
Southern Lowland	Blue Lagoon/ BL-03 and BL-04	Cu	17,450	Deer Mice	890 - 2,630	Likely
	Blue Lagoon/ WQ-007	Cu	226,000	White-tailed Deer	18,790 - 46,970	Likely
				Deer Mice	890 - 2,630	Likely
				Red Fox	69,410 - 101,180	Likely
				American Robin	38,570 - 71,430	Likely
				Kestrel	46,960 - 86,960	Likely

[1] These are the only exceedances of drinking water ECs observed in the Anaconda Smelter surface water data base. See text for an explanation about how the surface water data were used, and Appendix 1 for a listing of all surface water data.

[2] COC concentrations between the NOAEL and the LOAEL are referred to as presenting a "potential" risk. Concentrations greater than the LOAEL are referred to as presenting a "likely" risk.

Source: Anaconda Regional Water, Waste, & Soils Baseline Ecological Risk Assessment, October 1997

Table 6-14

Wildlife Risk Summary for Drinking Water and Forage - Locations at the ARWWS OU Having Potential Toxicological Effects

Receptor	Home Range/ Duration	Media	COC (NOAEL Exceeded)	Toxicological Effect (Endpoint)	Location of Potential Toxicological Effects at the ARWWS OU
White-tailed Deer	482A/1.0Y	Drinking Water	Copper	Growth	Southern Lowlands - Blue Lagoon (WQ-007)
		Forage	Arsenic	Lowered body weight	Smelter Hill - VA17, 21 North Hills - VA2A Northern Lowlands - VA1 East Hills - VA15 South Hills - VA16 Southern Lowlands - VA13A, 14 Adjacent to WMAs - VA4, 6, 7, 8A, 9, 11, SN
			Cadmium	Reproduction	North Hills - VA2A Northern Lowlands - VA1 Adjacent to WMAs - VA4, 8A, 9, SN
			Copper	Reproduction	Smelter Hill - VA21 North Hills - VA2A East Hills - VA15 Southern Lowlands - VA13A, 14 Adjacent to WMAs - VA4, 6, 7, 9, 11, SN
			Lead	Reproduction	Southern Lowlands - VA14
			Zinc	Growth	Northern Lowlands - VA1 Southern Lowlands - VA14 Adjacent to WMAs - VA8A, 9, 11, SN
Deer Mouse	0.27A/1.0Y	Drinking Water	Arsenic	Reproduction	Smelter Hill - Seeps and Springs (SH-1, SH-2, SH-4, T-7, NG-01, NG-02, SG-01, SG-02, SP97-9, SP97-10, SP97-11, SP97-12, SP97-24, SP97-25) South Hills - Seeps and Springs (T-13, SP97-22, SP97-29) South Hills - Cabbage Gulch (CG-1,2)
			Copper	Reduced lifespan	Southern Lowlands - Blue Lagoon (BL-03, BL-04, WQ-007)
Red Fox	3881A/1.0Y	Drinking Water	Arsenic	Reproduction	Smelter Hill - Seeps and Springs (SH-1, SH-2, SH-4, T-7, NG-01, NG-02, SG-01, SG-02, SP97-9, SP97-10, SP97-11, SP97-12, SP97-21, SP97-24, SP97-25) South Hills - Seeps and Springs (T-13, T-25, SP97-22, SP97-29) South Hills - Cabbage Gulch (CG-1) Southern Lowlands - Willow Creek (WC-12)
			Copper	Reproduction	Southern Lowlands - Blue Lagoon (WQ-007)
Robin	0.62A/0.75Y	Drinking Water	Copper	Growth	Southern Lowlands - Blue Lagoon (WQ-007)
Kestrel	499A/1.0Y	Drinking Water	Copper	Growth	Southern Lowlands - Blue Lagoon (WQ-007)

Source: Anaconda Regional Water, Waste, & Soils Baseline Ecological Risk Assessment, October 1997

TABLE 6-15

Summary of Potential Risks to Aquatic Receptors at the ARWWS OU from Exposure of COCs in Surface Water and Sediment

		Water Column Effects								Direct Exposure and Food Chain Effects		
		Identification of a Potential Risk from Total Recoverable Metals in Surface Water		Identification of a Potential Risk from Dissolved Metals in Surface Water		Identification of a Potential Risk from Total Recoverable Cu in Surface Water Based on WER for CU		Identification of a Potential Risk from Dissolved CU in Surface Water Based on WER for CU		Identification of a Potential Risk from COCs in Sediment Based on the NOAEL	Identification of a Potential Risk from COCs in Sediment Based on the LOAEL	Identification of Impacts to Macro-Invertebrates from Exposures to Metals
		chronic	acute	chronic	acute	chronic	acute	chronic	acute			
Warm Springs Creek	Reach 1									As		
	Reach 2		Cu							As		
	Reach 3	Pb	Cu							As, Cu, Pb, Zn	As	No
	Reach 4		Cu							As, Cu		
	Reach 5	Cu, Pb	Cu, Zn				Cu					Yes
	Reach 6	Pb	Cu				Cu			Cu		
Mill Creek	Reach 1	Cd	Cd, Cu	Cd	Cd							
	Reach 2	Cu	Cu	Cu	Cu		Cu		Cu			No
	Reach 3	Cu	Cu	Cu	Cu		Cu					
	Reach 4	Cu, Pb	Cu	Cu								Yes
	Cabbage Gulch	As, Cu	Cu	As	As							
Willow Creek	Reach 1											
	Reach 2	Cu, Pb	Cd, Cu		Cd, Cu							Yes
	Reach 3			Cd								
	Reach 4	Cu, Pb	Cu, Zn	Cu	Cu		Cu		Cu			Yes
Lost Creek	Reach 1											
	Reach 2		Cu									
	Reach 3											
	Reach 4											
	Reach 5											
Other Habitat	North Drain									As, Cd, Cu		
	Pond 1 Decant Ditch									As, Cd, Cu, Pb, Zn	As, Cd, Cu, Pb, Zn	
	Pond 2 Decant Ditch	Zn	Zn							As, Cd, Cu, Pb, Zn	As, Cd, Cu, Pb, Zn	
	Ponds (D-2)	Cu, Cd, Zn	Cu, Zn	Cu, Zn	Cu, Zn							
	S. Lime Ditch											
	South Ditch	Cu										
	Combined Ditch											
	Old Lime Ditch											
	Yellow Ditch	Cu	Cu									
	Gardiner Ditch	Pb	Cu	Pb								

Shaded areas indicate No Data

Source: Anaconda Regional Water, Waste, & Soils Baseline Ecological Risk Assessment, October 1997

TABLE 8-1

COMPARISON OF ALTERNATIVES - HIGH ARSENIC SOILS

EVALUATION CRITERIA	**ALTERNATIVES**			
	No Further Action	**Soil Cover**	**Reclamation - Levels I, II**	**Partial Reclamation**
Overall Protection of Human Health and the Environment	Low	Moderate	Moderate	Moderate in reclaimed areas
Compliance with ARARs	Not compliant	Compliant	Compliant	Compliant in reclaimed areas
Long Term Effectiveness and Permanence	None	High	Moderate	Moderate in reclaimed areas
Reduction of Toxicity, Mobility, and Volume	No reduction in toxicity, mobility or volume of waste	Moderate reduction in mobility	Moderate reduction in mobility	Moderate reduction in mobility within reclaimed areas
Short Term Effectiveness	Low	Moderate	Moderate	Moderate
Implementability	No implementation required	Easy to implement	Easy to implement	Easy to implement
Total Acres/ Cost*				
Opportunity Ponds	$11,000	356 / $29,279,000	356 / $3,011,000	45 / $832,000
North Opportunity	$11,000	162 / $14,476,000	162 / $1,638,000	59 / $3,497,000
Old Works/Stucky Ridge	$27,000	80 / $7,985,000	80 / $1,111,000	24 / $1,125,000
Smelter Hill	$11,000	520 / $40,421,000	520 / $4,074,000	20 / $4,294,000

*Present Worth Cost for Capital Cost Plus

TABLE 8-2

COMPARISON OF ALTERNATIVES - SPARSELY VEGETATED SOILS

EVALUATION CRITERIA	**ALTERNATIVE**		
	No Further Action	**Reclamation -Levels I, II**	**Partial Reclamation - Level I, II**
Overall Protection of Human Health and the Environment	Low	Moderate	Moderate in reclaimed areas
Compliance with ARARs	Not compliant	Compliant	Compliant in reclaimed areas
Long Term Effectiveness and Permanence	None	Moderate	Moderate
Reduction of Toxicity, Mobility, and Volume	No reduction in toxicity, mobility or volume of waste	Moderate reduction in mobility	Moderate reduction in mobility in reclaimed areas
Short Term Effectiveness	Low	Moderate	Moderate
Implementability	No implementation required	Easy to implement	Easy to implement
Total Acres / Cost*			
Opportunity Ponds	$22,000	491 / $3,665,000	475 / $5,033,000
North Opportunity	$11,000	870 / $10,835,000	425 / $6,732,000
South Opportunity	$11,000	342 / $2,758,000	200 / $2,228,000
Old Works/Stucky Ridge	$70,000	4949 / $29,676,000	1270 / $16,973,000
Smelter Hill	$11,000	2466 / $16,264,000	1470 / $15,082,000

*Present Worth Cost for Capital Cost plus O&M

TABLE 8-3

COMPARISON OF ALTERNATIVES OPPORTUNITY PONDS, CELL A, MAIN GRANULATED SLAG, DISTURBED AREA AND ANACONDA PONDS WASTE AREAS*

EVALUATION CRITERIA	**ALTERNATIVE**						
	No Further Action	**Soil Cover**	**Reclamation-Level III**	**Partial Reclamation Level II**	**Reclamation/ Soil Cover**	**Rock Amendment**	**Removal**
Overall Protection of Human Health and the Environment	Low	Moderate	Moderate	Moderate in reclaimed areas	Moderate	Low	High
Compliance with ARARs	Not compliant	Compliant, may be designated WMA	Compliant, may be designated WMA	Compliant, may be designated WMA	Compliant, may be designated WMA	Not compliant	Compliant
Long Term Effectiveness and Permanence	None	High	Moderate	Moderate in reclaimed areas	High	Low	High
Reduction of Toxicity, Mobility, and Volume	No reduction in toxicity, mobility or volume of waste	Moderate reduction in mobility	Moderate reduction in mobility	Moderate reduction in mobility in reclaimed areas	Moderate reduction in mobility	None	Elimination of volume, toxicity, and mobility
Short Term Effectiveness	Low	Moderate	Moderate	Moderate	Moderate	Moderate	High
Implementability	No implementation required	Easy to implement	Easy to implement	Easy to implement	Easy to implement	Easy to implement	Easy to implement
Total Acres / Cost***							
Opportunity Ponds	$26,000	2508 / $110,894,000	2508 / $62,787,000	362 **/ $54,018,000	2508 / $87,253,000	2508 / $64,633,000	146.0 mcy / $893,981,000
Cell A	$11,000	N/A	N/A	N/A	N/A	198 / $6,706,000	6.2 mcy / $62,917,000
Main Granulated Slag	$11,000	N/A	N/A	N/A	N/A	88 / $3,147,000	30.24 mcy / $228,117,000
Disturbed Area	$11,000	522 / $40,885,000	522 / $5,852,000	110 / $4,541,000	N/A	N/A	983,470 cy / $17,459,000
Anaconda Ponds	$44,000	449 / $36,159,000	$17,370,000	176 / $1,428,000	449 / $23,480,000	449 / $13,912,000	114.5 mcy / $692,123,000

*The waste areas for the ARWW&S OU are separated into two groups for the comparison of alternatives. The Opportunity Ponds, Opportunity Ponds - Cell A, Main Granulated Slag, Disturbed Area and Anaconda Ponds waste areas are compared in one table with alternatives for the remaining waste areas, South Lime Ditch, Triangle Waste, Warm Springs Creek Stream Side Tailings, Willow Creek SST, Yellow Ditch, Blue Lagoon and East Yard Wastes compared in another table.

** Includes rock cover on 2,146 acres

***Present Worth Cost for Capital Cost plus O&M

TABLE 8-4

COMPARISON OF ALTERNATIVES - REMAINING WASTE AREAS*

EVALUATION CRITERIA	**ALTERNATIVE**						
	No Further Action	**Capping**	**Soil Cover**	**Reclamation - Level III**	**Partial Reclamation - Level II**	**Removal**	**Partial Removal**
Overall Protection of Human Health and the Environment	None	High	Moderate	Moderate	Moderate in reclaimed areas	High	High in affected areas
Compliance with ARARs	Not compliant	Compliant	Compliant	Compliant	Compliant in reclaimed areas	Compliant	Compliant in affected areas
Long Term Effectiveness and Permanence	None	High	High	Moderate	Moderate in reclaimed areas	High	High in affected areas
Reduction of Toxicity, Mobility, and Volume	No reduction in toxicity, mobility or volume of waste	High reduction in mobility	Moderate reduction in mobility	Moderate reduction in mobility	Moderate reduction in reclaimed areas	High, complete elimination of waste	High, elimination of waste in affected areas
Short Term Effectiveness	Low	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Implementability	No implementation required	Easy to implement	Easy to implement	Easy to implement	Easy to implement	Easy to implement	Easy to implement
Total Acres / Cost**							
South Lime Ditch	$11,000	196 / $25,330,000	196 / $17,243,00	196 / $6,330,000	N/A	1.9 mcy / $30,913,000	423,000 cy / $9,631,000
Triangle Waste	$21,000	N/A	300 / $25,479,000	300 / $8,387,000	86 / $685,000	1.6 mcy / $23,786,000	N/A
Warm Springs Creek SST	$11,000	1 / $394,000	N/A	1 / $280,000	N/A	1,400 cy / $95,000	N/A
Willow Creek SST	$11,000	65 / $9,643,000	N/A	65 / $2,360,000	N/A	185,500 cy / $3,189,000	96,200 cy / $1,706,000
Yellow Ditch	$11,000	10 / $1646,000	10 / $1,184,000	10 / $502,000	N/A	140,000 cy / $5,699,000	N/A
Blue Lagoon	$11,000	N/A	N/A	N/A	N/A	84,000 cy / $3,911,000	5,100 cy / $811,000
East Yard	$11,000	86 / $12,515,000	8 / $990,000	N/A	N/A	459,000 cy / $25,081,000	103,500 cy / $4,425,000

*The waste areas for the ARWW&S OU are separated into two groups for the comparison of alternatives. The Opportunity Ponds, Opportunity Ponds - Cell A, Main Granulated Slag, Disturbed Area and Anaconda Ponds waste areas are compared in one table with alternatives for the remaining waste areas, South Lime Ditch, Triangle Waste, Warm Springs Creek Stream Side Tailings, Willow Creek SST, Yellow Ditch, Blue Lagoon and East Yard Wastes compared in another table.

**Present Worth Cost for Capital Cost plus O&M

TABLE 8-5

COMPARISON OF ALTERNATIVES - GROUND WATER

EVALUATION CRITERIA	**ALTERNATIVE**		
	No Further Action	**Extraction Wells**	**Slurry Wall**
Overall Protection of Human Health and the Environment	High if aquifer underlies a designated WMA	High	High
Compliance with ARARs	Compliant if underlies WMA	Compliant at WMA boundary	Compliant at WMA
Long Term Effectiveness and Permanence	None	Moderate	Moderate
Reduction of Toxicity, Mobility, and Volume	No reduction in toxicity, mobility or volume of waste	Reduction in toxicity, mobility and volume (concentration) of contaminants	Reduction in toxicity, mobility and volume (concentration) of contaminants
Short Term Effectiveness	High	Moderate	Moderate
Implementability	No implementation required	Easy to implement	Easy to implement
Cost*			
Opportunity Ponds	$202,000	$7,270,000	$8,636,000
South Opportunity	$153,000	N/A	N/A
Old Works/Stucky Ridge	$172,000	$9,828,000	$7,197,000
Smelter Hill - Alluvial	$305,000	$18,196,000	N/A
Smelter Hill - Bedrock	$305,000	$2,858,000	N/A

*Present Worth Cost for Capital Cost plus O&M

TABLE 8-6

COMPARISON OF ALTERNATIVES - SURFACE WATER

EVALUATION CRITERIA	ALTERNATIVE			
	No Further Action	**Pump and Treat Oxidation/ Precipitation**	**Pump and Treat Ion Exchange**	**Wetlands**
Overall Protection of Human Health and the Environment	None	High	High	Moderate
Compliance with ARARs	Not compliant	Compliant	Compliant	Compliant
Long Term Effectiveness and Permanence	None	High	High	Moderate
Reduction of Toxicity, Mobility, and Volume	No reduction in toxicity, mobility or volume of waste	Reduction in toxicity, mobility and volume (concentration) of contaminants. Arsenic may pose a problem	Reduction in toxicity, mobility and volume (concentration) of contaminants. Arsenic may pose a problem	Reduction in toxicity, mobility and volume (concentration) of contaminants. Arsenic may pose problem
Short Term Effectiveness	Low	High	High	Moderate
Implementability	No implementation required	Easy to implement	Easy to implement	Easy to implement
Cost*				
Yellow Ditch	$119,000	N/A	N/A	N/A
Cabbage Gulch	$120,000	$6,077,000	N/A	$2,617,000

*Present Worth Cost for Capital Cost plus O&M

TABLE 9-1

SUMMARY OF REMEDIAL COSTS FOR AREAS OF CONCERN AT THE ARWW&S OU

SUBAREA	AREA OF CONCERN	No Further Action	No Further Action; Natural Attenuation	Soil Cover	Land Reclamation		Removal	Partial Removal	Total Costs*	
					Minimum	Maximum			Minimum	Maximum
North Opportunity	High Arsenic Soils				$1,069,000	$1,292,000			$1,069,000	$1,292,000
	Sparsely Vegetated Soils				$9,091,000	$9,560,000			$9,091,000	$9,560,000
	Warm Springs Creek SST						$85,000		$85,000	$85,000
	Subarea Total								$10,245,000	$10,937,000
Opportunity Ponds	High Arsenic Soils				$1,896,000	$2,304,000			$1,896,000	$2,304,000
	Sparsely Vegetated Soils				$2,298,000	$2,751,000			$2,298,000	$2,751,000
	Opportunity Ponds			$45,144,000	$18,362,000	$54,384,000			$18,362,000	$54,384,000
	Cell A			$5,142,000	$1,965,000	$5,553,000			$1,965,000	$5,553,000
	South Lime Ditch			$4,341,000	$1,948,000	$5,499,000			$1,948,000	$5,499,000
	Triangle Waste Area			$6,427,000	$3,379,000	$7,587,000			$3,379,000	$7,587,000
	Groundwater	$202,000							$202,000	$202,000
	Subarea Total								$30,050,000	$78,280,000
Old Works/ Stucky Ridge	High Arsenic Soils				$845,000	$986,000			$845,000	$986,000
	Sparsely Vegetated Soils				$18,823,000	$22,782,000			$18,823,000	$22,782,000
	Groundwater		$172,000						$172,000	$172,000
	Subarea Total								$19,840,000	$23,940,000
Smelter Hill	High Arsenic Soils				$2,674,000	$3,162,000			$2,674,000	$3,162,000
	Sparsely Vegetated Soils				$10,587,000	$12,646,000			$10,587,000	$12,646,000
	Anaconda Ponds			$11,401,000	$6,790,000	$15,170,000			$6,790,000	$15,170,000
	Disturbed Area			$12,318,000	$4,041,000	$5,170,000			$4,041,000	$12,318,000
	East Anaconda Yards	$11,000							$11,000	$11,000
	Main Granulated Slag	$11,000							$11,000	$11,000
	Groundwater - Bedrock	$305,000							$305,000	$305,000
	Groundwater - Alluvial	$305,000							$305,000	$305,000
	Cabbage Gulch Surface Water	$120,000							$120,000	$120,000
	Subarea Total								$24,844,000	$44,048,000
South Opportunity	Sparsely Vegetated Soils				$1,753,000	$2,109,000			$1,753,000	$2,109,000
	Blue Lagoon							$800,000	$800,000	$800,000
	Willow Creek SST							$1,660,000	$1,660,000	$1,660,000
	Yellow Ditch			$509,000					$509,000	$509,000
	Groundwater		$153,000						$153,000	$153,000
	Yellow Ditch Surface Water	$119,000							$119,000	$119,000
	Subarea Total								$4,994,000	$5,350,000
TOTAL COSTS*									$89,973,000	$162,555,000

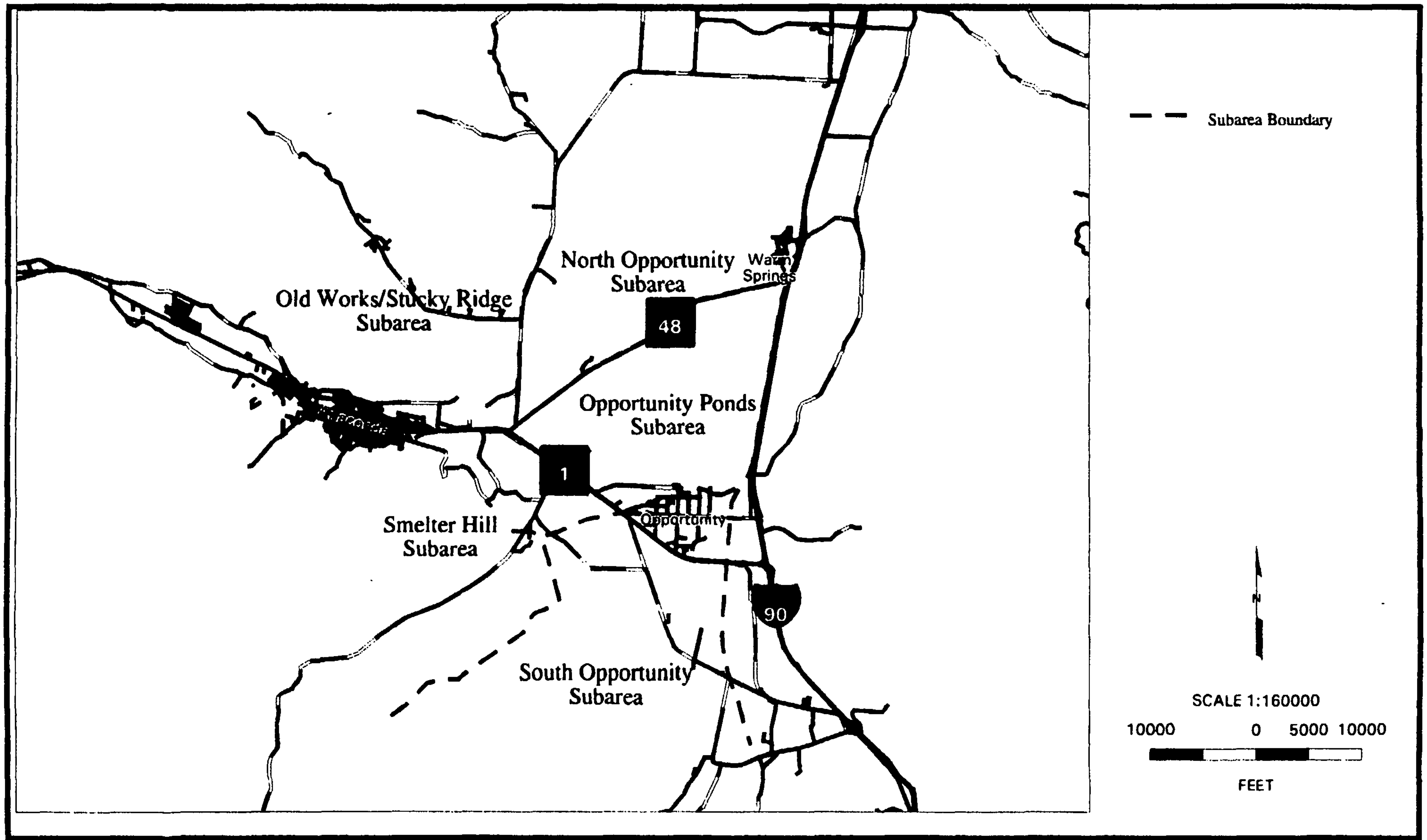
*Present Worth Cost for Capital Cost plus O&M

FIGURES

MAP
6

Contact Region 8

Figure 1-1
Site Location Map
Anaconda Regional Water, Waste, and Soils
Operable Unit, Anaconda Smelter NPL Site
Anaconda, Montana



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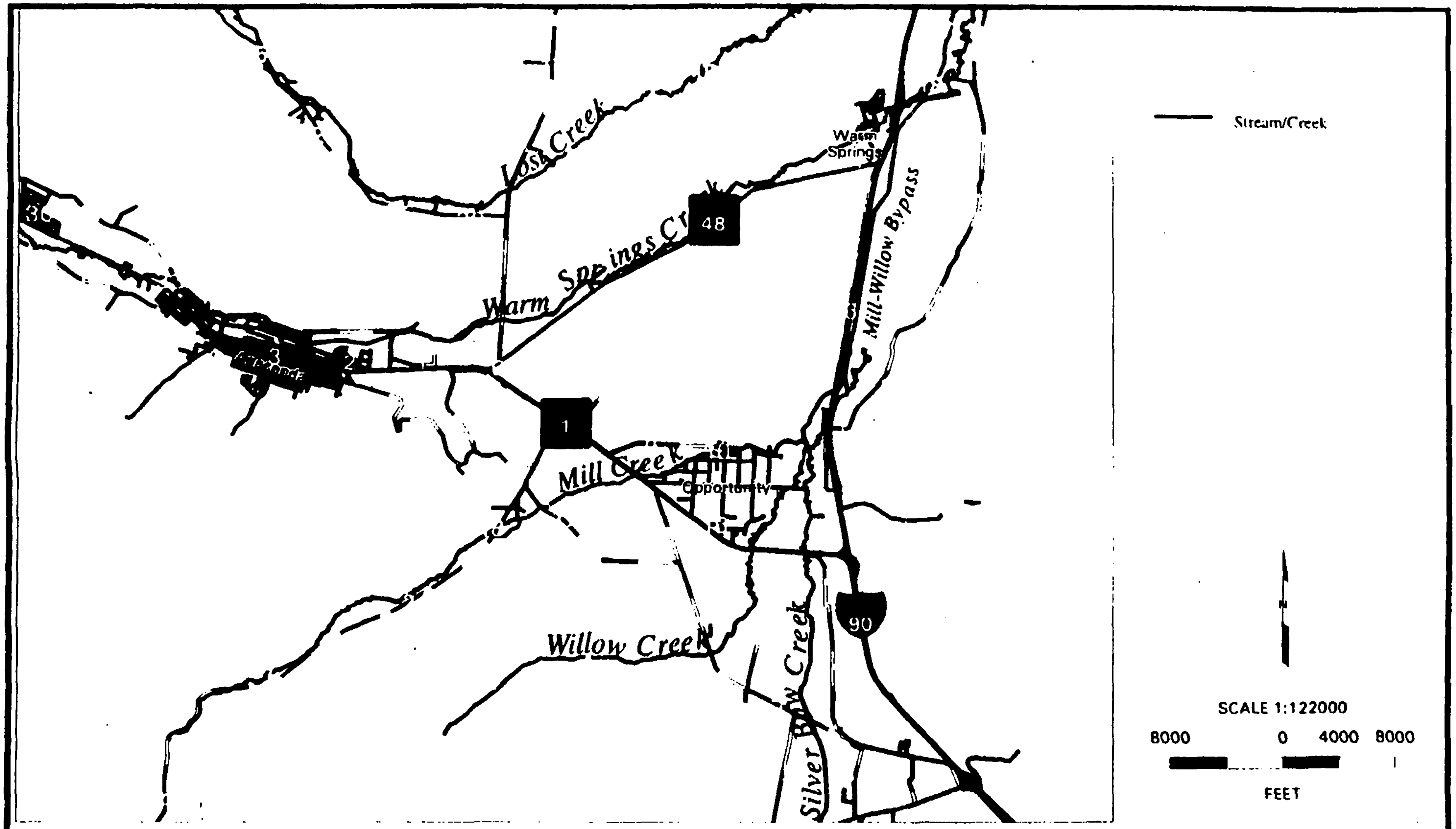
September 1998

Subarea Boundaries
Anaconda Regional Water, Waste, and Soils Operable Unit
Anaconda Smelter NPL Site
Anaconda, Montana

Figure 1-2

Date: 23-SEP-1998
Map File Name: rod-fig1-2_lyt



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Perennial Streams at the
Anaconda Regional Water, Waste, and Soils Operable Unit
Anaconda Smelter NPL Site
Anaconda, Montana

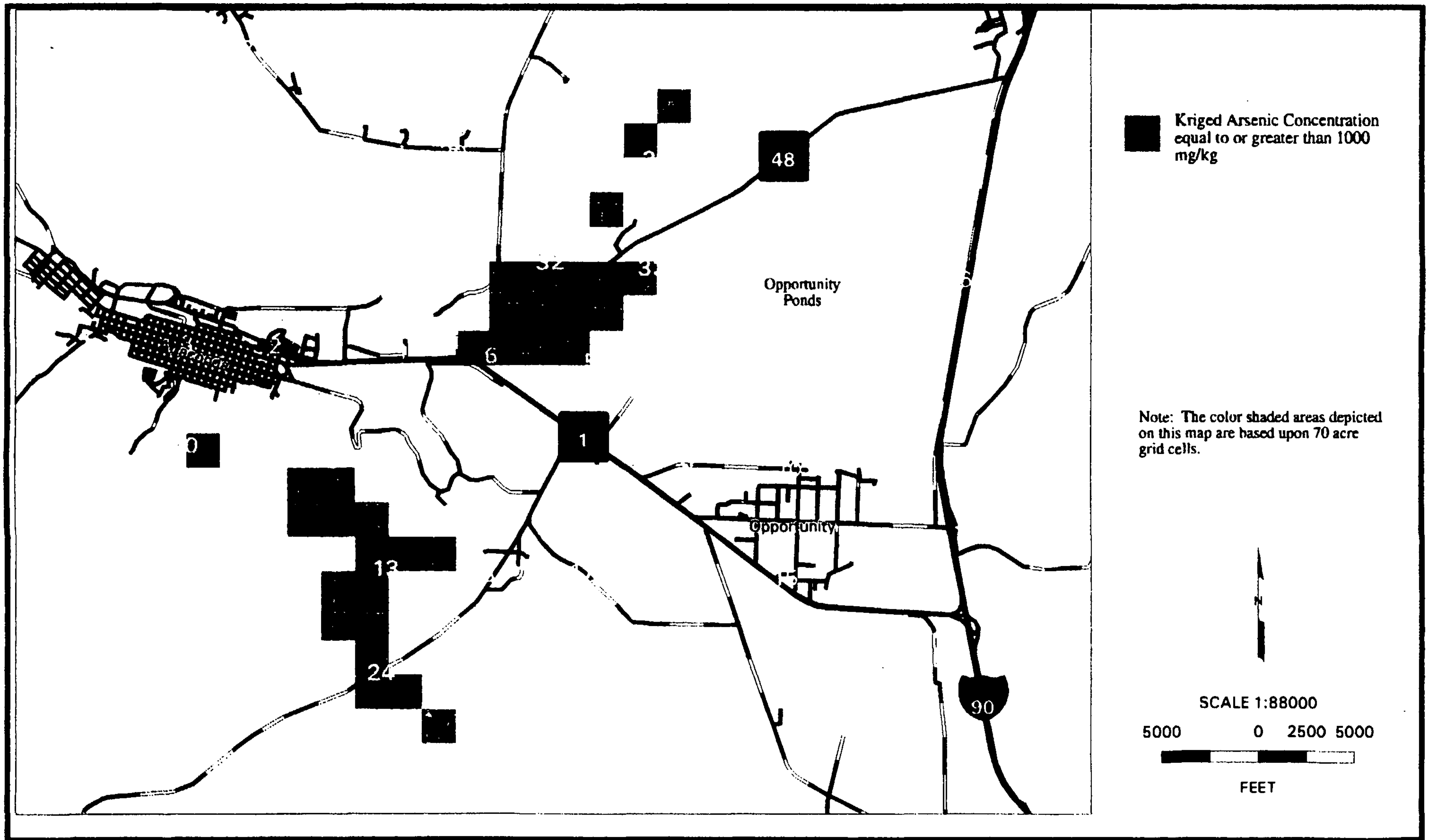
Figure 5-1

Date: 23-SEP-1998
Map File Name: rod-fig5-1 lvt

MAP
7

Contact Region 8

Figure 5-2
Existing Current Land Uses Within the Anaconda Regional Water, Waste, and Soils Operable Unit, Anaconda Smelter NPL Site
Anaconda, Montana



▪ Kriged Arsenic Concentration equal to or greater than 1000 mg/kg

Note: The color shaded areas depicted on this map are based upon 70 acre grid cells.

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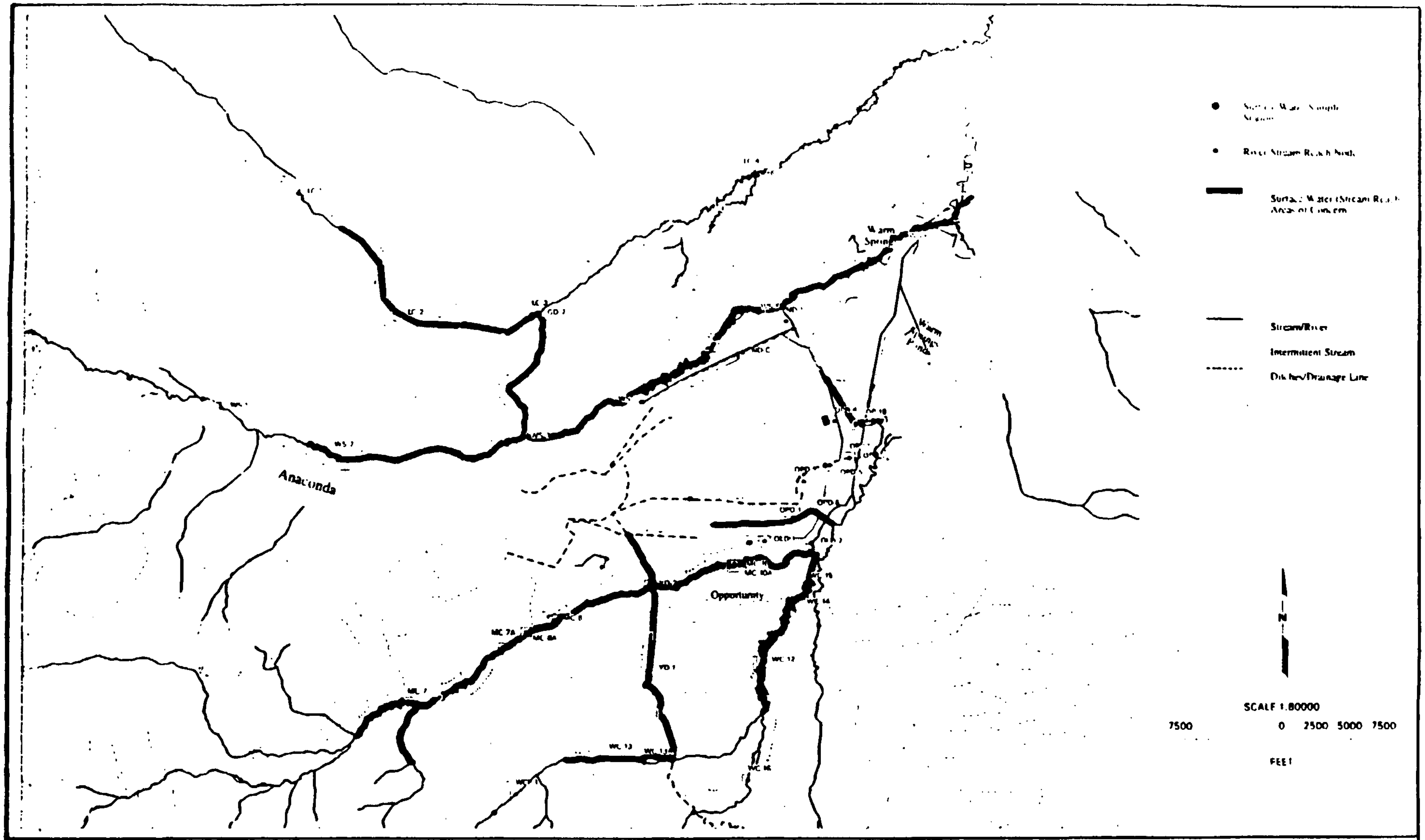
Kriging Map Depicting High Arsenic Soils
Anaconda Regional Water, Waste, and Soils Operable Unit
Anaconda Smelter NPL Site
Anaconda, Montana

Figure 6-1

Date: 24-SEP-1998
Map File Name: rod-fig6-1_lyt



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September 1998

Surface Water (Stream Reach) Areas of Concern for the
Anaconda Regional Water, Waste, and Soils Operable Unit
Anaconda Smelter NPL Site
Anaconda, Montana

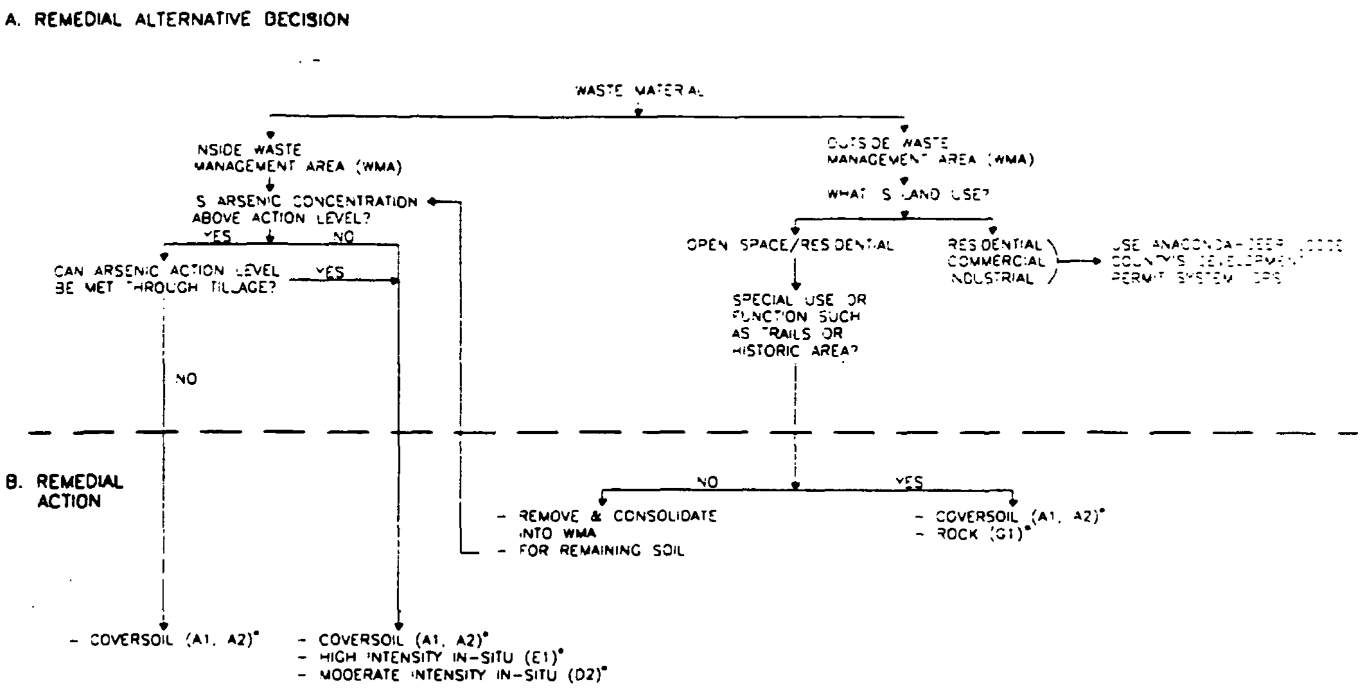
Figure 6-2

SEP-1998

WASTE MATERIAL LRES DECISION DIAGRAM

FIGURE 9-1

ANACONDA REGIONAL WATER, WASTE & SOILS OPERABLE UNIT



SELECT SPECIFIC ALTERNATIVE THROUGH:
1. DATA EVALUATION
2. DATA GAP DETERMINATION, COLLECTION, INTERPRETATION
3. COMPARING COSTSS TO THE REMEDIAL ACTION OBJECTIVES/GOALS

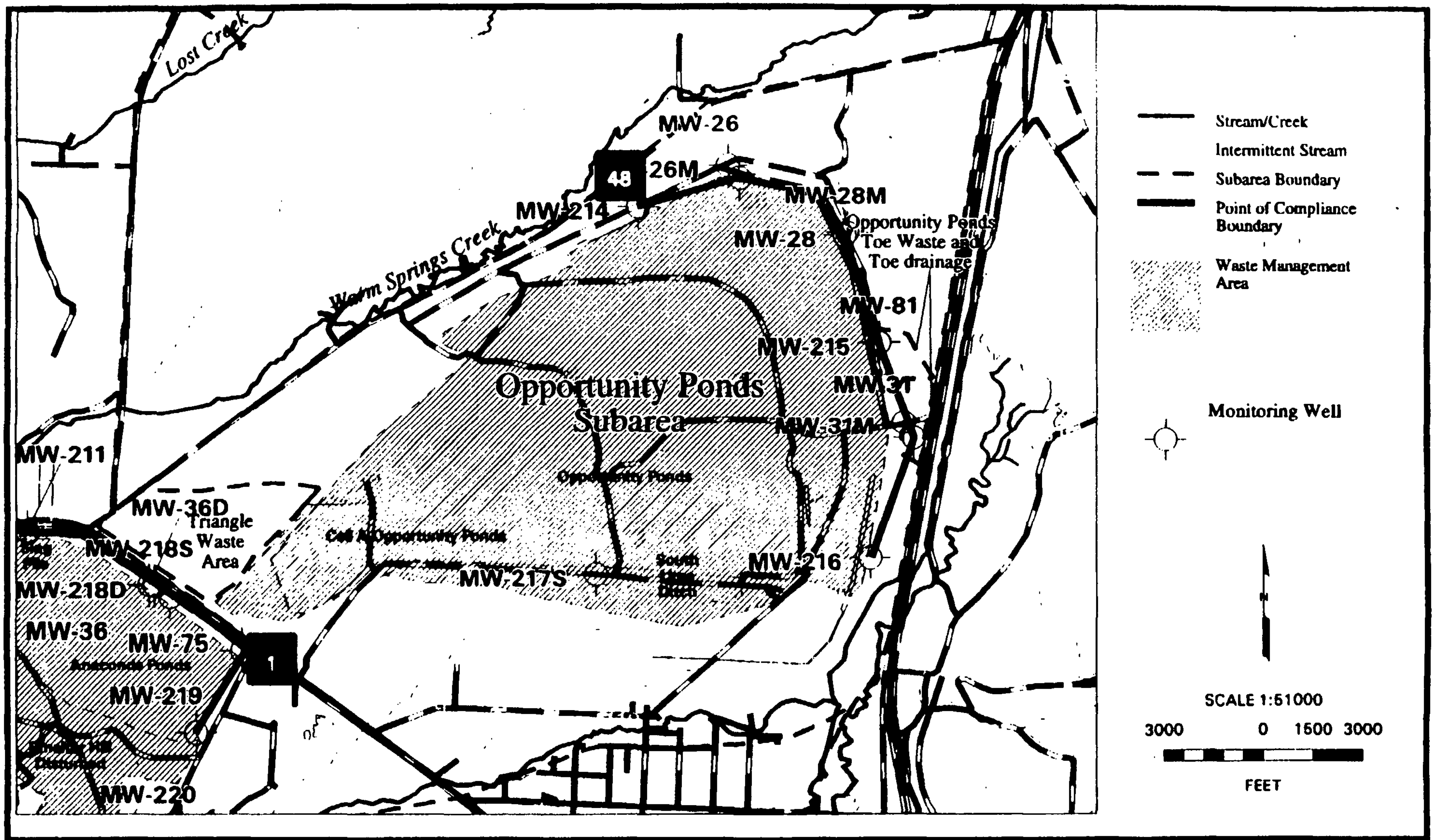
KEY DATA INCLUDE:
- SLOPE ANGLE AND ASPECT
- SOIL ROCK CONTENT
- COC THICKNESS
- SOIL NUTRIENT/FERTILITY
- SOIL TEXTURE
- SOIL PH AND ABA
- EQUIPMENT USE PROBLEMS

* POSSIBLE ALTERNATIVES. APPROPRIATENESS DEPENDS UPON THE ALTERNATIVE'S ABILITY TO MEET THE REMEDIAL ACTION OBJECTIVES/GOALS

CDM Federal Programs

ARWW&S OU RECORD [illegible]
SEPTEMBER 1998 [illegible]

DATE 9/17/98 DRAWN [illegible]



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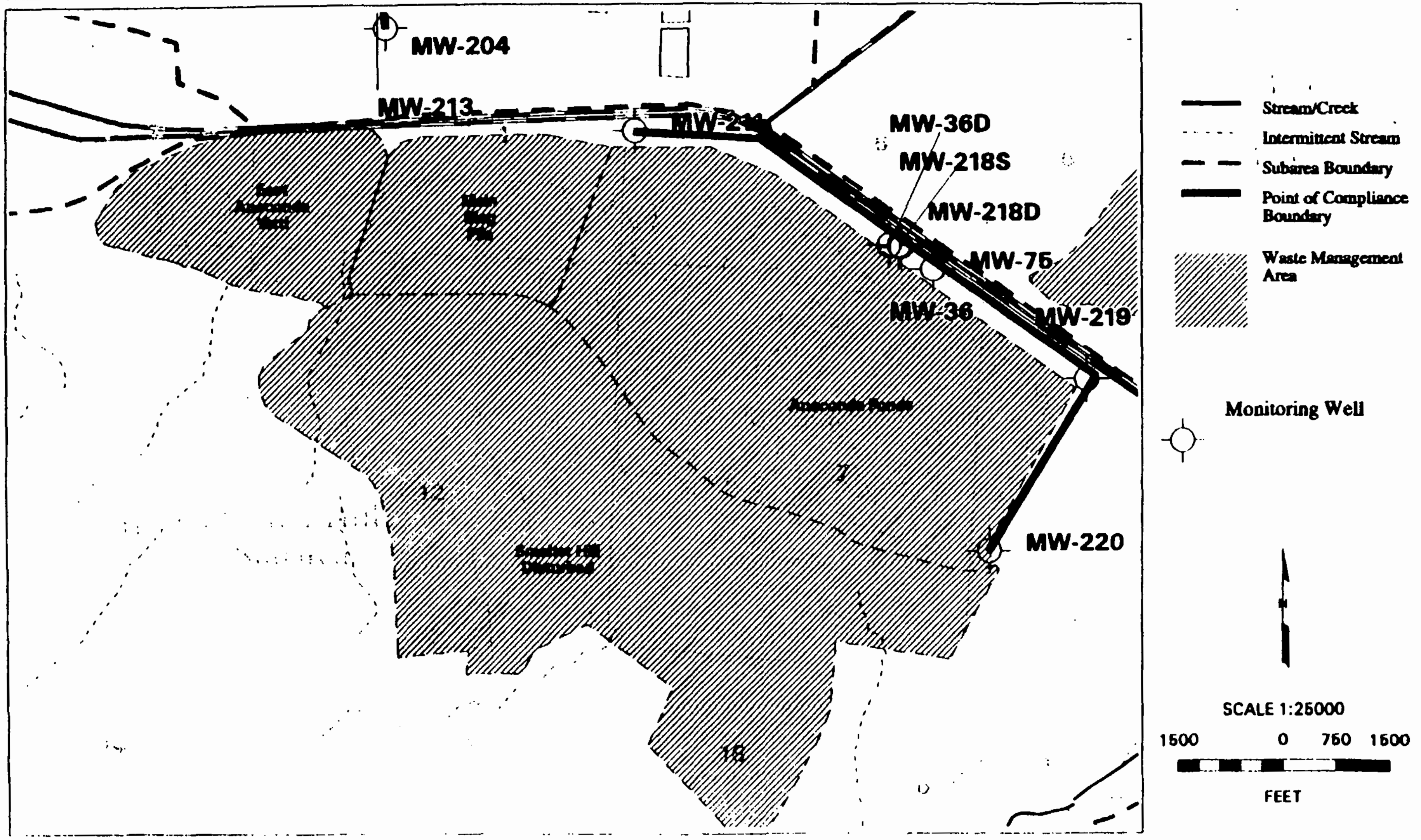
September 1998

Waste Management Areas and Associated Groundwater Point of Compliance
for the Opportunity Ponds Subarea
Anaconda Smelter NPL Site
Anaconda, Montana

Figure 9-2

Date: 24-SEP-1998
Map File Name: rod-fig9-2_lyt

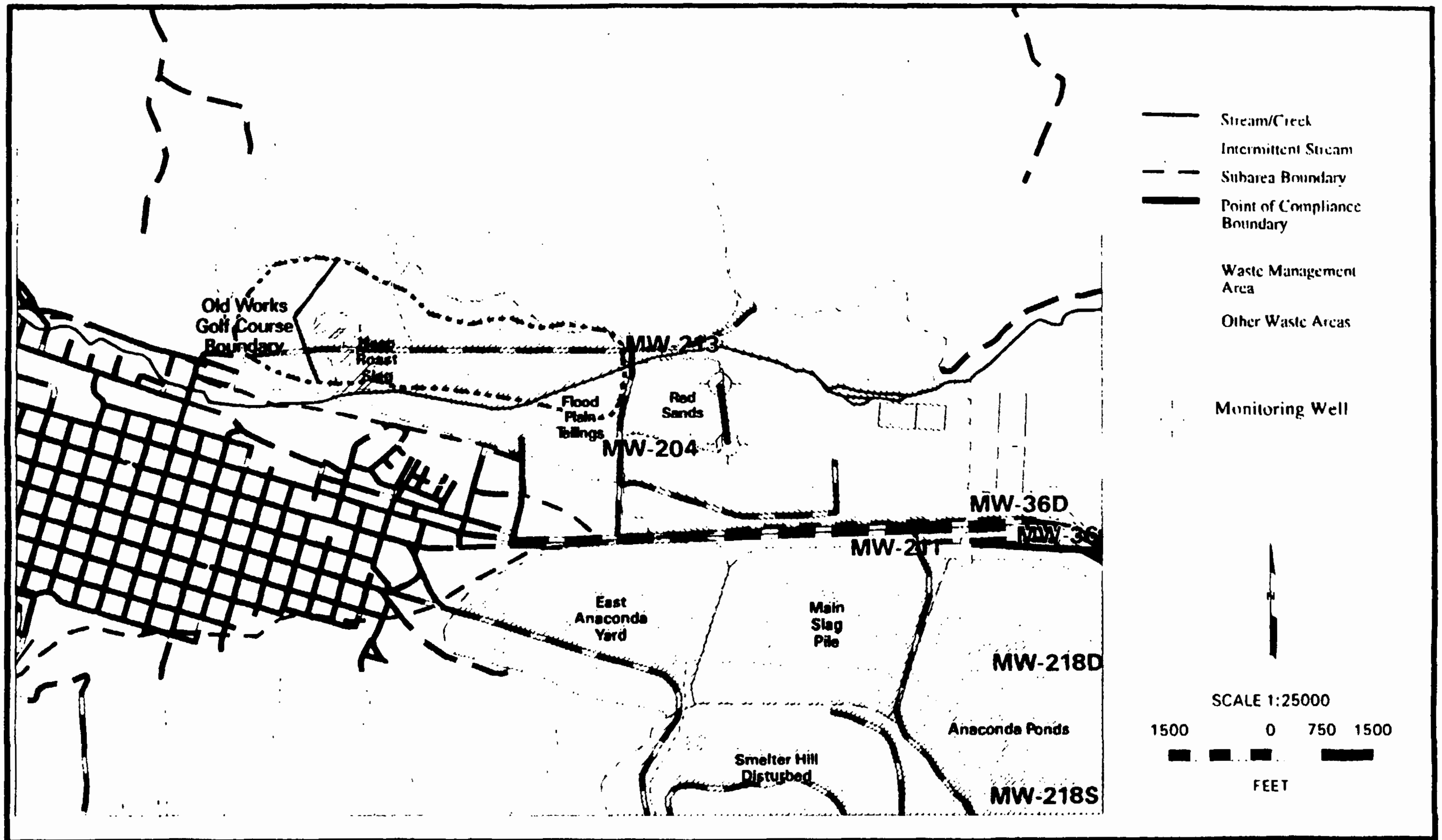


CDM

ARWW&S OU ROD
September 1998

Waste Management Areas and Associated Groundwater Point of Compliance for the Smelter Hill Subarea
Anaconda Smelter NPL Site
Anaconda, Montana

Figure 9-3



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September 1998

Waste Management Areas and Associated Groundwater Point of Compliance
for the Old Works/Stucky Ridge Subarea
Anaconda Smelter NPL Site
Anaconda, Montana

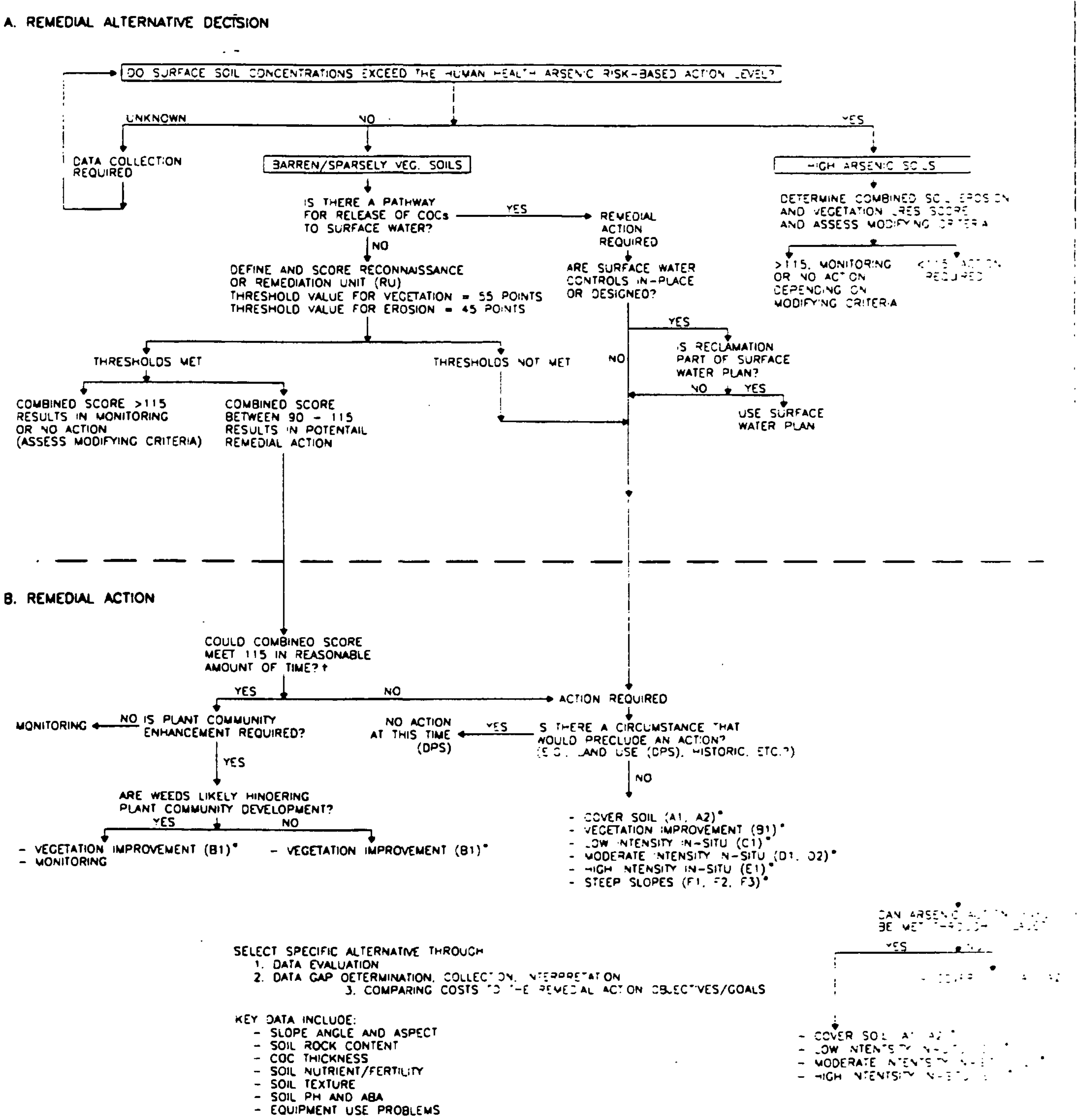
Figure 9-4

Date: 24-SEP 1998
Map File Name: rod-fig9-4_lyt

CONTAMINATED SOILS LRES DECISION DIAGRAM

FIGURE 9-5

ANACONDA REGIONAL WATER, WASTE & SOILS OPERABLE UNIT



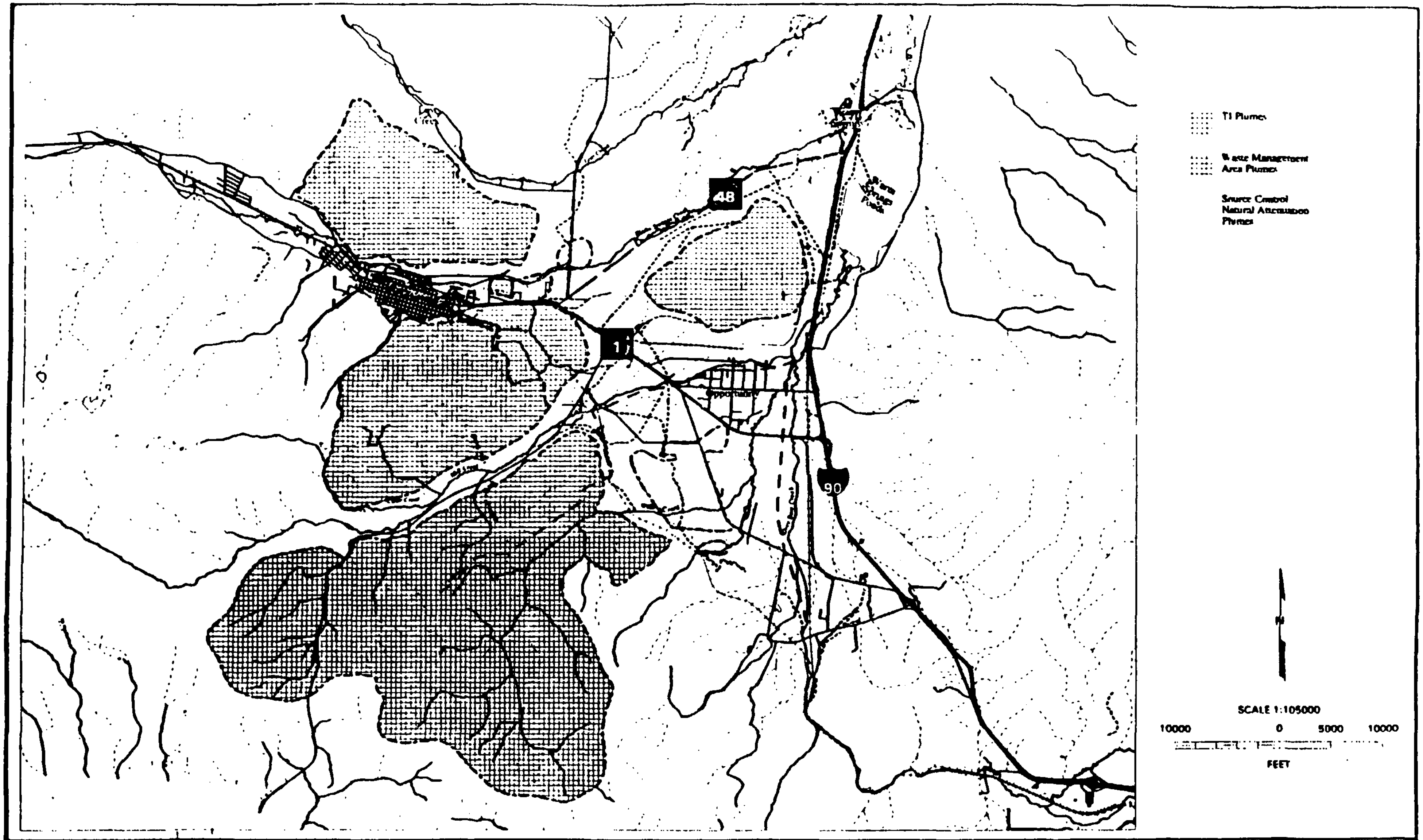
† AS ASSESSED BY TECHNICAL EVALUATION TEAM

* POSSIBLE ALTERNATIVES; APPROPRIATENESS DEPENDS UPON THE ALTERNATIVE'S ABILITY TO MEET THE REMEDIAL ACTION OBJECTIVES/GOALS

CDM Federal Programs

ARWW&S OU RECORD OF DECISION
SEPTEMBER 1998

DATE 9/1?/98 DRAWN BY



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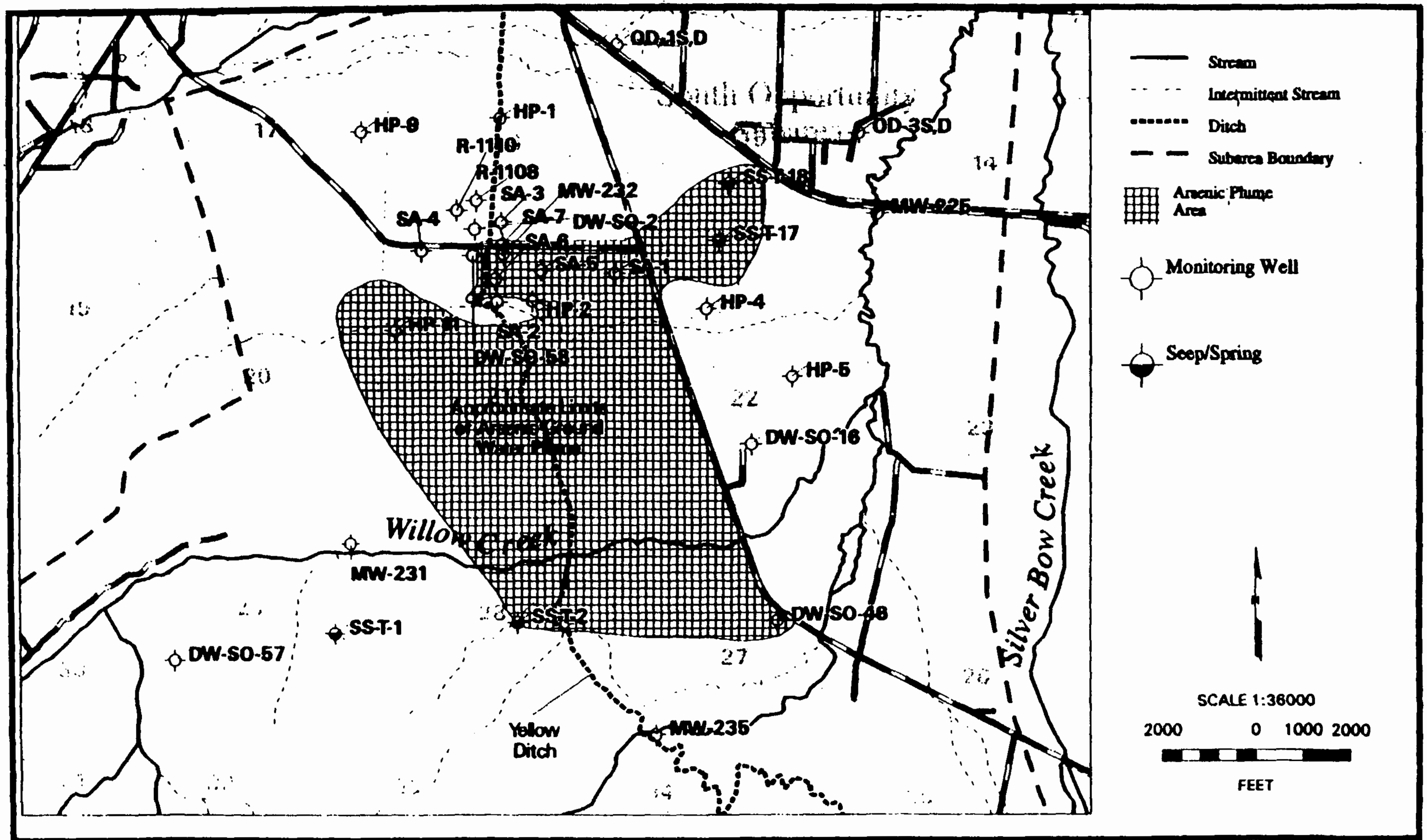
ARWW&S OU ROD
September 1998

Ground Water (Plumes) Areas Exceeding the Remedial Action Goal
Anaconda Regional Water, Waste, and Soils Operable Unit
Anaconda Smelter NPL Site
Anaconda, Montana

Figure 9-6



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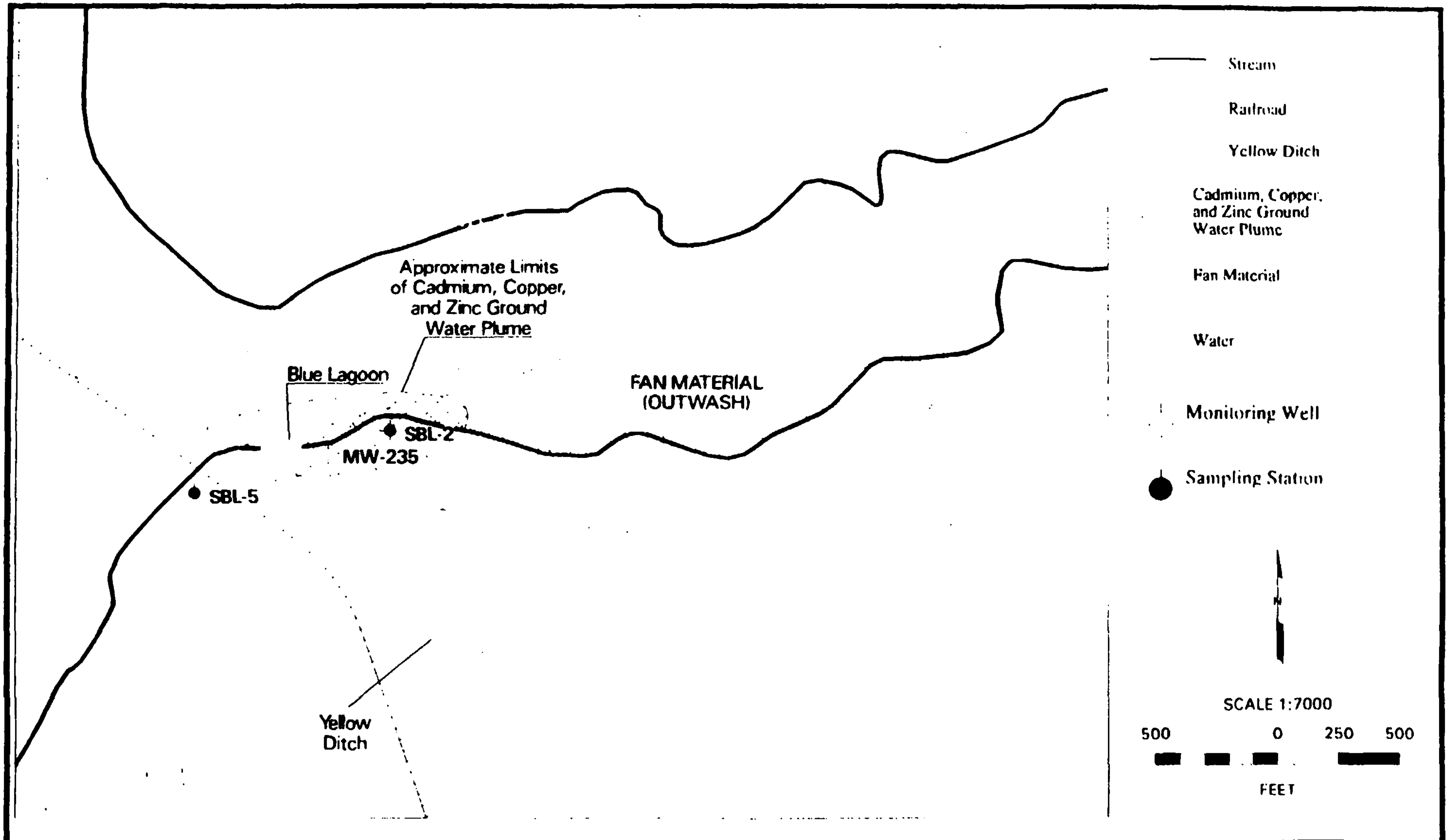
September 1998

Yellow Ditch and South Opportunity
Alluvial Aquifer Plume Area
Anaconda Smelter NPL Site
Anaconda, Montana

Figure 9-7



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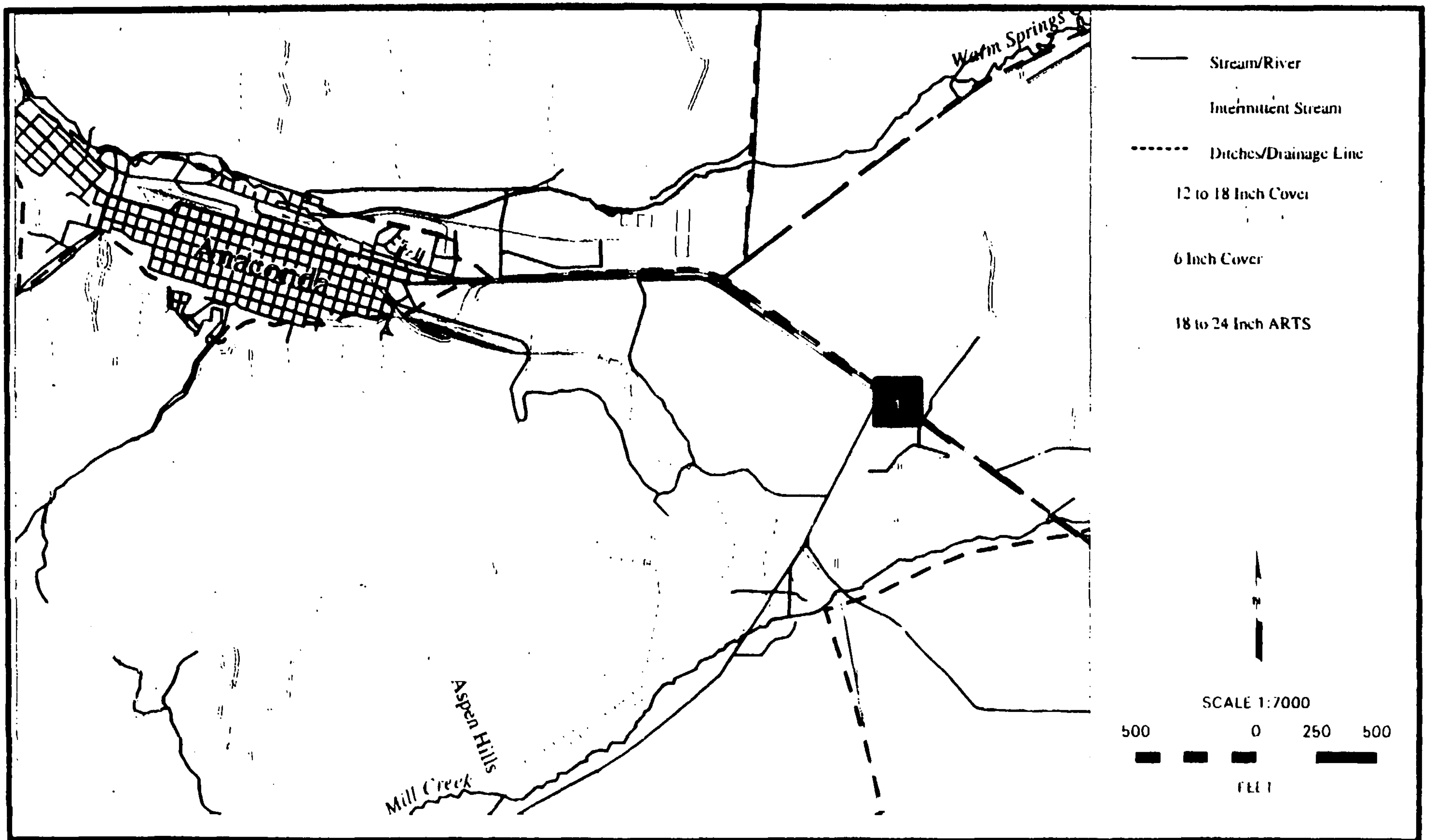
September 1998

Blue Lagoon Ground Water Contamination Area
Anaconda Smelter NPL Site
Anaconda, Montana

Figure 9-8

Date: 23 SEP 1998
Map File Name: rod-fig9-8_lyt



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ARWW&S OU ROD
September 1998

Old Works Remediation Areas
Anaconda Smelter NPL Site
Anaconda, Montana

Figure 9-9

APPENDIX A

Identification and Description of Applicable or Relevant and Appropriate Requirements

Anaconda Smelter Superfund Site, Regional Water, Waste, and Soils Operable Unit

September 1998

TABLE OF CONTENTS

INTRODUCTION

Section 121(d) of CERCLA, 42 U.S.C. § 9621(d), the National Oil and Hazardous Substances Pollution Contingency Plan (the "NCP"), 40 CFR Part 300 (1990), and guidance and policy issued by the Environmental Protection Agency (EPA) require that remedial actions under CERCLA comply with substantive provisions of applicable or relevant and appropriate standards, requirements, criteria, or limitations (ARARs) from State of Montana and federal environmental laws and State facility siting laws during and at the completion of the remedial action. These requirements are threshold standards that any selected remedy must meet, unless an ARAR waiver is invoked.

This document identifies final ARARs for the activities to be conducted under the Anaconda Regional Water, Waste, and Soils Operable Unit (ARWW&S OU) remedial action. The following ARARs or groups of related ARARs are each identified by a statutory or regulatory citation, followed by a brief explanation of the ARAR and how and to what extent the ARAR is expected to apply to the activities to be conducted under this remedial action.

Substantive provisions of the requirements listed below are identified as ARARs pursuant to 40 CFR § 300.400. ARARs that are within the scope of this remedial action must be attained during and at the completion of the remedial action.[1] No permits are anticipated for the remedial action for the ARWW&S OU in accordance with Section 121(e) of CERCLA.

TYPES OF ARARs

ARARs are either "applicable" or "relevant and appropriate." Both types of requirements are mandatory under CERCLA and the NCP.[2] Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria or limitations promulgated under federal environmental or state environmental and facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable.[3]

Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria or limitations promulgated under federal environmental or state environmental or facility siting laws that, while not "applicable" to hazardous substances, pollutants, contaminants, remedial actions, locations, or other circumstances at a CERCLA site, address problems or situations sufficiently similar to those

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[1] 40 CFR Section 300.435(b)(2); Preamble to the National Oil and Hazardous Substances Pollution Contingency Plan, 55 Fed. Reg. 8755-8757 (March 8, 1990).

[2] CERCLA § 121(d)(2)(A), 42 U.S.C. § 6921(d)(2)(a). See also, 40 CFR § 300.430(f)(1)(i)(A).

[3] 40 CFR § 300.5.

encountered at the CERCLA site that their use is well suited to the particular site. Only those state standards that are identified in a timely manner and are more stringent than federal requirements may be relevant and appropriate.[4]

The determination that a requirement is relevant and appropriate is a two-step process: (1) determination if a requirement is relevant and (2) determination if a requirement is appropriate. In general, this involves a comparison of a number of site-specific factors, including an examination of the purpose of the requirement and the purpose of the proposed CERCLA action; the medium and substances regulated by the requirement and the proposed requirement; the actions or activities regulated by the requirement and the remedial action; and the potential use of resources addressed in the requirement and the remedial action. When the analysis results in a determination that a requirement is both relevant and appropriate, such a requirement must be complied with to the same degree as if it were applicable.[5]

ARARs are contaminant, location, or action specific. Contaminant specific requirements address chemical or physical characteristics of compounds or substances on sites. These values establish acceptable amounts or concentrations of chemicals which may be found in or discharged to the ambient environment.

Location specific requirements are restrictions placed upon the concentrations of hazardous substances or the conduct of cleanup activities because they are in specific locations. Location specific ARARs relate to the geographical or physical positions of sites, rather than to the nature of contaminants at sites.

Action specific requirements are usually technology based or activity based requirements or limitations on actions taken with respect to hazardous substances, pollutants or contaminants. A given cleanup activity will trigger an action specific requirement. Such requirements do not themselves determine the cleanup alternative, but define how chosen cleanup methods should be performed.

Many requirements listed as ARARs are promulgated as identical or near identical requirements in both federal and state law, usually pursuant to delegated environmental programs administered by EPA and the state. The Preamble to the NCP provides that such a situation results in citation to the state provision and treatment of the provision as a federal requirement.

Also contained in this list are policies, guidance or other sources of information which are "to be considered" in the selection of the remedy and implementation of the record of decision (ROD). Although not enforceable requirements, these documents are important sources of information which EPA and the State of Montana Department of Environmental Quality (MDEQ) may consider during selection of the remedy, especially in regard to the evaluation of

---

[4] 40 CFR § 300.5.

[5] CERCLA Compliance with Other Laws Manual, Vol. I, OSWER Directive 9234.1-01, August 8, 1988, p. 1-11.

public health and environmental risks; or which will be referred to, as appropriate, in selecting and developing cleanup actions.[6]

This Appendix constitutes EPA's and MDEQ's formal identification and detailed description of ARARs for the implementation of the remedial action at the Anaconda Smelter NPL Site, Anaconda Regional Water, Waste & Soils Operable Unit. Final ARARs will be set forth as performance standards for any and all remedial design or remedial action work plans.

I. CONTAMINANT SPECIFIC ARARs

A. Federal and State Groundwater ARARs.

Groundwater ARARs are must be met throughout the ARWW&S OU. Compliance with groundwater ARARs in waste management areas will generally be measured at the edge of each area.

i. State of Montana requirements.

a. ARM § 17.30.1002 and -1003 (all applicable).

ARM § 17.30.1002 provides that groundwater is classified I through IV based on its present and future most beneficial uses, and states that groundwater is to be classified according to actual quality or use, whichever places the groundwater in a higher class. Class I is the highest quality class; class IV the lowest. Based upon its specific conductance, groundwater throughout the entire ARWW&S OU is considered Class I groundwater.

ARM § 17.30.1003 sets the standards for the different classes of groundwater. Concentrations of dissolved substances in Class I or II groundwater may not exceed the human health standards listed in department Circular WQB-7.[7] These levels are listed below for the primary contaminants of concern. Levels that are more stringent than the MCL or MCLG identified in the federal portion of the ARARs are set out in boldface type.

---

[6] 40 CFR Section 300.400(g)(3); 40 CFR Section 300.415(i); Preamble to the NCP, 55 Fed. Reg. 8744-8746 (March 8, 1990).

[7] Montana Department of Environmental Quality, Water Quality Division, Circular WQB-7, Montana Numeric Water Quality Standards (December 3, 1995).

Contaminant	**WQB-7 Standard***
Arsenic	18 μg/L
Beryllium	4 μg/L
Cadmium	5 μg/L
Copper	1,000 μg/L
Lead	15 μg/L
Zinc	5,000 μg/L

*WQB-7 standards for metals and arsenic in ground water are based on the dissolved portion of the sample.

ARM § 17.30.1003 requires that concentrations of other dissolved or suspended substances must not exceed levels that render the waters harmful, detrimental or injurious to public health. Maximum allowable concentrations of these substances also must not exceed acute or chronic problem levels that would adversely affect existing or designated beneficial uses of groundwater of that classification.

b. ARM § 17.30.1011 (applicable).

This section provides that any groundwater whose existing quality is higher than the standard for its classification must be maintained at that high quality in accordance with MCA § 75-5-303.

An additional concern with respect to ARARs for groundwater is the impact of groundwater upon surface water. If significant loadings of contaminants from groundwater sources to Warm Springs Creek, Mill Creek and Willow Creek contribute to the inability of the stream to meet B-1 class standards, then alternatives to alleviate such groundwater loading must be evaluated and, if appropriate, implemented. Groundwater in certain areas may have to be remediated to levels more stringent than the groundwater classification standards in order to achieve the standards for affected surface water. See Compliance with Federal Water Quality Criteria, OSWER Publication 9234.2-09/FS (June 1990) ("Where the ground water flows naturally into the surface water, the ground-water remediation should be designed so that the receiving surface-water body will be able to meet any ambient water-quality standards (such as State WQSs or FWQC) that may be ARARs for the surface water.")

ii. Federal requirements.

Safe Drinking Water Act, 42 U.S.C. § 300f, et seq., National Primary and Secondary Drinking Water Regulations, 40 CFR Parts 141 and 142 (relevant and appropriate). The National Primary and Secondary Drinking Water Regulations (40 CFR Parts 141 and 143) establish maximum contaminant levels (MCLs) for chemicals in drinking water distributed in public water systems. These are enforceable in Montana under the Public Water Safety Act, MCA § 75-6-101, et seq., and ARM § 17.30.204. Safe Drinking Water Act MCLs are not applicable to the ARWW&S remedial action because the contaminated portions of the aquifers found within the ARWW&S OU are currently not a source for public water supplies. There is no known public use of groundwater underlying or coming into contact with contaminants from the ARWW&S OU. These standards may be applicable in the future should EPA detect an exceedance at a public water outlet.

These drinking water standards are relevant and appropriate, however, because groundwater in the area is a potential source of drinking water. Since Warm Springs Creek, Mill Creek and Willow Creek are potential sources of drinking water, these standards are relevant and appropriate for these surface waters as well.

The determination that the drinking water standards are relevant and appropriate for portions of the ARWW&S OU remedial action is fully supported by the regulations and guidance. The Preamble to the NCP clearly states that the MCLs are relevant and appropriate for groundwater that is a current or potential source of drinking water. See 55 Fed. Reg. 8750, March 8, 1990, and 40 CFR § 300.430(e)(2)(i)(B). MCLs developed under the Safe Drinking Water Act generally are ARARs for current or potential drinking water sources. See, EPA Guidance On Remedial Action For Contaminated Groundwater at Superfund Sites, OSWER Dir. #9283.1-2, December 1988.

In addition, maximum contaminant level goals (MCLGs) may also be relevant and appropriate in certain site-specific situations. See 55 Fed. Reg. 8750-8752. MCLGs are health-based goals which are established at levels at which no known or anticipated adverse effects on the health of persons occur and which allow an adequate margin of safety. According to the NCP, MCLGs that are set at levels above zero must be attained by remedial actions for ground or surface waters that are current or potential sources of drinking water, where the MCLGs are relevant and appropriate under the circumstances of the release. Where the MCLG for a contaminant has been set at a level of zero, the MCL promulgated for that contaminant must be attained by the remedial actions.

The MCLGs and MCLs for contaminants of concern are:

Contaminant	**MCL (mg/L)**	**MCLG (mg/L)**
Arsenic	0.05[*]	none
Beryllium	none[**]	.004[***]
Cadmium	.005[*]	.005[***]
Copper	1.3[***]	1.3[***]
Lead	.015[****]	0[***]

[*] 40 CFR § 141.62(b)
[**] 40 CFR § 141.51(c) no MCL, does specify BAT to be applied
[***] 40 CFR § 141.51(b)
[****] 40 CFR § 141.80(b)-this is an action level, not a true MCL

B. Federal and State Surface Water ARARs.

1. State of Montana Surface Water Quality Requirements, Montana Water Quality Act, MCA § 75-5-101, et seq., and implementing regulations (applicable). General. The Clean Water Act, 33 U.S.C. § 1251, et seq., provides the authority for each state to adopt water quality standards (40 CFR Part 131) designed to protect beneficial uses of each water body and requires each state to designate uses for each water body. The Montana Water Quality Act, MCA § 75-5-101, et seq., establishes requirements for restoring and maintaining the quality of surface and groundwaters. The State has the authority to adopt water quality standards designed to protect beneficial uses of each water body and to designate uses for each water body. Montana's regulations classify State waters according to quality, place restrictions on the discharge of pollutants to State waters, and prohibit degradation of State waters. Pursuant to this authority and the criteria established by Montana surface water quality regulations, ARM § 17.30.601, et seq., Montana has established the Water-Use Classification system. Under ARM § 17.30.607, tributaries to Clark Fork River, including Warms Springs Creek, Mill Creek, Willow Creek, Lost Creek, and the Mill Willow Bypass have been classified "B-1." Ditches and certain other bodies of surface water must also meet these requirements.[8] Certain of the B-1 standards, codified at ARM § 17.30.623, as well as Montana's nondegradation requirements, are presented below.

a. ARM § 17.30.623 (applicable). Waters classified B-1 are, after conventional treatment, suitable for drinking, culinary and food processing purposes. These waters are also suitable for bathing, swimming and recreation, growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers, and use for agricultural and industrial purposes. This section provides also that concentrations of carcinogenic, bioconcentrating, toxic or harmful parameters which would remain in water after conventional water treatment may not exceed standards set forth in department circular WQB-7. WQB-7 provides that "whenever both Aquatic Life Standards and Human Health Standards exist for the same analyte, the more restrictive of these values will be used as the numeric Surface Water Quality Standard." For the primary Contaminants of Concern the Circular WQB-7 standards are listed below.

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[8] As provided under ARM § 17.30.602(25), "'surface waters' means any waters on the earth's surface, including but not limited to, streams, lakes, ponds, and reservoirs; and irrigation and drainage systems discharging directly into a stream, lake, pond, reservoir or other surface water. Water bodies used solely for treating, transporting or impounding pollutants shall not be considered surface water."

Contaminant	**WQB-7 Standard**
Arsenic	18 μg/L
Cadmium	1.1 μg/L*
Copper	12 μg/L*
Iron	300 μg/L
Lead	3.2 μg/L*
Zinc	110 μg/L*

*Chronic Aquatic Life Standard based on 100 mg/L hardness.

The B-1 classification standards at ARM § 17.30.623 also include the following criteria: 1) dissolved oxygen concentration must not be reduced below the levels given in department circular WQB-7; 2) hydrogen ion concentration (pH) must be maintained within the range of 6.5 to 8.5; 3) the maximum allowable increase above naturally occurring turbidity is 5 nephelometric turbidity units; 4) temperature increases must be kept within prescribed limits; 5) no increases above naturally occurring concentrations of sediment, settleable solids, oils, floating solids, which will or are likely to create a nuisance or render the waters harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish or other wildlife are allowed; 5) True color must be kept within specified limits.

b. **ARM § 17.30.637 (applicable).** Provides that surface waters must be free of substances attributable to industrial practices or other discharges that will: (a) settle to form objectionable sludge deposits or emulsions beneath the surface of the water or upon adjoining shorelines; (b) create floating debris, scum, a visible oil film (or be present in concentrations at or in excess of 10 milligrams per liter) or globules of grease or other floating materials; (c) produce odors, colors or other conditions which create a nuisance or render undesirable tastes to fish flesh or make fish inedible; (d) create concentrations or combinations of materials which are toxic or harmful to human, animal, plant or aquatic life; (e) create conditions which produce undesirable aquatic life.

ARM § 17.30.637 also states that no waste may be discharged and no activities conducted which, either along or in combination with other waste activities, will cause violation of surface water quality standards; provided a short term exemption from a surface water quality standard may be authorized by the department under certain conditions.

c. **ARM § 17.30.705 (applicable).** Existing and anticipated uses of surface water and water quality necessary to support those uses must be maintained and protected.

2. **Federal Surface Water Quality Requirements, Clean Water Act, 33 U.S.C. §§ 1251, et seq. (applicable).** As provided under Section 303 of the Clean Water Act, 33 U.S.C. § 1313, the State of Montana has promulgated water quality standards. See the discussion above under State surface water quality requirements.

C. <u>Federal and State Air Quality ARARs</u>.

1. **<u>National Ambient Air Quality Standards, 40 CFR § 50.6 (PM-10); 40 CFR § 50.12 (lead) (applicable)</u>.** These provisions establish standards for PM-10 and lead emissions to air. (Corresponding state standards are found at ARM § 17.8.222 (lead) and ARM § 17.8.223 (PM-10).)

2. **<u>Montana Ambient Air Quality Regulations, ARM §§ 17.8.206, -.222, -.220, and -.223 (applicable)</u>.**

a. **<u>ARM § 17.8.206</u>.** This provision establishes sampling, data collection and analytical requirements to ensure compliance with ambient air quality standards.

b. **<u>ARM § 17.8.222</u>.** Lead emissions to ambient air shall not exceed a ninety (90) day average of 1.5 micrograms per cubic liter of air.

c. **<u>ARM § 17.8.220</u>.** Settled particulate matter shall not exceed a thirty (30) day average of 10 grams per square meter.

d. **<u>ARM § 17.8.223</u>.** PM-10 concentrations in ambient air shall not exceed a 24 hour average of 150 micrograms per cubic meter of air and an annual average of 50 micrograms per cubic meter of air.

II. <u>LOCATION SPECIFIC REQUIREMENTS</u>

The statutes and regulations set forth below relate to solid waste, floodplains, floodways, streambeds, and the preservation of certain cultural, historic, natural or other national resources located in certain areas which may be adversely affected by the ARWW&S OU remedial action.

A. <u>National Historic Preservation Act, 16 U.S.C. § 470, 40 CFR § 6.301(b), 36 CFR Part 800 (NHPA) (applicable)</u>.

This statute and implementing regulations require Federal agencies to take into account the effect of this response action upon any district, site, building, structure, or object that is included in or eligible for the Register of Historic Places. Compliance with NHPA requirements will be attained through the Regional Historic Preservation Plan as implemented pursuant to agreements entered into with EPA and Anaconda/Deer Lodge.

B. <u>Archaeological and Historic Preservation Act, 16 U.S.C. § 469, 40 CFR 6.301(c) (applicable)</u>.

This statute and implementing regulations establish requirements for the evaluation and preservation of historical and archaeological data, which may be destroyed through alteration of terrain as a result of a Federal construction project or a federally licensed activity or program. This requires EPA or the PRP to survey the site for covered scientific, prehistorical or archaeological artifacts. The results of this survey will be reflected in the Administrative Record. Preservation of appropriate data concerning the artifacts is hereby identified as an ARAR requirement, to be completed during the implementation of the remedial action.

C. **Historic Sites, Buildings and Antiquities Act, 16 U.S.C. § 461, et seq., 40 CFR § 6.310(a) (applicable).** This statute and implementing regulations require federal agencies to consider the existence and location of land marks on the National Registry of National Landmarks and to avoid undesirable impacts on such landmarks.

D. **Fish and Wildlife Coordination Act, 16 U.S.C. §§ 1531, et seq., 40 CFR § 6.302(g) (applicable).** This statute and implementing regulations require that Federal agencies or federally funded projects ensure that any modification of any stream or other water body affected by any action authorized or funded by the Federal agency provides for adequate protection of fish and wildlife resources. Compliance with this ARAR requires EPA to consult with the U.S. Fish and Wildlife Service and the Montana Department of Fish, Wildlife, and Parks. Further consultation will occur during remedial design and remedial action.

E. **Endangered Species Act, 16 U.S.C. § 1531, 40 CFR § 6.302(h), 50 CFR Parts 17 and 402 (applicable).** This statute and implementing regulations provide that federal activities not jeopardize the continued existence of any threatened or endangered species. As part of on-going site investigations, ARCO completed a report, **Wetlands and Threatened/Endangered Species Inventory with Determination of Effective Wetland Area (May 1994),** which noted that the following threatened or endangered animal species are present in the Anaconda area: bald eagles and peregrine falcons. Additionally, the Montana Natural Heritage Program data base indicates that Preble's shrew has been observed on site. The remedy selection process, including the Feasibility Study, should identify whether the proposed remedial actions will impact threatened and/or endangered species and/or their habitat, and what avoidance or mitigative measures are necessary in Section 1.0, Statutory Determinations, of the Decision Summary of the ROD.

F. **Floodplain Management, 40 CFR § 6.302(b), and Executive Order No. 11988 (applicable).** These require that actions be taken to avoid, to the extent possible, adverse effects associated with direct or indirect development of a floodplain, or to minimize adverse impacts if no practicable alternative exists.

G. **Protection of Wetlands, 40 CFR Part 6, Appendix A, Executive Order No. 11990 (applicable).** This ARAR requires Federal agencies and the PRP to avoid, to the extent possible, the adverse impacts associated with the destruction or loss of wetlands and to avoid support of new construction in wetlands if a practicable alternative exists. Wetlands are defined as those areas that are inundated or saturated by groundwater or surface water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Compliance with this ARAR will be achieved through consultation with the U.S. Fish and Wildlife Service and the U.S. Corp of Engineers, to determine the existence and category of wetlands present at the site, and any avoidance or mitigation and replacement which may be necessary. As part of on-going site investigations, ARCO completed a report, **Wetlands and Threatened/Endangered Species Inventory with Determination of Effective Wetland Area (May 1994).** A total of 10,714 acres were positively identified as jurisdictional wetlands and 164 acres of aquatic habitat were identified.

H. Montana Floodplain and Floodway Management Act and Regulations, MCA § 76-5-401, et seq., ARM § 36.15.601, et seq. (applicable). The Floodplain and Floodway Management Act and regulations specify types of uses and structures that are allowed or prohibited in the designated 100-year floodway[9] and floodplain.[10] Since the ARWW&S OU lies partially within the 100-year floodplain of Warm Springs Creek, these standards are applicable to all actions within this floodplain area.

1. Allowed uses

The law recognizes certain uses as allowable in the floodway and a broader range of uses as allowed in the floodplain. Residential use is among the possible allowed uses expressly recognized in both the floodway and floodplain. "Residential uses such as lawns, gardens, parking areas, and play areas," as well as certain agricultural, industrial-commercial, recreational and other uses are permissible within the designated floodway, provided they do not require structures other than portable structures, fill or permanent storage of materials or equipment. MCA § 76-5-401; ARM § 36.15.601 (Applicable). In addition, in the flood fringe (i.e., within the floodplain but outside the floodway), residential, commercial, industrial, and other structures may be permitted subject to certain conditions relating to placement of fill, roads, floodproofing, etc. MCA § 76-5-402; ARM § 36.15.701 (Applicable). Domestic water supply wells may be permitted, even within the floodway, provided the well casing is watertight to a depth of 25 feet and the well meets certain conditions for floodproofing, sealing, and positive drainage away from the well head. ARM § 36.15.602(6).

2. Prohibited uses

Uses prohibited anywhere in either the floodway or the floodplain are:

1. solid and hazardous waste disposal; and
2. storage of toxic, flammable, hazardous, or explosive materials.

ARM §§ 36.15.605(2) and 36.15.703 (Applicable); see also ARM § 36.15.602(5)(b) (Applicable).

In the floodway, additional prohibitions apply, including prohibition of:

1. a building for living purposes or place of assembly or permanent use by human beings;

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[9] The "floodway" is the channel of a watercourse or drainway and those portions of the floodplain adjoining the channel which are reasonably required to carry and discharge the floodwater of the watercourse or drainway. ARM § 36.15.101(13).

[10] The "floodplain" is the area adjoining the watercourse or drainway which would be covered by the floodwater of a base (100-year) flood except for sheetflood areas that receive less than one foot of water per occurrence. The floodplain consists of the floodway and flood fringe.

2. any structure or excavation that will cause water to be diverted from the established floodway, cause erosion, obstruct the natural flow of water, or reduce the carrying capacity of the floodway; and

3. the construction or permanent storage of an object subject to flotation or movement during flood level periods.

MCA § 76-5-402 (Applicable).

3. Applicable considerations in use of floodplain or floodway

Applicable regulations also specify factors that must be considered in allowing diversions of the stream, changes in place of diversion of the stream, flood control works, new construction or alteration of artificial obstructions, or any other nonconforming use within the floodplain or floodway. Many of these requirements are set forth as factors that must be considered in determining whether a permit can be issued for certain obstructions or uses. While permit requirements are not directly applicable to remedial actions conducted entirely on site, the substantive criteria used to determine whether a proposed obstruction or use is permissible within the floodway or floodplain are applicable standards. Factors which must be considered in addressing any obstruction or use within the floodway or floodplain include:

1. the danger to life and property from backwater or diverted flow caused by the obstruction or use;

2. the danger that the obstruction or use will be swept downstream to the injury of others;

3. the availability of alternate locations;

4. the construction or alteration of the obstruction or use in such a manner as to lessen the danger;

5. the permanence of the obstruction or use; and

6. the anticipated development in the foreseeable future of the area which may be affected by the obstruction or use.

See MCA § 76-5-406; ARM § 36.15.216 (Applicable, substantive provisions only). Conditions or restrictions that generally apply to specific activities within the floodway or floodplain are:

1. the proposed activity, construction, or use cannot increase the upstream elevation of the 100-year flood a significant amount (½ foot or as otherwise determined by the permit issuing authority) or significantly increase flood velocities, ARM § 36.15.604 (Applicable, substantive provisions only); and

2. the proposed activity, construction, or use must be designed and constructed to minimize potential erosion.

For the substantive conditions and restrictions applicable to specific obstructions or uses, see the following applicable regulations:

Excavation of material from pits or pools - ARM § 36.15.602(1).

Water diversions or changes in place of diversion - ARM § 36.15.603.

Flood control works (levees, floodwalls, and riprap must comply with specified safety standards) - ARM § 36.15.606.

Roads, streets, highways and rail lines (must be designed to minimize increases in flood heights) - ARM § 36.15.701(3)(c).

Structures and facilities for liquid or solid waste treatment and disposal (must be floodproofed to ensure that no pollutants enter flood waters and may be allowed and approved only in accordance with MDEQ regulations, which include certain additional prohibitions on such disposal) - ARM § 36.15.701(3)(d).

Residential structures -ARM § 36.15.702(1).

Commercial or industrial structures - ARM § 36.15.702(2).

I. Montana Natural Streambed and Land Preservation Act and Regulations, MCA § 75-7-101 and ARM §§ 36.2.404, 405, and 406 (applicable). Applicable if this remedial action alters or affects a streambed or its banks. The adverse effects of any such action must be minimized.

MCA §§ 87-5-502 and 504 (Applicable -- substantive provisions only) provide that a state agency or subdivision shall not construct, modify, operate, maintain or fail to maintain any construction project or hydraulic project which may or will obstruct, damage, diminish, destroy, change, modify, or vary the natural existing shape and form of any stream or its banks or tributaries in a manner that will adversely affect any fish or game habitat. The requirement that any such project must eliminate or diminish any adverse effect on fish or game habitat is applicable to the state in approving remedial actions to be conducted. The Natural Streambed and Land Preservation Act of 1975, MCA § 75-7-101, et seq., (Applicable -- substantive provisions only) includes similar requirements and is applicable to private parties as well as government agencies.

ARM § 36.2.404 (Applicable) establishes minimum standards which would be applicable if a remedial action alters or affects a streambed, including any channel change, new diversion, riprap or other stream bank protection project, jetty, new dam or reservoir or other commercial, industrial or residential development. No such project may be approved unless reasonable efforts will be made consistent with the purpose of the project to minimize the amount of stream channel alteration, insure that the project will be as permanent a solution as possible and will create a reasonably permanent and stable situation, insure that the project will pass anticipated water flows without creating harmful erosion upstream or downstream, minimize turbidity, effects on fish and aquatic habitat, and adverse effects on the natural beauty of the area and insure that streambed gravels will not be used in the project unless there is no reasonable alternative. Soils erosion and sedimentation must be kept to a minimum. Such projects must also protect the use of water for any useful or beneficial purpose. See MCA § 75-7-102.

While the administrative/procedural requirements, including the consent and approval requirements, set forth in these statutes and regulations are not ARARs, the party designing and implementing the remedial action for the ARWW&S OU is encouraged to continue to consult with the Montana Department of Fish, Wildlife and Parks, and any conservation district or board of county commissioners (or consolidated city/county government) as provided in the referenced statutes, to assist in the evaluation of factors discussed above.

J. **Migratory Bird Treaty Act, 16 U.S.C. §§ 703, et seq. (applicable).** This requirement establishes a federal responsibility for the protection of the international migratory bird resource and requires continued consultation with the USFWS during remedial design and remedial construction to ensure that the cleanup of the site does not unnecessarily impact migratory birds. Specific mitigative measures may be identified for compliance with this requirement.

K. **Bald Eagle Protection Act, 16 U.S.C. §§ 668, et seq. (applicable).** This requirement establishes a federal responsibility for protection of bald and golden eagles, and requires continued consultation with the USFWS during remedial design and remedial construction to ensure that any cleanup of the site does not unnecessarily adversely affect the bald and golden eagles. Specific mitigative measures may be identified for compliance with this requirement.

L. **Resource Conservation and Recovery Act and regulations, 40 CFR § 264.18 (a) and (b) (relevant and appropriate).** Regulations promulgated under the Solid Waste Management, MCA § 75-10-201, et seq., specify requirements that apply to the location of any solid waste management facility.

M. **Montana Solid Waste Management Act and regulations, MCA § 75-10-201, et seq., ARM § 17.50.505 (applicable).** Sets forth requirements applying to the location of any solid waste management facility. Among other things, the location must have sufficient acreage, must not be within a 100-year floodplain, must be located so as to prevent pollution of ground, surface, and private and public water supply systems, and must allow for reclamation of the land.

N. **American Indian Religious Freedom Act, 42 U.S.C. § 1996, et seq. (applicable).** This Act establishes a federal responsibility to protect and preserve the inherent right of American Indians to believe, express and exercise the traditional religions of American Indians. This right includes, but is not limited to, access to sites, use and possession of sacred objects, and the freedom to worship through ceremonials and traditional rites. The Act requires Federal agencies to protect Indian religious freedom by refraining from interfering with access, possession and use of religious objects, and by consulting with Indian organizations regarding proposed actions affecting their religious freedom.

O. Native American Graves and Repatration Act, 25 U.S.C. § 3001, et seq. (applicable). The Act prioritizes ownership or control over Native American cultural items, including human remains, funerary objects and sacred objects, excavated or discovered on Federal or tribal lands. Federal agencies and museums that have possession or control over Native American human remains and associated funerary objects are required under the Act to compile an inventory of such items and, to the extent possible, identify their geographical and cultural affiliation. Once the cultural affiliation of such objects is established, the Federal agency or museum must expeditiously return such items, upon request by a lineal descendent of the individual Native American or tribe identified.

III. ACTION SPECIFIC REQUIREMENTS

A. Federal and State Water Requirements.

1. Clean Water Act Point Source Discharges requirements, 33 U.S.C. § 1342 (applicable). Section 402 of the Clean Water Act, 33 U.S.C. § 1342, et seq., authorizes the issuance of permits for the "discharge" of any "pollutant." This includes storm water discharges associated with "industrial activity." See, 40 CFR § 122.1(b)(2)(iv). "Industrial activity includes inactive mining operations that discharge storm water contaminated by contact with or that has come into contact with any overburden, raw material, intermediate products, finished products, byproducts or waste products located on the site of such operations, see, 40 CFR § 122.26(b)(14)(iii); landfills, land application sites, and open dumps that receive or have received any industrial wastes including those subject to regulation under RCRA subtitle D, see, 40 CFR § 122.26(b)(14)(v); and construction activity including clearing, grading, and excavation activities, see, 40 CFR § 122.26(b)(14)(x). Because the State of Montana has been delegated the authority to implement the Clean Water Act, these requirements are enforced in Montana through the Montana Pollutant Discharge Elimination System (MPDES). The MPDES requirements are set forth below.

a. Substantive MPDES Permit Requirements, ARM §§ 17.30.1342-1344 (applicable). These set forth the substantive requirements applicable to all MPDES and NPDES permits. The substantive requirements, including the requirement to properly operate and maintain all facilities and systems of treatment and control are applicable requirements.

b. Technology-Based Treatment, ARM §§ 17.30.1203 and 1344 (applicable). Provisions of 40 CFR Part 125 for criteria and standards for the imposition of technology-based treatment requirements are adopted and incorporated in MDEQ permits. Although the permit requirement would not apply to on-site discharges, the substantive requirements of Part 125 are applicable, i.e., for toxic and nonconventional pollutants treatment must apply the best available technology economically achievable (BAT); for conventional pollutants, application of the best conventional pollutant control technology (BCT) is required. Where effluent limitations are not specified for the particular industry or industrial category at issue, BCT/BAT technology-based treatment requirements are determined on a case by case basis using best professional judgment (BPJ). See CERCLA Compliance with Other Laws Manual, Vol. I, August 1988, p. 3-4 and 3-7.

2. Additional State of Montana requirements.

a. Water Quality Statute and Regulations (all applicable).

i. Causing of Pollution, MCA § 75-5-605. This section of the Montana Water Quality Act prohibits the causing of pollution of any state waters. Pollution is defined as contamination or other alteration of physical, chemical, or biological properties of state waters which exceeds that permitted by the water quality standards. Also, it is unlawful to place or caused to be placed any wastes where they will cause pollution of any state waters. Any permitted placement of waste is not placement if the agency's permitting authority contains provisions for review of the placement of materials to ensure it will not cause pollution to state waters.

ii. Nondegradation, MCA § 75-5-303. This provision states that existing uses of state waters and the level of water quality necessary to protect the uses must be maintained and protected. Under MCA § 75-5-317, changes in existing water quality resulting from an emergency or remedial activity that is designed to protect the public health or the environment and is approved, authorized, or required by the department are considered nonsignificant activities, and are not subject to the nondegradation rules promulgated pursuant to MCA § 75-5-303.

(a). ARM § 17.30.705. This provides that for any surface water, existing and anticipated uses and the water quality necessary to protect these uses must be maintained and protected unless degradation is allowed under the nondegradation rules at ARM § 17.30.708.

(b). ARM § 17.30.1011. This provides that any groundwater whose existing quality is higher than the standard for its classification must be maintained at that high quality unless degradation may be allowed under the principles established in MCA § 75-5-303, and the nondegradation rules at ARM § 17.30.701, et seq.

iv. Stormwater Runoff.

(a). ARM § 17.24.633. All surface drainage from a disturbed area must be treated by the best technology currently available.

(b). General Permits. Under ARM § 17.30.601, et seq., and ARM § 17.30.1301, et seq., including ARM § 17.30.1332, the Water Quality Division has issued general storm water permits for certain activities. The substantive requirements of the following permits are applicable for the following activities: (1) for construction activities: General Discharge Permit for Storm Water Associated with Construction Activity, Permit No. MTR100000 (May 19, 1997); (2) for mining activities: General Discharge Permit for Storm Water Associated with Mining and with Oil and Gas Activities, Permit No. MTR300000

(September 10, 1997).[11] (3) for industrial activities: General Discharge Permit for Storm Water Associated with Industrial Activity, Permit No. MTR000000 (October 26, 1994).[12]

Generally, the permits require the permittee to implement Best Management Practices (BMP) and to take all reasonable steps to minimize or prevent any discharge which has a reasonable likelihood of adversely affecting human health or the environment. However, if there is evidence indicating potential or realized impacts on water quality due to any storm water discharge associated with the activity, an individual MPDES permit or alternative general permit may be required.

v. **Surface Water, ARM § 17.30.637**. Prohibits discharges containing substances that will: (a) settle to form objectionable sludge deposits or emulsions beneath the surface of the water or upon adjoining shorelines; (b) create floating debris, scum, a visible oil film (or be present in concentrations at or in excess of 10 milligrams per liter) or globules of grease or other floating materials; (c) produce odors, colors or other conditions which create a nuisance or render undesirable tastes to fish flesh or make fish inedible; (d) create concentrations or combinations of materials which are toxic or harmful to human, animal, plant or aquatic life; or (e) create conditions which produce undesirable aquatic life.

B. Federal and State RCRA Subtitle C Requirements, 42 U.S.C. Section 6921, et seq. (relevant and appropriate for solid wastes, applicable for hazardous wastes). The presentation of RCRA Subtitle C requirements in this section assumes that there will be many solid wastes at the ARWW&S OU, and that some of these may be left in place in "waste management areas" as a result of this remedial action. Because of the similarity of these waste management areas to the RCRA "waste management unit," certain discrete portions of the RCRA Subtitle C implementing regulations will be relevant and appropriate for the ARWW&S remedial action. Also, although it is unlikely that hazardous wastes still exist at the ARWW&S OU (these should have been addressed the Arbiter/Beryllium removal and Flue Dust remedial actions) this possibility has not yet been eliminated. Therefore, RCRA Subtitle C and implementing regulations are hereby designated as applicable for any hazardous wastes that are actively "managed" as part of the ARWW&S OU remedial action or that were "placed" or "disposed" after 1980. These RCRA C requirements are also applicable for continued operation and maintenance of the Arbiter/Beryllium waste repository. Also, should hazardous wastes be discovered as part of any remedial design or remedial action activity taken in connection with this ROD, EPA reserves the right to identify RCRA Subtitle C requirements in more detail at a later date. All federal RCRA Subtitle C requirements set forth below are incorporated by reference as State of Montana requirements as provided for under ARM § 17.54.112(6) unless mentioned otherwise below.

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[11] This permit covers point source discharges of storm water from mining and milling activities (including active, inactive, and abandoned mine and mill sites) including activities with Standard Industrial Code 14 (metal mining).

[12] Industrial activities are defined as all industries defined in 40 CFR §§ 122, 123, and 124, excluding construction, mining, oil & gas extraction activities and storm water discharges subject to effluent limitations guidelines. This includes wood treatment operations, as well as the production of slag.

1. **40 CFR Part 264 Subpart F. General Facility Standards.** This is potentially relevant and appropriate for solid wastes at this OU. Any waste management unit or similar area would be required to comply with the following requirements. These are not final cleanup standards for the ARWW&S OU.

a. **40 CFR § 264.92, .93. and .94**. Prescribes groundwater protection standards.

b. **40 CFR § 264.97**. Prescribes general groundwater monitoring requirements.

e. **40 CFR § 264.98**. Prescribes requirements for monitoring and detecting indicator parameters.

2. **Closure requirements.**

a. **40 CFR § 264.111**. This provides that the owner or operator of a hazardous waste management facility must close the facility in a way that minimizes the need for further maintenance, and controls or eliminates the leaching or escape of hazardous waste or its constituents, leachate, or runoff to the extent necessary to protect human health and the environment.

b. **40 CFR § 264.117**. This provision incorporates monitoring requirements in Part 264, including those mentioned at Part 264.97 and Part 264.303. It governs the length of the post-closure care period, permits a lengthened security period, and prohibits any use of the property which would disturb the integrity of the management facility.

c. **40 CFR § 264.310**. This specifies requirements for caps, maintenance, and monitoring after closure.

3. **40 CFR § 264.301**. Prescribes design and operating requirements for landfills.

a. **40 CFR § 264.301(a)**. This provides for a single liner and leachate collection and removal system.

b. **40 CFR § 264.301(f)**. This requires a run-on control system.

c. **40 CFR § 264.301(g)**. This requires a run-off management system.

d. **40 CFR § 264.301(h)**. This requires prudent management of facilities for collection and holding of run-on and run-off.

e. **40 CFR § 264.301(i)**. This requires that wind dispersal of particulate matter be controlled.

C. **Federal and State RCRA Subtitle D and Solid Waste Requirements (applicable).** 40 CFR Part 257 establishes criteria under Subtitle D of the Resource Conservation and Recovery Act for use in determining which solid waste disposal facilities and practices pose a reasonable probability of adverse effects on health or the environment. See 40 CFR § 257.1(a). This part comes into play whenever there is a "disposal" of any solid or hazardous waste from a "facility." "Disposal" is defined as "the discharge, deposit, injection, dumping, spilling, leaking, or placing of any solid waste or hazardous waste into or on any land or water so that such solid waste or hazardous waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters, including ground waters." See 40 CFR § 257.2. "Facility" means "any land and appurtenances thereto used for the disposal of solid wastes." Solid waste requirements are listed herein because the there may be disposal of solid wastes as a result of this remedial action.

1. **Federal Requirements - 40 CFR § 257.** Criteria for Classification of Solid Waste Disposal Facilities and Practices. The activities to be performed for the ARWW&S OU remedial action are expected to comply with the following requirements.

a. **40 CFR § 257.3-1.** Washout of solid waste in facilities in a floodplain posing a hazard to human life, wildlife, or land or water resources shall not occur.

b. **40 CFR § 257.3-2.** Facilities shall not contribute to the taking of endangered species or the endangering of critical habitat of endangered species.

c. **40 CFR § 257.3-3.** A facility shall not cause a discharge of pollutants, dredged or fill material, into waters of the United States in violation of sections 402 and 404 of the Clean Water Act, as amended, and shall not cause non-point source pollution, in violation of applicable legal requirements implementing an area wide or statewide water quality management plan that has been approved by the Administrator under Section 208 of the Clean Water Act, as amended.

d. **40 CFR § 257.3-4.** A facility shall not contaminate an underground source of drinking water beyond the solid waste boundary or beyond an alternative boundary specified in accordance with this section.

e. **40 CFR § 257.3-8(d).** Access to a facility shall be controlled so as to prevent exposure of the public to potential health and safety hazards at the site.

2. **State of Montana Solid Waste Requirements (applicable).**

a. **ARM § 17.50.505(1) and (2).** Sets forth standards that all solid waste disposal sites must meet, including the requirements that (1) Class II landfills must confine solid waste and leachate to the disposal facility. If there is the potential for leachate migration, it must be demonstrated that leachate will only migrate to underlying formations which have no hydraulic continuity with any state waters; (2) adequate separation of group II wastes from underlying or adjacent water must be provided; and (3) no new disposal units or lateral expansions may be located in wetlands. ARM § 17.50.505 also specifies general soil and hydrogeological requirements pertaining to the location of any solid waste management facility.

b. **ARM § 17.50.506**. Specifies design requirements for landfills. Landfills must either be designed to ensure that MCLs are not exceeded or the landfill must contain a composite liner and leachate collection system which comply with specified criteria.

c. **ARM § 17.50.510**. Sets forth general operational and maintenance and design requirements for solid waste facilities using land filling methods. Specific operational and maintenance requirements specified in ARM § 17.50.510 that are applicable are run-on and run-off control systems requirements, requirements that sites be fenced to prevent unauthorized access, and prohibitions of point source and non-point source discharges which would violate Clean Water Act requirements.

d. **MCA § 75-10-121 and ARM § 17.50.523**. For solid wastes, MCA § 75-10-212 prohibits dumping or leaving any debris or refuse upon or within 200 yards of any highway, road, street, or alley of the State or other public property, or on privately owned property where hunting, fishing, or other recreation is permitted. ARM § 17.50.523 specifies that solid waste must be transported in such a manner as to prevent its discharge, dumping, spilling or leaking from the transport vehicle.

e. **MCA § 75-10-206**. Provides for a variance from solid waste requirements where such variance would not result in a danger to public health or safety. EPA invokes the variance with respect to some or all of the solid waste provisions listed above and finds that variance from these requirements will not result in danger to public health or safety.

f. **ARM § 17.50.530**. Sets forth the closure requirements for landfills. Class II landfills must meet the following criteria: (1) install a final cover that is designed to minimize infiltration and erosion; (2) design and construct the final cover system to minimize infiltration through the closed unit by the use of an infiltration layer that contains a minimum 18 inches of earthen material and has a permeability less than or equal to the permeability of any bottom liner, barrier layer, or natural subsoils or a permeability no greater than 1 X 10-5 cm/sec, whichever is less; (3) minimize erosion of the final cover by the use of a seed bed layer that contains a minimum of six inches of earthen material that is capable of sustaining native plant growth and protecting the infiltration layer from frost effects and rooting damage; (4) revegetate the final cover with native plant growth within one year of placement of the final cover.

g. **ARM § 17.50.531**. Sets forth post closure care requirements for Class II landfills. Post closure care must be conducted for a period sufficient to protect human health and the environment. Post closure care requires maintenance of the integrity of the integrity and effectiveness of any final cover, including making repairs to the cover as necessary to correct the effects of settlement, subsidence, erosion, or other events, and preventing run-on and run-off from eroding or otherwise damaging the cover and comply with the groundwater monitoring requirements found at ARM Title 17, chapter 50, subchapter 7.

D. **Surface Mining Control and Reclamation Act, 30 U.S.C. §§ 1201-1326 (relevant and appropriate).** This Act and implementing regulations found at 30 CFR Parts 784 and 816 establish provisions designed to protect the environment from the effects of surface coal mining operations, and to a lesser extent non-coal mining. These requirements are relevant and appropriate to the covering of discrete areas of contamination. The regulations require that revegetation be used to stabilize soil covers over reclaimed areas. They also require that revegetation be done according to a plan which specifies schedules, species which are diverse and effective, planting methods, mulching techniques, irrigation if appropriate, and appropriate soil testing. Reclamation performance standards are currently relevant and appropriate to mining waste sites.

E. **Montana Strip and Underground Mine Reclamation Act, MCA § 82-4-201, et seq., (all relevant and appropriate) and Montana Metal Mining Reclamation Act, MCA § 82-4-301, et seq., (relevant and appropriate).** Certain discrete portions of the following statutory or regulatory provisions are relevant and appropriate requirements.

1. **MCA § 82-4-231.** Requires operators to reclaim and revegetate affected lands using most modern technology available. Operators must grade, backfill, topsoil, reduce high walls, stabilize subsidence, control water, minimize erosion, subsidence, land slides, and water pollution.

2. **MCA § 82-4-233.** Operators must plant vegetation that will yield a diverse, effective, and permanent vegetative cover of the same seasonal variety native to the area and capable of self-regeneration.

3. **MCA § 82-4-336 (Montana Metal Mine Reclamation Act).** Disturbed areas must be reclaimed to utility and stability comparable to areas adjacent.

4. **ARM § 17.24.501(3)(a) and (d) and (4).** Backfill must be placed so as to minimize sedimentation, erosion, and leaching of acid or toxic materials into waters, unless otherwise approved.

5. **ARM § 17.24.501(A)(1)a and (2).** Final graded slopes will be 5:1 unless otherwise approved. If steeper, slopes must have a long term static safety factor of 1:3, not to exceed the angle of repose unless the existing grade of the area is steeper, in which case the existing grade meets this requirement. Disturbed areas must be blended with undisturbed ground to provide a smooth transition in topography.

6. **ARM § 17.24.514.** Final grading will be done along the existing contour in order to minimize subsequent erosion and instability, unless otherwise approved.

7. **ARM § 17.24.519.** Pertinent areas of the ARWW&S OU where excavation will occur will be regraded to minimize settlement.

8. **ARM § 17.24.631(1), (2), (3)(a) and (b).** Disturbances to the prevailing hydrologic balance will be minimized. Changes in water quality and quantity, in the depth to

groundwater and in the location of surface water drainage channels will be minimized, to the extent consistent with the selected remedial alternatives. Other pollution minimization devices must be used if appropriate, including stabilizing disturbed areas through land shaping, diverting runoff, planting quickly germinating and growing stands of temporary vegetation, regulating channel velocity of water, lining drainage channels with rock or vegetation, mulching, and control of acid-forming, and toxic-forming waste materials.

9. **ARM § 17.24.633.** Surface drainage from a disturbed area must be treated by the best technology currently available (BTCA). Treatment must continue until the area is stabilized.

10. **ARM § 17.24.634.** Disturbed drainages will be restored to the approximate pre-disturbance configuration, to the extent consistent with the selected remedial alternatives. Drainage design must emphasize channel and floodplain dimensions that approximate the pre-mining configuration and that will blend with the undisturbed drainage above and below the area to be reclaimed. The average stream gradient must be maintained with a concave longitudinal profile. This regulation provides specific requirements for designing the reclaimed drainage to: (1) meander naturally; (2) remain in dynamic equilibrium with the system; (3) improve unstable premining conditions; (4) provide for floods; and (5) establish a premining diversity of aquatic habitats and riparian vegetation.

11. **ARM §§ 17.24.635 through 17.24.637.** Set forth requirements for temporary and permanent diversions.

12. **ARM § 17.24.638.** Sediment control measures must be implemented during operations.

13. **ARM § 17.24.639.** Sets forth requirements for construction and maintenance of sedimentation ponds.

14. **ARM § 17.24.640.** Discharges from sedimentation ponds, permanent and temporary impoundments, must be controlled to reduce erosion and enlargement of stream channels, and to minimize disturbance of the hydrologic balance.

15. **ARM § 17.24.641.** Practices to prevent drainage from acid or toxic forming spoil material into ground and surface water will be employed.

16. **ARM §§ 17.24.643 through 17.24.646.** Provisions for groundwater protection, groundwater recharge protection, and groundwater and surface water monitoring.

17. **ARM §§ 17.24.701 and 702.** Requirements for redistributing and stockpiling of soil for reclamation. Also, outline practices to prevent compaction, slippage, erosion, and deterioration of biological properties of soil will be employed.

18. **ARM § 17.24.703.** When using materials other than, or along with, soil for final surfacing in reclamation, the operator must demonstrate that the material (1) is at least as capable as the soil of supporting the approved vegetation and subsequent land use, and (2) the medium must be the best available in the area to support vegetation. Such substitutes must be used in a manner consistent with the requirements for redistribution of soil in ARM § 17.24.701 and 702.

19. **ARM § 17.24.711.** Requires that a diverse, effective and permanent vegetative cover of the same seasonal variety and utility as the vegetation native to the area of land to be affected must be established. This provision would not be relevant and appropriate in certain instances, for example, where there is dedicated development.

20. **ARM § 17.24.713.** Seeding and planting of disturbed areas must be conducted during the first appropriate period for favorable planting after final seedbed preparation but may not be more than 90 days after soil has been replaced.

21. **ARM § 17.24.714.** Mulch or cover crop or both must be used until adequate permanent cover can be established.

22. **ARM § 17.24.716.** Establishes method of revegetation.

23. **ARM § 17.24.718.** Requires soil amendments, irrigation, management, fencing, or other measures, if necessary to establish a diverse and permanent vegetative cover.

24. **ARM § 17.24.721.** Specifies that rills or gullies deeper than nine inches must be stabilized. In some instances shallower rills and gullies must be stabilized.

25. **ARM § 17.24.723.** States that operators shall conduct approved periodic measurements of vegetation, soils, water, and wildlife during the period of liability.

26. **ARM § 17.24.724.** Specifies that revegetation success must be measured by approved unmined reference areas. There shall be at least one reference area for each plant community type. Required management for these reference areas is set forth.

27. **ARM § 17.24.726.** Sets the required methods for measuring productivity.

28. **ARM § 17.24.728.** Sets requirements for measurements of the permanence of vegetation on reclaimed areas.

29. **ARM §§ 17.24.730 and 17.24.731.** Provide that the revegetated area must furnish palatable forage in comparable quantity and quality during the same grazing period as the reference area. If toxicity to plants or animals is suspected, comparative chemical analyses may be required.

30. **ARM § 17.24.733.** Provides additional requirements and measurement standards for trees, shrubs and half-shrubs.

31. <u>**ARM § 17.24.751**</u>. Measures to prevent degradation of fish and wildlife habitat will be employed.

32. <u>**ARM § 17.24.761**</u>. This specifies fugitive dust control measures which will be employed during excavation and construction activities to minimize the emission of fugitive dust in the ARWW&S OU. These provisions are addressed below in Section III.C.

33. <u>**ARM § 17.24.824**</u>. Post-mining land use must be judged on the highest and best use that can be achieved and is compatible with surrounding areas.

F. Air Requirements (all applicable).

1. **ARM § 17.8.308(2), (3), and (4)**. Airborne particulate matter. There shall be no production, handling, transportation, or storage of any material, use of any street, road, or parking lot, or operation of a construction site or demolition project unless reasonable precautions are taken to control emissions of airborne particles. Emissions shall not exhibit an opacity exceeding 20% or greater averaged over 6 consecutive minutes.

2. **ARM § 17.8.304(2)**. Visible Air Contaminants. Emissions into the outdoor atmosphere shall not exhibit an opacity of 20% or greater averaged over 6 consecutive minutes.

3. **ARM § 17.8.315(1)**. Nuisance or odor bearing gases. Gases, vapors and dusts will be controlled such that no public nuisance is caused within the ARWW&S OU.

4. **ARM § 17.24.761(2)(a), (e), (h), (j), and (k)**. Fugitive dust control measures such as 1) watering, stabilization, or paving of roads, 2) vehicle speed restrictions, 3) stabilization of surface areas adjoining roads, 4) restriction of travel on other than authorized roads, 5) enclosing, covering, watering, or otherwise treating loaded haul truck, 6) minimizing area of disturbed land, and 7) revegetation, must be planned and implemented, if any such measure or measures are appropriate for this remedial action.

G. Air Quality Requirements (applicable).

Remedial activities will comply with the following requirements to ensure that existing air quality will not be adversely affected by the ARWW&S OU remedial action.

1. **ARM § 17.8.222**. The concentration of lead in ambient air shall not exceed a 90 day average of 1.5 micrograms per cubic meter of air.

2. **ARM § 17.8.220**. Settled particulate matter shall not exceed a 30 day average of 10 grams per square meter.

3. **ARM § 17.8.823**. The concentration of PM-10 in ambient air shall not exceed a 24 hour average of 150 micrograms per cubic meter of air and an annual average of 50 micrograms per cubic meter of air.

H. Noxious Weeds, MCA § 7-22-2101(7)(a) and ARM § 4.5.201, et seq. MCA § 7-22-2101(7)(a) defines "noxious weeds" as any exotic plant species established or that may be introduced in the state which may render land unfit for agriculture, forestry, livestock, wildlife, or other beneficial uses or that may harm native plant communities and that is designated: (i) as a statewide noxious weed by rule of the department; or (ii) as a district noxious weed by a board, following public notice of intent and a public hearing. Designated noxious weeds are listed in ARM § 4.5.201 through 4.5.204 and must be managed consistent with weed management criteria developed under MCA § 7-22-2109(2)(b).

IV. TO BE CONSIDERED DOCUMENTS (TBCs).

The use of documents identified as TBCs is addressed in the Introduction, above. A list of TBC documents is included in the Preamble to the NCP, 55 Fed. Reg. 8765 (March 8, 1990). Those documents, plus any additional similar or related documents issued since that time, will be considered by EPA and MDEQ during the conduct of the RI/FS, during remedy selection, and during remedy implementation.

V. OTHER LAWS (NON-EXCLUSIVE LIST).

CERCLA defines as ARARs only federal environmental and state environmental and siting laws. Remedial design, implementation, and operation and maintenance must nevertheless comply with all other applicable laws, both state and federal, if the remediation work is done by parties other than the federal government or its contractors.

The following "other laws" are included here to provide a reminder of other legally applicable requirements for actions being conducted at the reservoir sediments operable unit. They do not purport to be an exhaustive list of such legal requirements, but are included because they set out related concerns that must be addressed and, in some cases, may require some advance planning. They are not included as ARARs because they are not "environmental or facility siting laws." As applicable laws other than ARARs, they are not subject to ARAR waiver provisions.

Section 121(e) of CERCLA exempts removal or remedial actions conducted entirely on-site from federal, state, or local permits. This exemption is not limited to environmental or facility siting laws, but applies to other permit requirements as well.

A. Other Federal Laws.

1. Occupational Safety and Health Regulations. The federal Occupational Safety and Health Act regulations found at 29 CFR § 1910 are applicable to worker protection during conduct of RI/FS or remedial activities.

B. Other State Laws.

1. Groundwater Act. MCA § 85-2-505, precludes the wasting of groundwater. Any well producing waters that contaminate other waters must be plugged or capped, and wells must be constructed and maintained so as to prevent waste, contamination, or pollution of groundwater.

2. Public Water Supply Regulations. If remedial action at the site requires any reconstruction or modification of any public water supply line or sewer line, the construction standards specified in ARM § 17.38.101(3) must be observed.

3. Groundwater Act. MCA § 85-2-516 states that within 60 days after any well is completed a well log report must be filed by the driller with the DNRC and the appropriate county clerk and recorder.

4. Water Rights. MCA § 85-2-101 declares that all waters within the state are the state's property, and may be appropriated for beneficial uses. The wise use of water resources is encouraged for the maximum benefit to the people and with minimum degradation of natural aquatic ecosystems.

Parts 3 and 4 of Title 85, MCA, set out requirements for obtaining water rights and appropriating and utilizing water. All requirements of these parts are laws which must be complied with in any action using or affecting waters of the state. Some of the specific requirements are set forth below.

MCA § 85-2-301 provides that a person may only appropriate water for a beneficial use.

MCA § 85-2-302 specifies that a person may not appropriate water or commence construction of diversion, impoundment, withdrawal or distribution works therefor except by applying for and receiving a permit from the Montana Department of Natural Resources and Conservation. While the permit itself may not be required under federal law, appropriate notification and submission of an application should be performed and a permit should be applied for in order to establish a priority date in the prior appropriation system. A 1991 amendment imposes a fee of $1.00 per acre foot for appropriations of ground water, effective until July 1, 1993.

MCA § 85-2-306 specifies the conditions on which groundwater may be appropriated, and, at a minimum, requires notice of completion and appropriation within 60 days of well completion.

MCA § 85-2-311 specifies the criteria which must be met in order to appropriate water and includes requirements that:

1. there are unappropriated waters in the source of supply;

2. the proposed use of water is a beneficial use; and

3. the proposed use will not interfere unreasonably with other planned uses or developments.

MCA § 85-2-402 specifies that an appropriator may not change an appropriated right except as provided in this section with the approval of the DNRC.

MCA § 85-2-412 provides that where a person has diverted all of the water of a stream by virtue of prior appropriation and there is a surplus of water, over and above what is actually and necessarily used, such surplus must be returned to the stream.

5. **Occupational Health Act, MCA § 50-70-101, et seq.** ARM § 17.74.101 addresses occupational noise. In accordance with this section, no worker shall be exposed to noise levels in excess of the levels specified in this regulation. This regulation is applicable only to limited categories of workers and for most workers the similar federal standard in 29 CFR § 1910.95 applies.

ARM § 17.74.102 addresses occupational air contaminants. The purpose of this rule is to establish maximum threshold limit values for air contaminants under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse health effects. In accordance with this rule, no worker shall be exposed to air contaminant levels in excess of the threshold limit values listed in the regulation.

This regulation is applicable only to limited categories of workers and for most workers the similar federal standard in 29 CFR § 1910.1000 applies.

6. **Montana Safety Act.** MCA §§ 50-71-201, 202 and 203 state that every employer must provide and maintain a safe place of employment, provide and require use of safety devices and safeguards, and ensure that operations and processes are reasonably adequate to render the place of employment safe. The employer must also do every other thing reasonably necessary to protect the life and safety of its employees. Employees are prohibited from refusing to use or interfering with the use of safety devices.

7. **Employee and Community Hazardous Chemical Information Act.** MCA §§ 50-78-201, 202, and 204 state that each employer must post notice of employee rights, maintain at the work place a list of chemical names of each chemical in the work place, and indicate the work area where the chemical is stored or used. Employees must be informed of the chemicals at the work place and trained in the proper handling of the chemicals.

APPENDIX B

Methods for Estimating Potential Risks to Terrestrial Wildlife Receptors via the Food Chain at the Anaconda Smelter Site

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1.0 PURPOSE AND SCOPE OF THIS ANALYSIS OF WILDLIFE RISKS

This appendix re-evaluated the food chain modeling for the Anaconda Smelter Site that was conducted during the preparation of the Final BERA, and incorporated many proposed changes by ARCO consultants, ENSR Toxicology. The general purposes of the modeling include: 1) identifying the range of potential metals-related risk to selected wildlife species at the site; 2) identifying the trophic levels, or feeding guilds, that are potentially at risk from metals; and 3) predicting the pertinent pathways of exposure within trophic levels at the greatest risk. This information will be used by the risk managers to design future risk-related sampling efforts and post-remediation biomonitoring programs.

The modeling efforts evaluate risks to wildlife through food chain exposures (i.e., risks from the ingestion of contaminated vegetation, soil, invertebrates, and/or prey species). The results of this modeling provide only general information on several of the following points: 1) geographic references of relative potential risk to multiple receptors; 2) relative potential risks among several individual receptor species representing different feeding guilds; 3) the pathway of exposure of highest potential concerns; and 4) relative importance of all the COCs. Nonetheless, this information is important when used along with estimates of risk from the ingestion of contaminated drinking water and forage to estimate overall risk to wildlife at the Anaconda Smelter Site. Thus, this modeling effort constitutes only one component of the weight-of-evidence approach to assessing wildlife risks. Risks from drinking water and forage, and the combined risk to wildlife from these sources is fully described in Section 5.0 of the Final BERA.

2.0 ESTIMATION OF WILDLIFE RISKS

2.1 FOOD CHAIN ANALYSIS (METHODS)

Potential exposures and risks to wildlife receptors were evaluated using a simple food chain model in combination with geographic information systems (GIS) mapping. Risks were estimated by comparing the predicted exposure (i.e., estimated daily dose) to an extrapolated (from scientific toxicity literature) toxicity reference value (TRV; dose-based in mg/kg/day) to derive hazard quotients (HQ = estimated dose/TRV) for each COC-receptor combination. The range of TRVs for each COC included both a No Observable Adverse Effect Level (NOAEL) and a Lowest Observable Adverse Effect Level (LOAEL). NOAEL TRVs represent extrapolated doses in which no effect from the predicted exposure is anticipated to occur. LOAEL TRVs represent extrapolated doses in which effects from the predicted exposures in at least some of the individuals in a population are potentially occurring. Since ecological risk assessment is focused on protection at the population level, predicted exposures greater than the LOAEL are of most concern (i.e. $HQ_{LOAEL} > 1$). For each receptor, HQs were summed for all chemicals to derive a Hazard Index ($HI = HQ_{As} + HQ_{Cd} + HQ_{Cu} + HQ_{Pb} + HQ_{Zn}$) and illustrated for each receptor on GIS maps of the site in four different forms: 1) Site HI_{NOAEL} / Reference HI_{NOAEL}; 2) Site HI_{LOAEL} / Reference HI_{LOAEL}; 3) Site HI_{NOAEL} - Reference HI_{NOAEL} ; 4) Site HI_{LOAEL} - Reference HI_{LOAEL}. The first two forms of predicted risk are expressions of *relative risk.* The last two forms of predicted risk are expressions of *absolute risk.* Both expressions of risk are useful in the modeled characterizations. The estimates of relative risk are useful for several reasons. First of all, it is important to document incremental risk above a background, or reference area. In the form of a ratio, comparing the site to a reference, incremental risk can be used in a semi-quantitative and qualitative sensitivity analysis to help judge where the greatest uncertainty in the model appears. For example, if the relative increase in predicted risk is 5-fold, and the uncertainty factor in the toxicity reference value is 100, semi-quantitative terms can be used to say that great uncertainty lie in the extrapolated toxicity reference value for a particular chemical-receptor combination. Indeed, estimates of risks are highly uncertain within two orders of magnitude in this case. However, in full quantitative analyses of modeling predictive wildlife risks, estimates of absolute risks are also necessary. Consider the case in which there would a relative increase of 10-fold, but HQs were only $0.01_{reference}$ and 0.1_{site}; both indicative of minimal absolute risk. Therefore, both models used together can provide information to risk managers describing the limitations and uncertainties on the estimates of risk to wildlife species.

The goals of these analyses are to: 1) quantitatively and qualitatively demonstrate the potential for risk to wildlife receptors on the Anaconda smelter site; and 2) provide geographic reference to predicted pathways of most concern for chemical-receptor combinations such that field work investigations can be focused to validate the model in the most appropriate and efficient manner. Potential risks were calculated for five receptors: American robin (*Turdus migratorius*), white-tailed deer (*Odocoileus virginianus*), deer mouse *(Peromyscus maniculatus*), red fox (*Vulpes vulpes*), and American kestrel (*Falco sparverius*). The red fox is used below as an example to transparently illustrate the process of estimating exposure.

2.1.1 CALCULATING A PREDICTED DOSE

The calculation of a daily dose to the fox is an iterative process. First, the dietary items of the receptors must be identified (Table 1). Based on EPA's *Wildlife Exposure Factors Handbook* (EPA 1993), these items for the fox were determined to be: invertebrates, plants, small mammals, small birds and soil.

Second, the tissue concentration for each food item that the fox consumes must be estimated. The tissue concentration (TC in ppm; mg/kg) is estimated by multiplying a soil concentration (SC in ppm, mg/kg) by a bioaccumulation factor (BAF, unitless, Tables 2 and 3):

SC x BAF invertebrates = TC invertebrates
SC x BAF plants = TC plants
SC x BAF small mammals = TC small mammals
SC x BAF small birds = TC small birds
SC x BAF soil = SC soil

Because of the large size of the site and the density of soil sample locations, kriged estimates of metal soil concentrations were developed by ARCO and used to estimate exposure and hazard quotients to wildlife receptors on the site. The geometric mean of metal concentrations in the soils of the reference location was used to estimate a "background", or reference exposure for site comparisons to unimpacted sites (Table 4). The kriged estimates of soil concentrations from 70 acre blocks of throughout the Anaconda Smelter Site were used as the soil concentrations for each COC. In this re-evaluation, site-specific data collected by EPA in 1995 were used to derive plant BAFs, while BAFs recommended by ENSR Toxicology (ENSR 1997) and derived from empirical data on the Kennecott Utah Copper mine site in Utah were used for invertebrates and small mammals. Finally, small bird BAFs were calculated from the scientific literature.

Third, daily ingestion rates of each food item are estimated by multiplying the respective dietary fractions of each food type (expressed as a percentage of the total dietary intake, %FR, Table 1) by the total daily ingestion rate ($kg_{food}/kg_{body\ weight}$/day, IR, Table 1) of the wildlife receptor.

Food Items for Red Fox	**%FR**		**IR (kg/kg/day)**	**Respective Dietary Intake of Items (kg/kg/day)**
invertebrates	0.04	*	.095	= 3.8 x 10^{-03}
plants	0.17	*	.095	= 1.6 x 10^{-02}
sm mammals	0.64	*	.095	= 6.1 x 10^{-02}
sm birds	0.14	*	.095	= 1.3 x 10^{-02}
soil	0.03	*	.095	= 2.8 x 10^{-03}

Fourth, for any COC-receptor combination (in this example for the red fox), the daily dose from each prey item is estimated from multiplying the tissue concentration (ppm) by the daily ingestion rate (kg/kg/day):

Food Items for Red Fox		**Intake of Respective Dietary Items (kg/kg/day)**	**Dose**
invertebrate TC	x	3.8 x 10^{-03}	dose from invertebrates
plant TC	x	1.6 x 10^{-02}	dose from plants
small mammal TC	x	6.1 x 10^{-02}	dose from small mammals
small bird TC	x	1.3 x 10^{-02}	dose from small birds
soil concentration	x	2.8 x 10^{-03}	dose from soil
			Total Dose

The estimated total daily dose (mg/kg/day) to the fox is the sum of daily doses from each food item.

2.1.2 HAZARD QUOTIENT AND HAZARD INDEX CALCULATION

As one estimated expression of risk, a hazard quotient (HQ) is calculated by comparing the total daily dose from each COC with the appropriate dose-based TRV:

$$\frac{\text{total daily dose to fox from one COC}}{\text{TRV}} = \text{HQ}$$

TRVs represent the toxicity of the COC to wildlife receptors, and were obtained from a review of the literature. The TRVs represent no-observed-adverse-effects-levels (NOAELs) and lowest-observed-adverse-effects-levels (LOAELs) from the studies reviewed. Uncertainty factors (Hoff and Henningsen, 1998; see Attachment 1) are then applied to literature values to derive the extrapolated TRVs for each COC-receptor combination (Attachment 2).

To estimate risks to a given receptor who may be exposed to more than one COC, a hazard index (HI) is calculated, which is the sum of all HQs for a given receptor (i.e., this represents the risk to a particular species from exposure to all COCs). Since these metals act with different toxic modes of action, the net result of the risk from the mixture of metals may be far less than additive, and potentially antagonistic. However, it is difficult to exclude the possibility of "more-than-additive" and synergistic interactions among the metals without more empirical data that currently exists in the toxicological literature. The current document, therefore, considers the current methodology of assumed additivity as a reasonably conservative approach.

3.0 MODELED ESTIMATES OF RISKS THROUGH DIETARY EXPOSURE (RESULTS)

3.1 MODELED ESTIMATES OF RISK FROM REFERENCE SOILS

Using the geometric mean of reference soil concentrations for each COC, HIs for wildlife receptors ranged from 1.8 to 8.58 for NOAEL, and 0.648 to 4.17 for LOAEL TRV comparisons with estimated doses (Table 5). The elevated reference HIs were primarily due to lead. For example, the LOAEL HI for robins, kestrels and red fox were 2.38, 2.97, and 4.17, respectively. The respective HQ values contributing to these HIs from lead were 1.4 (59% of HI value), 2.75 (97% of HI value) and 3.56 (85% of HI value). If it were not for lead, hazard indices from the reference soils would all range below 1 (0.22 to 0.98). This generally indicates that TRVs and exposure parameters for compounds, other than lead, were generally not extremely and/or unreasonably conservative. Most likely, the elevated reference HQs from lead are coming from the TRV, rather than the exposure parameters. The TRV for birds was derived from an avian study (Edens and Garlich 1983), in which chickens were administered lead as lead acetate. This form of lead is much more bioavailable than mineralogic forms of lead found in natural settings or in mining waste. Likewise, the TRV derived for red fox was from a 60 year old dog dosing study also utilizing lead acetate as the chemical form for dosing.

3.2 MODELED ESTIMATES OF RISK FROM ANACONDA SITE SOILS

Hazard quotients, derived in the model from Anaconda Site soils (Table 6), were generally highest for the American robin, followed by the deer mouse >American kestrel > red fox > white-tailed deer. Similar to the reference soils, lead HQs were greatest for the red fox, kestrel and robin. If risks from lead are inflated because of poor toxicity data in the literature, arsenic and copper appear to be contributing most of the risk in the HQ-summed hazard indices (Table 7).

3.3 MODELED ESTIMATES OF RELATIVE SITE RISK COMPARED WITH REFERENCE SOILS

3.3.1 ESTIMATES OF RELATIVE HAZARD INDICES

3.3.1.1 American Robin

Relative Hazard indices range from >0 to < 99.9 for both the $\mathrm{NOAEL}_{\mathrm{TRV}}$ and the $\mathrm{LOAEL}_{\mathrm{TRV}}$ with the highest fold increase in predicted risk in areas nearest the smelter (Figures 1a and 1b respectively). Uncertainty factors used in the development of TRVs ranged from 3-5, indicating toxicological insensitivity in noting increases of risk for individual metals up to 5-fold that of background (assuming Robins would have equal sensitivity with literature values used in the extrapolation). Average relative increases of arsenic, cadmium, and copper HQs were approximately 21, 5, and 7-fold background (Table 8), and thus, still predict risks above those which could be associated with a highly conservative TRV because of uncertainty factor extrapolation.

Exposure factors for the Robin were all central tendency estimates. As for all receptors, no reasonable maximum, or maximum exposure factors were used in the model. Therefore, although some individuals may be exposed less than predicted, strong arguments could be made for possibilities of seasonal increases in factors such as ingestion rates, body weights, etc. which all influence the dose. It is reasonable, therefore, to consider that the relative increases in risk are within the range of sensitivity able to be distinguished by the model in estimating exposure relative to background.

Bioaccumulation factors are potentially the biggest source of error in the model. Although site-specific information was used when possible and empirical data were used from another copper mining site, either small sample sizes were available for BAF derivitization, or uptake by biological matrices was highly variable, thereby decreasing the ability for accurate predictions of dose. The use of data from another site, estimating uptake of metals from co-located biological and soil samples, although less uncertain than predictive models designed to do the same, may have also either under- or over-estimated exposure depending on site soil characteristics influencing bioavailability of arsenic and metals for biotic uptake. These uncertainties alone may have up to a 10-, or greater, fold difference in actual uptake and exposure to the robin, or other insectivorous birds. The potential model error using bioaccumulation factors to estimate concentrations in dietary items therefore decrease the sensitivity of the model in the estimate of predicted risk.

The combined sensitivity of toxicity uncertainty (up to 5-fold) and exposure (assumed 10-fold) make the model insensitive to detecting true differences in risk for up to 50-fold increases in predicted risk on site relative to background. Average individual metal HQs are within this range of insensitivity (approximately 20) and maximum values are well above this range. Most of the model parameter uncertainty lies within estimates of uptake of arsenic and metals in the dietary items of insectivorous avian species.

Final conclusions of relative risk demonstrate that the model is fairly insensitive to sufficiently demonstrate significant differences above background. Relative HIs, however, are elevated up to 100-fold above background and can not be completely discounted. Predictions of absolute risk estimates will be useful in helping refine pertinent data needs to reduce the uncertainty in exposure.

3.3.1.2 American Kestrel

Relative Hazard indices range from >0 to < 99.9 for both the $NOAEL_{TRV}$ and the $LOAEL_{TRV}$ with the highest fold increase in predicted risk in areas nearest the smelter (Figures 2a and 2b respectively). Uncertainty factors used in the development of TRVs ranged from 3 to 5, indicating an inability to note increases of risk for individual metals up to 5-fold that of background, assuming kestrels would have equal sensitivity with literature values used in the extrapolation. Copper, arsenic, and cadmium have approximately 19-, 20-, and 6-fold relative increases in HQs above background (Table 8). Thus, these metals still predict risks above those which could be associated with a highly conservative TRV because of uncertainty factor extrapolation.

Exposure factors for the Kestrel were all central tendency estimates. As for all receptors, no reasonable maximum, or maximum exposure factors were used in the model. Therefore, although some individuals may be exposed less than predicted, strong arguments could be made for possibilities of seasonal increases in factors such as ingestion rates, body weights, etc. which all influence the dose. It is reasonable, therefore to consider the relative increases in risk are within the range of sensitivity able to be distinguished by the model in estimating exposure relative to background.

Bioaccumulation factors are potentially the biggest source of error in the model. Although site-specific information were used when possible and empirical data were used from another copper mining site, either small sample sizes were available for their derivitization, or uptake by biological matrices was highly variable, thereby decreasing the ability for accurate predictions of dose. The use of data from another site, estimating uptake of metals from co-located biological and soil samples, although less uncertain than predictive models designed to do the same, may have also either under- or over-estimated exposure depending on site soil characteristics influencing bioavailability of arsenic and metals for biotic uptake. These uncertainties alone may have up to a 10-, or greater, fold difference in actual uptake and exposure to the robin, or other insectivorous birds. The potential model error using bioaccumulation factors to estimate concentrations in dietary items therefore decrease the sensitivity of the model in the estimate of predicted risk.

The combined sensitivity of toxicity uncertainty (up to 5-fold) and exposure (assumed 10-fold) make the model insensitive to detecting true differences in risk from 1- to 50-fold increases in predicted risk on site relative to background. Average individual metal HQs are within this range of insensitivity (5-20) and maximum values are well above this range. Most of the model parameter uncertainty lies within estimates of uptake of arsenic and metals in the dietary items of omnivorous avian species.

Final conclusions of relative risk demonstrate that the model is fairly insensitive to sufficiently demonstrate significant differences above background. Relative HIs, however, are elevated up to 100-fold above background and can not be completely discounted. Predictions of absolute risk estimates will be useful in helping refine pertinent data needs to reduce the uncertainty in exposure.

3.2.1.3 White-tailed Deer

Relative Hazard indices range from >0 to < 99.9 for both the $NOAEL_{TRV}$ and the $LOAEL_{TRV}$ with the highest fold increase in predicted risk in areas nearest the smelter (Figures 3a and 3b respectively). In comparison with the robin and kestrel, the amount of area having relative risks 10- to 99-fold above background is much smaller. Uncertainty factors used in the development of TRVs ranged from 0.2 to 4, indicating an inability to note increases of risk for individual metals up to 4-fold that of background assuming white-tailed deer would have equal sensitivity with literature values used in the extrapolation. Relative increases in arsenic, cadmium, copper, and zinc HQs were approximately 3-, 5-, 3-, and 5-fold background (Table 8), respectively. Thus, site HQs still predict risks above those which could be associated with a highly conservative TRV because of uncertainty factor extrapolation.

Exposure factors for the white-tailed deer were all central tendency estimates. As for all receptors, no reasonable maximum, or maximum exposure factors were used in the model. Therefore, although some individuals may be exposed less than predicted, strong arguments could be made for possibilities of seasonal increases in factors such as ingestion rates, body weights, etc. which all influence the dose. It is reasonable, therefore to consider the relative increases in risk are within the range of sensitivity able to be distinguished by the model in estimating exposure relative to background.

Compared to the kestrel and robin, bioaccumulation factors may not be as large a source of error in the model. Site-specific information was used exclusively in estimating BAFs for exposure estimates primarily of arsenic and metals in vegetation. In fact, when no clear mathematical relationship between vegetation and soils metal concentrations were apparent, average BAFs were used which do not necessarily reflect the highest concentrations of metals on vegetation in close proximity to tailings where there is evidence of surficial deposition of metals not reflected in "average" concentrations. Variability of metals concentrations in vegetation generally ranged within an order of magnitude (1- to 10-fold differences).

The combined sensitivity of toxicity uncertainty (up to 4-fold) and exposure (assumed 1- to10-fold) make the model insensitive to detecting true differences in risk ranging from 4- to 40-fold increases in predicted risk on site relative to background. Average individual metal HQs (5) are within this range of insensitivity, and maximum values are well above this range.

Final conclusions of relative risk demonstrate that the model could be more sensitive than the robin and kestrel models to sufficiently demonstrate significant differences above background. If there truly is an uncertainty range of only 4-fold sensitivity for any given COC, relative HIs 100-fold above background perhaps indicate a more meaningful model. In particular, the area use factor used for all receptors in this analysis was 1. That is, t Predictions of absolute risk estimates will be useful in helping refine pertinent data needs to reduce the uncertainty in exposure more likely to be due to exposure factors than actual concentrations in dietary items. he receptor did not use areas outside the 70 acre cell. This is most likely an over-conservative assumption for the deer who would range in and out of these cell sizes, potentially diluting their exposures over time.

3.3.1.4 Deer Mouse

Relative hazard indices range from >0 to < 99.9 for both the $NOAEL_{TRV}$ and the $LOAEL_{TRV}$ with the highest fold increase in predicted risk in areas nearest the smelter (Figures 4a and 4b respectively), but compared to the other receptors, include a large portion of the site area. Uncertainty factors used in the development of TRVs ranged from 0.3-9, indicating an inability to note increases of risk for individual metals up to 9-fold that of background assuming deer mice would have equal sensitivity with literature values used in the extrapolation. Relative increases in arsenic and copper HQs were approximately 20- and 15-fold above background (Table 8), respectively. Thus, Site HQs still predict risks above those which could be associated with a highly conservative TRV because of uncertainty factor extrapolation.

Exposure factors for the deer mouse were all central tendency estimates. As for all receptors, no reasonable maximum, or maximum exposure factors were used in the model. Therefore, although some individuals may be exposed less than predicted, strong arguments could be made for possibilities of seasonal increases in factors such as ingestion rates, body weights, etc. which all influence the dose. It is reasonable, therefore to consider the relative increases in risk are within the range of sensitivity able to be distinguished by the model in estimating exposure relative to background.

Bioaccumulation factors are potentially the biggest source of error in the model. Although site-specific information was used when possible (in this case for vegetation) and empirical data were used from another copper mining site, either small sample sizes were available for their derivitization, or uptake by biological matrices of arsenic and metals was highly variable, thereby decreasing the ability for accurate predictions of dose. The use of data from another site, estimating uptake of metals from co-located biological and soil samples, although less uncertain than predictive models designed to do the same, may have also either under- or over-estimated exposure depending on site soil characteristics influencing bioavailability of arsenic and metals for biotic uptake. In the case of the deer mouse eating terrestrial invertebrates, it is unknown whether similar terrestrial invertebrates exist on Anaconda compared to the Kennecott site in which the BAF was calculated. These uncertainties alone may have up to a 10-, or greater, fold difference in actual uptake and exposure to the robin, or other insectivorous birds. The potential model error using bioaccumulation factors to estimate concentrations in dietary items therefore decrease the sensitivity of the model in the estimate of predicted risk.

The combined sensitivity of toxicity uncertainty (up to 9-fold) and exposure (assumed 10-fold) make the model insensitive to detecting true differences in risk from 1- to 90-fold increases in predicted risk on site relative to background. Average individual metal HQs (15 to 20), however, are in this range of insensitivity and maximum values are above this range. With deer mice, significant uncertainty lies both within the toxicity and the exposure functions.

Final conclusions of relative risk demonstrate that the model is insensitive to sufficiently demonstrate significant differences above background. Relative HIs, however, are elevated up to 100-fold above background which exists on a large portion of the site and can not be completely discounted. Predictions of absolute risk estimates will be useful in helping refine pertinent data needs to reduce the uncertainty in exposure.

3.3.1.5 Red Fox

Relative Hazard indices range from >0 to < 99.9 for both the $\mathrm{NOAEL}_{\mathrm{TRV}}$ and the $\mathrm{LOAEL}_{\mathrm{TRV}}$ with the highest fold increase in predicted risk in areas nearest the smelter (Figures 5a and 5b, respectively). Uncertainty factors used in the development of TRVs ranged from 3 to 5, indicating an inability to note increases of risk for individual metals up to 5-fold that of background assuming red fox would have equal sensitivity with literature values used in the extrapolation. Relative increases in copper, arsenic, and cadmium HQs were approximately 16-, 18-, and 4-fold background (Table 8) values. Thus, HQs still predict risks above those which could be associated with a highly conservative TRV because of uncertainty factor extrapolation.

Exposure factors for the red fox were all central tendency estimates. As for all receptors, no reasonable maximum, or maximum exposure factors were used in the model. Therefore, although some individuals may be exposed less than predicted, strong arguments could be made for possibilities of seasonal increases in factors such as ingestion rates, body weights, etc. which all influence the dose. It is reasonable, therefore to consider the relative increases in risk are within the range of sensitivity able to be distinguished by the model in estimating exposure relative to background.

Bioaccumulation factors are potentially the biggest source of error in the model. Although site-specific information was used when possible and empirical data were used from another copper mining site, either small sample sizes were available for their derivitization, or uptake by biological matrices was highly variable, thereby decreasing the ability for accurate predictions of dose. The use of data from another site, estimating uptake of metals from co-located biological and soil samples, although less uncertain than predictive models designed to do the same, may have also either under- or over-estimated exposure depending on site soil characteristics influencing bioavailability of arsenic and metals for biotic uptake. These uncertainties alone may have up to a 10-, or greater, fold difference in actual uptake and exposure to the robin, or other insectivorous birds. The potential model error using bioaccumulation factors to estimate concentrations in dietary items therefore decrease the sensitivity of the model in the estimate of predicted risk.

The combined sensitivity of toxicity uncertainty (up to 5-fold) and exposure (assumed 10-fold) make the model insensitive to detecting true differences in risk for up to 50-fold increases in predicted risk on site relative to background. Average individual metal HQs (15 to 16) are within this range of insensitivity and maximum values are well above this range. Most of the model parameter uncertainty lies within estimates of uptake of arsenic and metals in the dietary items of this carnivorous mammalian species. Similar to the white-tailed deer, the assumption of 100% area use within the 70 acre area of kriged polygons of estimated soil concentrations, most likely overestimates risks in some areas. Home range areas for red fox have been known to vary from

50 to 3,000 ha (124 to 7,400 acres) depending on prey abundance and habitat (EPA 1993). With the lack of vegetative habitat and, therefore, probable low prey abundance, home ranges on the Anaconda site most likely are quite larger than the assumed 70 acres. Exposures are, therefore, more likely to be much more diluted than predicted in the current model.

Final conclusions of relative risk demonstrate that the model is fairly insensitive to sufficiently demonstrate significant differences above background. Relative HIs, however, are elevated up to 100-fold above background and can not completely discounted. Predictions of absolute risk estimates will be useful in helping refine pertinent data needs to reduce the uncertainty in exposure.

3.3.2 ESTIMATES OF ABSOLUTE HAZARD INDICES

Although relative increases of risk are useful in describing the sensitivity of the model and identifying TRVs with poor toxicity information, estimates of absolute risk (Table 9, HI_{site}-$HI_{reference}$) are more useful for prioritizing the geographic areas, contaminants and pathways of concern for wildlife receptors. For the following discussion, only the comparisons of central tendency estimates of exposure with LOAEL TRVs are discussed. This comparison is the least conservative predictor of risks (as opposed to maximum exposure estimates compared with the NOAEL TRV), but is focused on here because the relative increases in risk described above indicated that all receptors lie within the range of insensitivity of the model to accurately predict risk to wildlife receptors. Therefore, some type of site-investigation is warranted to reduce uncertainties in either exposure or toxicity. Since site-specific data are needed to validate predictive models, the least conservative methods for estimates of risk are used to help identify the highest priorities.

3.3.2.1 Priortization of Geographical Areas of Concern

The site was portioned into 4 general areas (Figures 1c and 1d through 5c and 5d): Old Works/Stucky Ridge, North Opportunity, Smelter Hill and South Opportunity. For nearly all receptors, Smelter Hill had the highest HIs (Table 10, Figures 1c and 1d through 5c and 5d). The decreasing order of prioritized general geographic risk areas for most receptors were generally Smelter Hill > North Opportunity > Old Works/Stucky Ridge > South Opportunity (Table 11). Red fox was the only receptor in which Smelter Hill did not predict the HQ values. This finding is again related to the estimated effects from lead exposure. Elevated HQ values from lead were more pronounced in areas further away from the smelter stack.

3.3.2.2 Priortization of Chemicals of Concern

For robins, kestrels, and red fox, the largest absolute HQs were from exposures to lead. After considering the relative increases in risk for these receptors from lead, however, it is likely that these estimates of risk were elevated because of overly conservative TRVs. Its important to note that background HQs for these receptors exposed to lead were 1.4, 2.8, and 3.6 respectively (Table 5) and the average site HQs for all receptors were only approximately 3-fold background with TRV uncertainty factors of 5. Concurrently, average site arsenic and copper HQs for robin, kestrels, and fox were 21, 20, and 15, and 7, 20, and 15 above background HQs, respectively

(Table 8). Copper and arsenic background HQs were all well below 1 and uncertainty factors with the TRVs were 5 or less.

Following lead, arsenic and copper all had the highest average (Table 9) and maximum HQs (Table 6) for all receptors. Generally, cadmium and zinc are relatively small contributors to the overall HI. The largest absolute estimated HQ was deer mice and fox exposed to arsenic, followed by robins and kestrels exposed to copper.

Overall, arsenic and copper appear to be the primary contaminants of concern with a great deal of uncertainty associated with lead HQs (Table 7).

3.3.2.3 Priortization of Pathways of Exposure

Robins and deer mice were predicted to have approximately 56% and 71% of their metal exposure through ingestion of terrestrial invertebrates and 24% and 22% of their exposures coming from seeds and vegetation (Table 10). Kestrels and red fox were predicted to have approximately 72% and 94% of their metal exposure through ingestion of small mammals. Kestrels were predicted to be exposed an additional 23% through terrestrial invertebrates. Incidental soil ingestion was only predicted to be a significant portion of metals exposures to robins (20%), as they forage on earthworms. Vegetation was the primary exposure route for white-tailed deer only.

Overall, terrestrial invertebrates were predicted to be either the primary or secondary route of exposure for insectivorous passerines, omnivorous raptors, omnivorous small mammals and omnivorous carnivores (Table 12). Small mammals were primary routes of metal exposure for tertiary consumers such as the fox and kestrel.

4.0 UNCERTAINTIES

There are a number of uncertainties associated with any risk assessment because of the assumptions used throughout the assessment process to determine the chemicals, pathways, and receptors that drive the risk. Uncertainties associated with estimating risks to wildlife receptors at the Anaconda Smelter Site are related to the chosen receptors, estimates of exposure, the TRVs used, estimates of background soil concentrations, and use of kriged soil data. Each of these is discussed below.

4.1 UNCERTAINTIES ASSOCIATED WITH THE SELECTED RECEPTORS

It is impossible to assess potential risks to all species known or expected to occur at the site. However, the receptors selected for risk analysis (i.e., deer mouse, American robin, white-tailed deer, American kestrel, and red fox) were chosen to be representative of the different trophic levels of the food chain at the Anaconda Smelter Site (Attachment 3). Specific feeding habits, food items, and body weights for these receptors were incorporated into estimates of exposure. While this reduces the uncertainty of estimating the risk to these receptors and to representatives of each trophic level, there are other species at the site that have different feeding strategies, different exposure scenarios, and/or different threshold effects concentrations. This could result in either an over- or under-estimate of risks for those other receptors at the Anaconda Smelter Site.

4.2 UNCERTAINTIES ASSOCIATED WITH ESTIMATES OF EXPOSURE

The estimate of exposure for each receptor incorporates numerous parameters, for which site-specific data were not available, making it necessary to use literature-derived estimates or default values. Specifically, dietary composition, dietary fractions, daily ingestion rates, and body weights were obtained from the literature. Actual values for these parameters under site-specific conditions may be higher or lower than the reported literature values, leading to either an over- or under-estimate of risks.

In the absence of measured concentrations in food and prey items (i.e., except for vegetation samples used to assess potential risks to herbivores via that particular source/pathway), BAFs were used to model tissue concentrations in these items. This leads to uncertainty regarding actual tissue concentrations at the site, since BAFs obtained from the literature may not reflect actual site conditions. Literature-derived values do not account for site- or regional-specific variances in behavior and feeding strategies, seasons, food availability, or body size. To reduce this uncertainty, site-specific BAFs were used to estimate tissue concentrations in invertebrates and small mammals, while the remaining BAFs were obtained from other mining sites or from the literature. For small mammals site-specific data for small mammals collected by ARCO were used for the BAF. It is likely that the parameters used to estimate exposure could result in an over-estimate of risk for some species and an under-estimate of risk for others at the site; however, it is unlikely that risks to the selected receptors have been underestimated due to the conservative nature of the exposure parameters.

The kriged soil values were used to estimate exposure to each receptor at each 70 acre grid cell. Since each value represents an estimate of the soil concentration in each grid cell, there could be hot spots within the 70 acres that are not identified by the kriging. Likewise, there could be areas within these 70 acre parcels that have soil COC concentrations that are significantly lower than the kriged value. As a result, the use of estimated soil concentrations could potentially result in an under-estimation of risk in some areas and an over-estimation of risk in other areas.

The food chain exposure model assumes 100% bioavailability of the metals that are ingested. Actual site-specific conditions may bind the metals to the soil or render the metals insoluble in other ways, thereby reducing bioavailability. As a result, the food chain model may over-estimate risks to the selected receptors; it is unlikely that risks to the selected receptors have been underestimated via the food chain analysis.

4.3 UNCERTAINTIES ASSOCIATED WITH THE TRVs

Effects data in the literature are generally based on species other than those selected as receptors for the Anaconda Smelter Site. In addition, all toxicological studies are not conducted in the same way, may be conducted under field or laboratory conditions, and may have differing durations, endpoints, or dose levels. Uncertainties are associated with each of these factors when deriving TRVs. Because of these and other factors, EPA Region VIII reviewed all available wildlife toxicological literature and derived the best possible TRVs for use throughout Region VIII (Attachment 2). These new TRVs incorporate uncertainty factors to account for interspecies extrapolations, study endpoints, and site-specific modifying factors. These uncertainty factors were incorporated into the literature-derived NOAELs and LOAELs to derive the TRVs for use at the Anaconda Smelter Site. While this approach may have a tendency to overestimate risks, given the magnitude of risks elevated above background as shown on some of the risk maps, the estimated risk values are useful for identifying those areas of highest concern for risks to wildlife.

4.4 UNCERTAINTIES ASSOCIATED WITH ESTIMATES OF BACKGROUND SOIL CONCENTRATION

It is assumed that background soil concentrations are representative of actual conditions in an area comparable to the Anaconda Smelter Site in pre-smelting condition. If the control sites were neither adequately selected nor characterized, this could result in either an over- or under-estimation of risks relative to background conditions.

5.0 REFERENCES

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TABLES

TABLE 1

Assumptions Used in the Food Web Model

Species	Variable	Value	Reference
American Robin home range: 0.25 ha (0.62 acres)	resident in Montana	0.75 year	Jones 1990
	dietary fraction: plants invertebrates soil	 0.36 0.64 0.02	EPA 1993
	ingestion rate	0.89 kg/kg-d	EPA 1993
	body weight	0.081 kg	EPA 1993
Deer Mouse home range: 0.11 ha (0.27 acres)	dietary fraction: invertebrates plants soil	 0.45 0.55 0.02	EPA 1993
	ingestion rate	0.27 kg/kg-d	EPA 1993
	body weight	0.21 kg	EPA 1993
Red Fox home range: 1,571 ha (3,881 acres)	dietary fraction: invertebrates plants mammals birds soil	 0.04 0.17 0.64 0.14 0.03	EPA 1993
	ingestion rate	0.095 kg/kg-d	EPA 1993
	body weight	4.5 kg	EPA 1993
White-tailed Deer home range: 200 ha (482 acres)	dietary fraction: plants soil	 1 0.02	PTI 1994
	ingestion rate	0.0312 kg/kg-d	PTI 1994
	body weight	125 kg	PTI 1994
American Kestrel home range: 202 ha (499 acres)	dietary fraction: invertebrates mammals birds soil	 0.33 0.33 0.33 0.02	EPA 1993
	ingestion rate	0.3 kg/kg-d	EPA 1993
	body weight	0.119 kg	EPA 1993

TABLE 2

Representative Bioaccumulation Factors Used at Various Montana Superfund Sites

Chemical	Plant BAF[1] Used in the Anaconda BERA (wet weight)	Plant BAF[2] Used by ARCO for the Clark Fork River Screening ERA	Plant BAF Using 1995 Soil and Plant Data Collected by EPA	Invertebrate[3] BAF Used in the Anaconda BERA	Invertebrate BAF[2] Used by ARCO for the Clark Fork River Screening ERA	Small Mammal BAF[4] Used in the Anaconda BERA	Small Mammal BAF[2] Used by ARCO for the Clark Fork River Screening ERA	Small Bird BAF[5] Used in the Anaconda BERA
Arsenic	9.94E-03	8.50E-02	varies by COC; see Table 3	1.50E-01	3.70E-01	1.64E-03	1.10E-01	1.78E-03
Cadmium	4.86E-02	1.40E-01		2.15E-01	5.90E-01	3.45E-02	2.00E-01	4.90E-04
Copper	6.75E-03	(0.719-(0.235*(log10[soil])))		1.03E-01	(0.086+(exp(4.667+(-2.816*(log10[soil])))))	2.69E-02	4.70E-01	8.90E-03
Lead	6.82E-03	2.50E-02		1.99E-02	3.80E-02	7.50E-03	1.27E+00	2.67E-04
Zinc	8.40E-02	1.00E-01		2.35E-01	(5.95-(2.07*(log10[soil])))	2.85E-01	(1.25-(0.0042*[soil]))	8.90E-02

Values in shaded areas represent BAF values incorporated following ARCO's comments on the Final BERA.

[1] Calculated from ARCO data collected along Warm Springs Creek (PTI 1994)

[2] Based on data collected at the Kennecott Copper Smelter Site (ENSR 1996)

[3] BAFs for As, Cd, Cu, and Zn based on earthworm and soil data collected at Milltown Reservoir (ManTech 1991)
BAF for Pb based on data collected by ARCO (PTI 1994)

[4] Calculated from ARCO data collected along Warm Springs Creek (PTI 1994)

[5] Calculated from data provided in Baes 1984

TABLE 3

Comparison of Plant BAFs Used in the Final Food Chain Model and Plant BAFs Developed from the EPA 1995 Collection of Plants and Soils Anaconda Ecological Risk Assessment

Chemical	Plant BAF[1] Used in Final BERA (based on wet weight)	Herbaceous Plant BAF[2] Developed in Response to ARCO Comments (based on wet weight)	Shrub BAF[2] Developed in Response to ARCO Comments (based on wet weight)
Arsenic	9.94E-03	8.00E-02	2.448[soil]-0.805
Cadmium	4.86E-02	$0.6949[\text{soil}]^{-0.687}$	8.70E-01
Copper	6.75E-03	1.20E-01	$5.2025[\text{soil}]^{-0.7381}$
Lead	6.82E-03	$0.8754[\text{soil}]^{-0.5057}$	$1.212[\text{soil}]^{-0.7132}$
Zinc	8.40E-02	$5.0557[\text{soil}]^{-0.5087}$	5.80E-01

Values in shaded areas represent BAF values incorporated following ARCO's comments on the Final BERA.

Source of data for deriving BAF:

[1] Calculated from data presented in PTI Regional Ecorisk Field Investigation 1994

[2] Calculated from co-located soil and plant data collected by EPA in 1995

TABLE 4

Regional Background Soil Metal Concentrations (mg/kg) for Montana Communities[1]

	Arsenic	Cadmium	Copper	Lead	Zinc
Sample Size	19	19	12	19	13
Geometric Mean	9.3	0.9	22.4	35.7	66.1
Geometric Standard Deviation	2.88	2.64	1.5	4.1	1.3
Lower 95% Confidence Limit	5.6	0.5	17.2	18.1	56
Upper 95% Confidence Limit	15.5	1.4	29.1	70.4	78

[1] From Table 2-3 of the Anaconda Regional Soils Remedial Investigation Report, PTI 1996.

TABLE 5

Hazard Quotients and Indices of Wildlife Receptors on Reference Soils for the Anaconda Smelter Site

Receptor	Contaminant of Concern											
	Arsenic		Cadmium		Copper		Lead		Zinc		Hazard Index	
	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
American Robin	0.163	0.091	1.840	0.132	1.010	0.547	2.830	1.420	1.090	0.273	6.93	2.38
American Kestrel	0.038	0.002	0.245	0.018	0.264	0.142	5.500	2.750	0.246	0.062	6.29	2.97
White-tailed Deer	0.952	0.313	0.276	0.096	0.295	0.118	0.115	0.038	0.165	0.083	1.80	0.648
Deer Mouse	1.030	0.387	0.206	0.100	0.210	0.104	0.498	0.163	0.594	0.297	2.54	1.05
Red Fox	1.360	0.453	0.056	0.028	0.153	0.105	6.950	3.650	0.068	0.023	8.58	4.17

TABLE 6

Summary Statistics of Hazard Quotients for Wildlife Receptors at the Anaconda Smelter Site

Receptor	Contaminant of Concern									
	Arsenic		Cadmium		Copper		Lead		Zinc	
	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
American Robin										
MEAN	3.4	1.9	9.3	0.7	6.8	3.7	7.4	3.7	1.9	0.5
MIN	0.5	0.3	0.2	0.0	0.0	0.0	1.7	0.6	0.0	0.0
MAX	31.9	17.7	83.4	6.0	68.3	36.9	40.0	20.0	2.4	0.6
STD	3.3	1.8	8.6	0.6	7.0	3.7	5.2	2.6	0.7	0.2
American Kestrel										
MEAN	0.8	0.4	1.3	0.1	5.0	2.7	19.5	9.7	0.0	0.0
MIN	0.1	0.1	0.0	0.0	0.0	0.0	2.5	1.2	0.0	0.0
MAX	7.5	4.2	11.1	0.6	60.1	32.7	127	63.5	0.4	0.1
STD	0.8	0.4	1.1	0.1	6.2	3.3	16.7	8.3	1.4	0.4
White-tailed Deer										
MEAN	2.7	0.9	1.4	0.5	0.6	0.4	0.2	0.1	0.7	0.4
MIN	1.3	0.4	0.0	0.0	0.0	0.0	0.1	0.0	0.2	0.1
MAX	13.7	4.5	12.1	4.2	4.6	1.9	0.7	0.2	4.6	2.3
STD	1.4	0.5	1.2	0.4	0.5	0.2	0.1	0.1	0.6	0.3
Deer Mouse										
MEAN	20.1	7.5	0.7	0.3	3.2	1.6	1.2	0.4	0.9	0.5
MIN	3.0	1.1	0.1	0.0	0.0	0.0	0.3	0.1	0.0	0.0
MAX	189	71.0	4.7	2.3	38.7	19.1	5.3	1.7	1.1	0.6
STD	19.5	7.3	0.5	0.2	3.9	1.9	0.7	0.2	0.4	0.2
Red Fox										
MEAN	18.7	8.2	0.3	0.1	2.4	1.7	24.3	12.5	0.0	0.0
MIN	3.3	1.1	0.0	0.0	0.0	0.0	3.2	1.6	0.0	0.0
MAX	171	57.0	2.6	1.3	28.7	19.7	158	80.9	0.1	0.0
STD	17.6	5.9	0.3	0.1	2.9	2.0	20.7	10.6	0.6	0.0

TABLE 7

Prioritized Contaminants of Concern
Influencing the Hazard Indices of Wildlife Receptors
at the Anaconda Smelter Site

Receptor	Contaminant of Concern				
	Arsenic	Cadmium	Copper	Lead	Zinc
American Robin	1	RSC	1[a]	1	RSC
American Kestrel	RSC	RSC	2	1	RSC
White-tailed Deer	1	2	4	RSC	3
Deer Mouse	1	RSC	2	RSC	RSC
Red Fox	2	RSC	3	1	RSC

[a] contaminants with same ranking number are approximately equal contributors to the HI

RSC=relatively small contributor

TABLE 8

Relative (Average Site HQ/Reference HQ) Increases in Hazard Quotients for Selected Wildlife Species at the Anaconda Smelter Site

Receptor	Contaminant of Concern									
	Arsenic		Cadmium		Copper		Lead		Zinc	
	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
American Robin	20.9	20.9	5.1	5.3	6.7	6.8	2.6	2.6	1.7	1.8
American Kestrel	21.1	20.0	5.3	5.6	18.9	19.0	3.5	3.5	0.0	0.0
White-tailed Deer	2.8	2.9	5.1	5.2	2.0	3.4	1.7	2.6	4.2	4.8
Deer Mouse	19.5	19.4	3.4	3.0	15.2	15.4	2.4	2.5	1.5	1.7
Red Fox	13.8	18.1	5.4	3.6	15.7	15.7	3.5	3.5	0.0	0.0

TABLE 9

Predicted (Absolute) (Average Site HQ - Reference HQ) Hazard Quotients for Selected Wildlife Species at the Anaconda Smelter Site

Receptor	Contaminant of Concern									
	Arsenic		Cadmium		Copper		Lead		Zinc	
	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
American Robin	3.2	1.8	7.5	0.6	5.8	3.2	4.6	2.3	0.8	0.2
American Kestrel	0.8	0.4	1.1	0.1	4.7	2.6	14.0	7.0	-0.2	-0.1
White-tailed Deer	1.7	0.6	1.1	0.4	0.3	0.3	0.1	0.1	0.5	0.3
Deer Mouse	19.1	7.1	0.5	0.2	3.0	1.5	0.7	0.2	0.3	0.2
Red Fox	17.3	7.7	0.2	0.1	2.2	1.6	17.4	8.9	-0.1	0.0

TABLE 10

Summary of Predicted (Absolute) Metal-Related Risks to Wildlife Species (Estimated Exposures Compared with LOAELs) at the Anaconda Smelter Site

Receptor	Geographic Area[a]				COC Drivers[b]	Pathways of Concern[c]		
	Old Works/ Stucky Ridge	North Opportunity	Smelter Hill	South Opportunity		Primary	Secondary	Tertiary
American Robin	5 - 99	5 - 99	99	2 - 99	As = Cu = Pb	56% terrestrial invertebrates ± 4	24% vegetation ± 6	20% soil ± 3
American Kestrel	2 - 10	2 - 99	2 - 99	0 - 10	Pb>>Cu	72% small mammals ± 5	23% terrestrial invertebrates ± 5	5% soil ± 0.4
White-tailed Deer	0 - 5	0 - 10	2 - 99	0 - 2	As>Cd>Zn>Cu	81% vegetation ± 6	19% soil ± 6	
Deer Mouse	5 - 99	5 - 99	10 - 99	2 - 99	As>>Cu	71% terrestrial invertebrates ± 3	22% vegetation ± 3	7% soil ± 0.6
Red Fox	10 - 1,000	10 - 1,000	5 - 1,000	2 - 99	Pb>>As>Cu	94% small mammals ± 2	5% terrestrial invertebrates ± 2	1% soil ± 0.1

[a] values are the range of HI values for respective geographic areas listed on the GIS maps
[b] relative contribution of individual COCs as illustrated on GIS map with pie charts
[c] values are average (± standard) percent contribution to HI by dietary items listed in the column

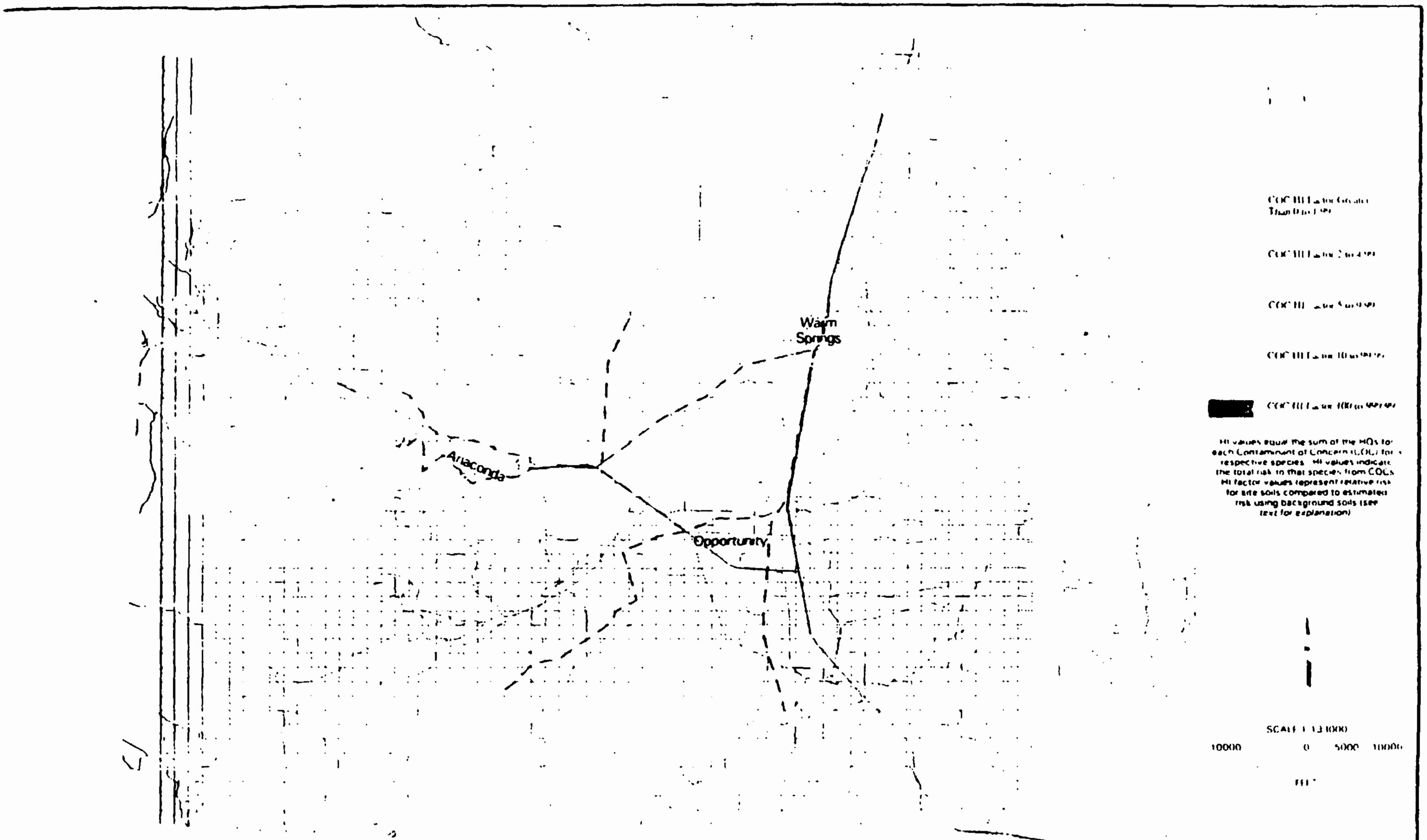
TABLE 11

Prioritized Geographic Areas Influencing the Hazard Indices of Wildlife Receptors at the Anaconda Smelter Site

Receptor	Geographic Area[a]			
	Old Works/ Stucky Ridge	North Opportunity	Smelter Hill	South Opportunity
American Robin	2	2	1	3
American Kestrel	2	1	1	3
White-tailed Deer	3	2	1	4
Deer Mouse	2	2	1	3
Red Fox	1	1	2	3

[a] values represent the ranked order of the magnitude of HI values from respective geographic areas listed on the GIS maps

FIGURES



HI values equal the sum of the HQs for each Contaminant of Concern (COC) for a respective species. HI values indicate the total risk to that species from COCs. HI factor values represent relative risk for site soils compared to estimated risk using background soils (see text for explanation)

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CDM

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American Robin HI Factor Values
(NOAEL)
HI Ratio to Background HI

Figure 1A

HI values equal the sum of the HQs for each Contaminant of Concern (COC) for a respective species. HI values indicate the total risk to that species from COCs. HI factor values represent relative risk for site soils compared to estimated risk using background soils (see text for explanation).

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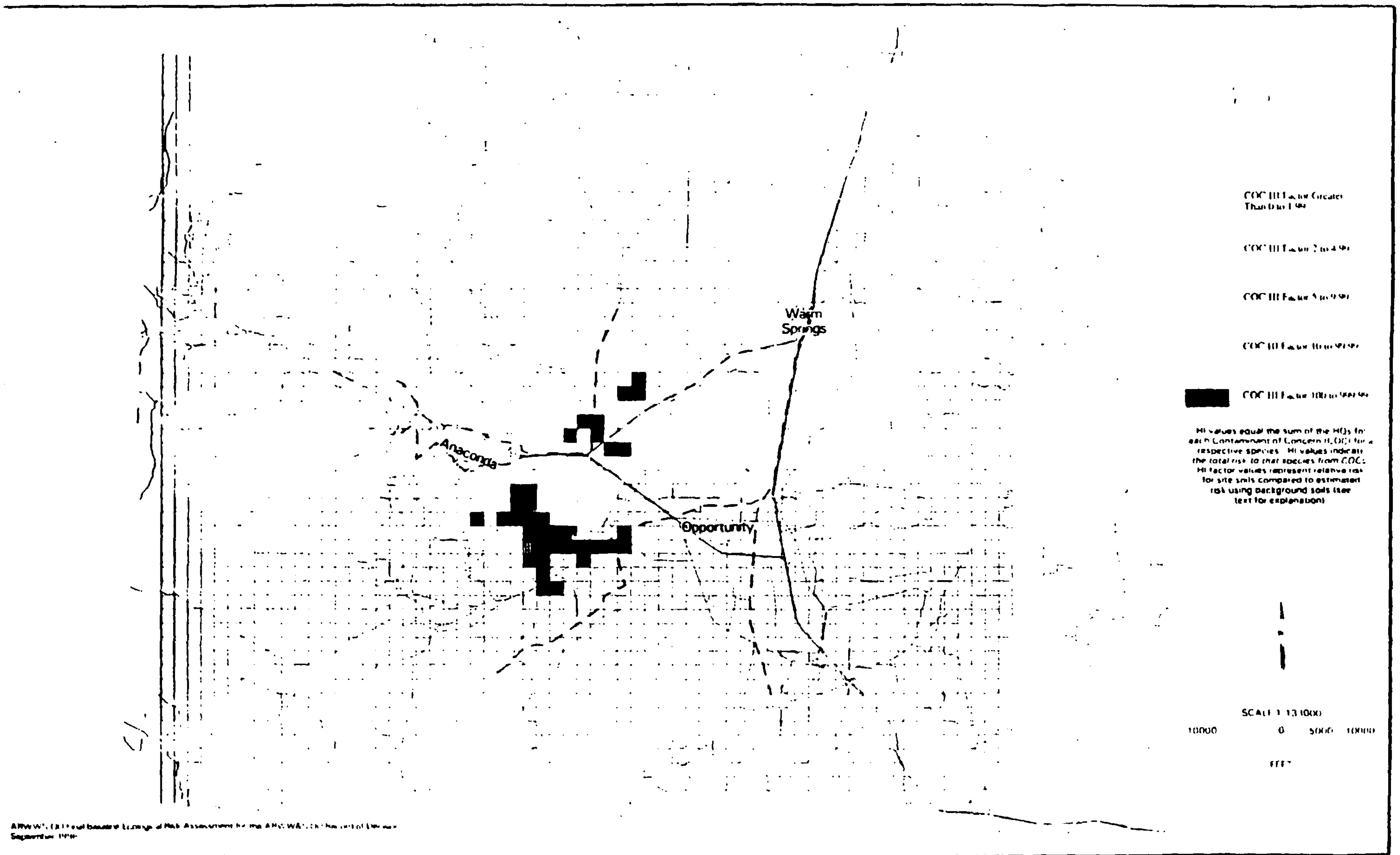
American Robin HI Factor Values
(LOAEL)
HI Ratio to Background HI

Figure 18

bird hot rad map_lyr



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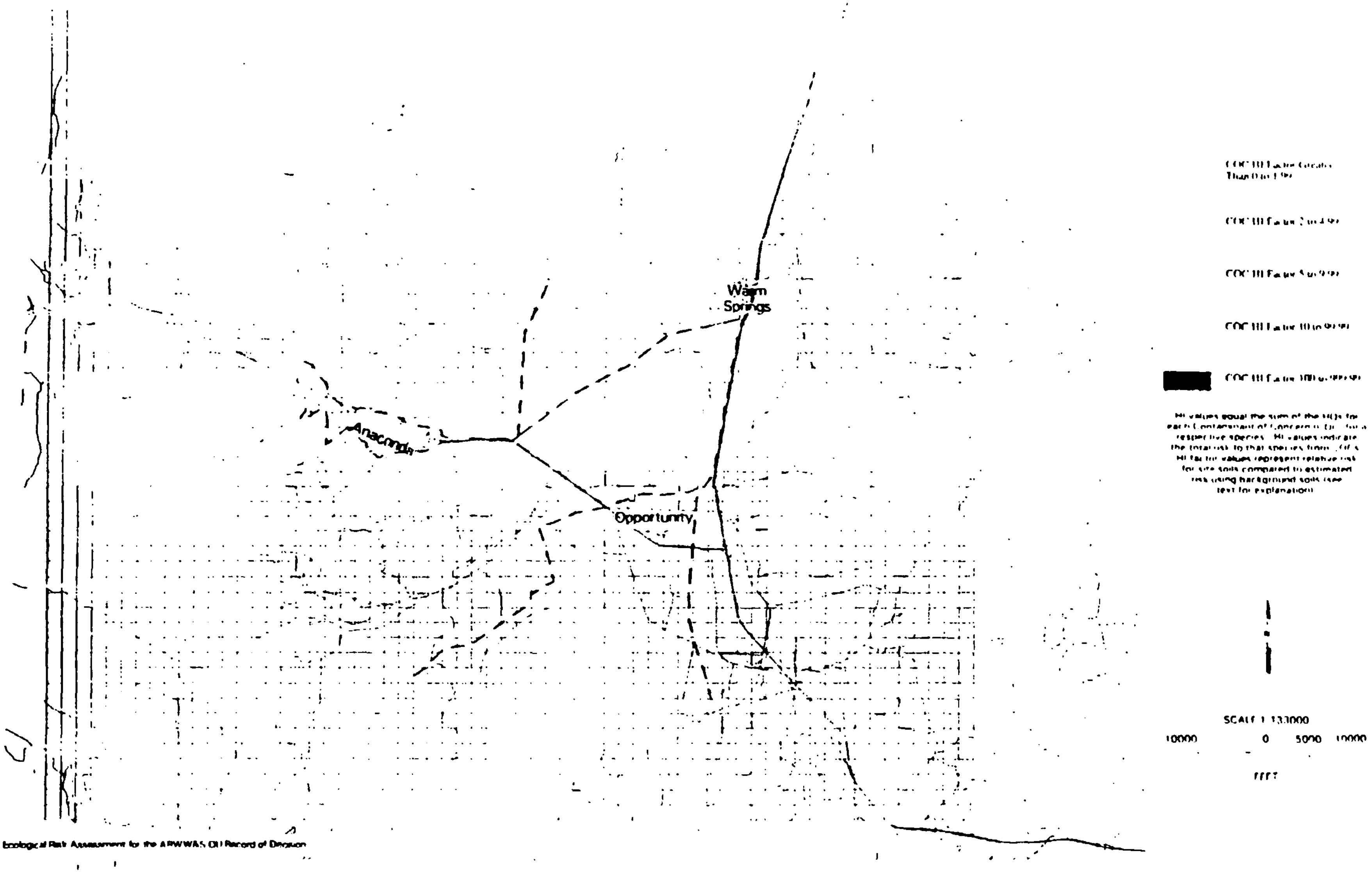
American Robin HI Factor Values (NOAEL) Subtracting Background HI

Figure 1C



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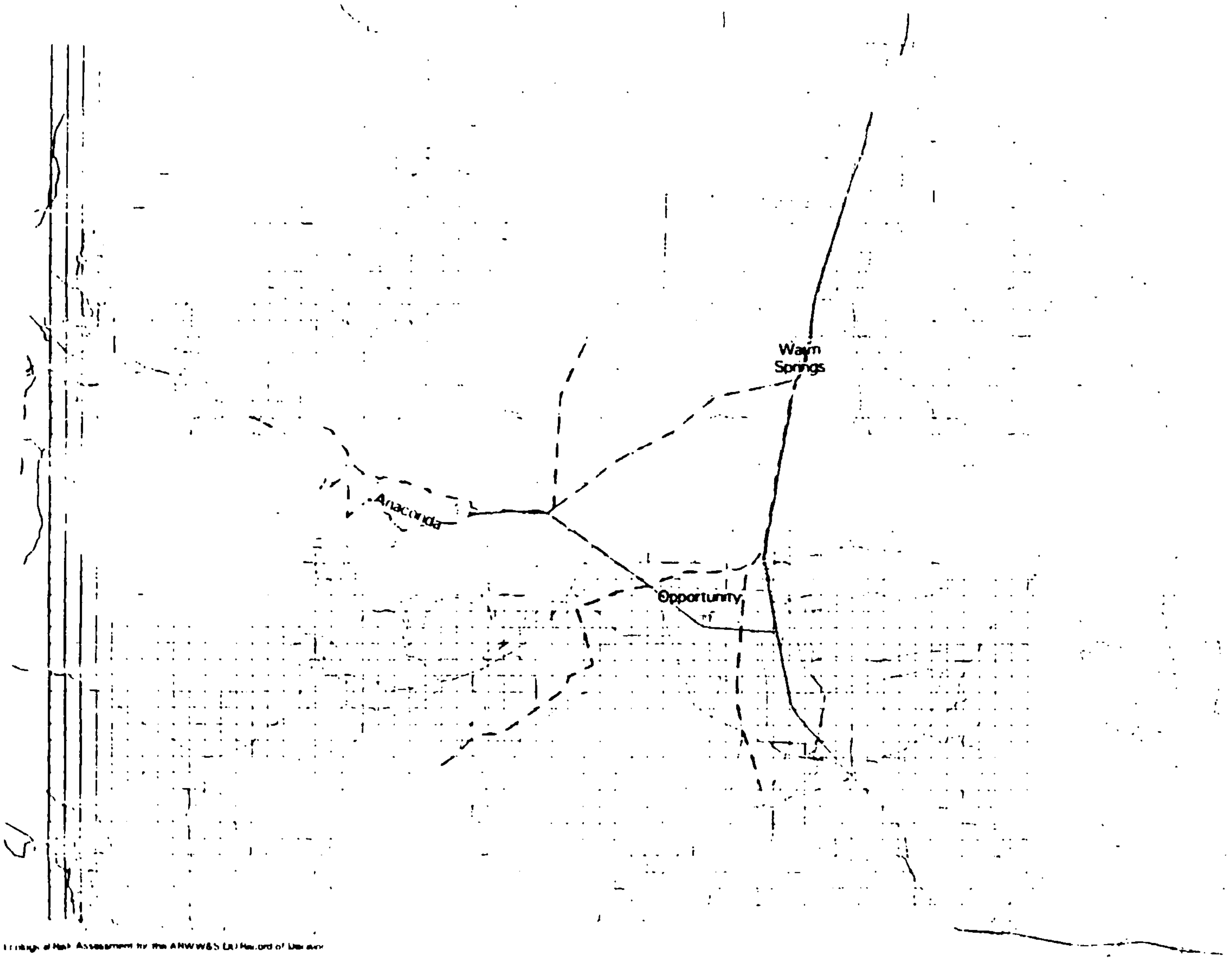
September 1998

CDM
A Subsidiary of Camp Dresser & McKee Inc.

American Robin HI Factor Values
(LOAEL)
Subtracting Background HI

Figure 1D



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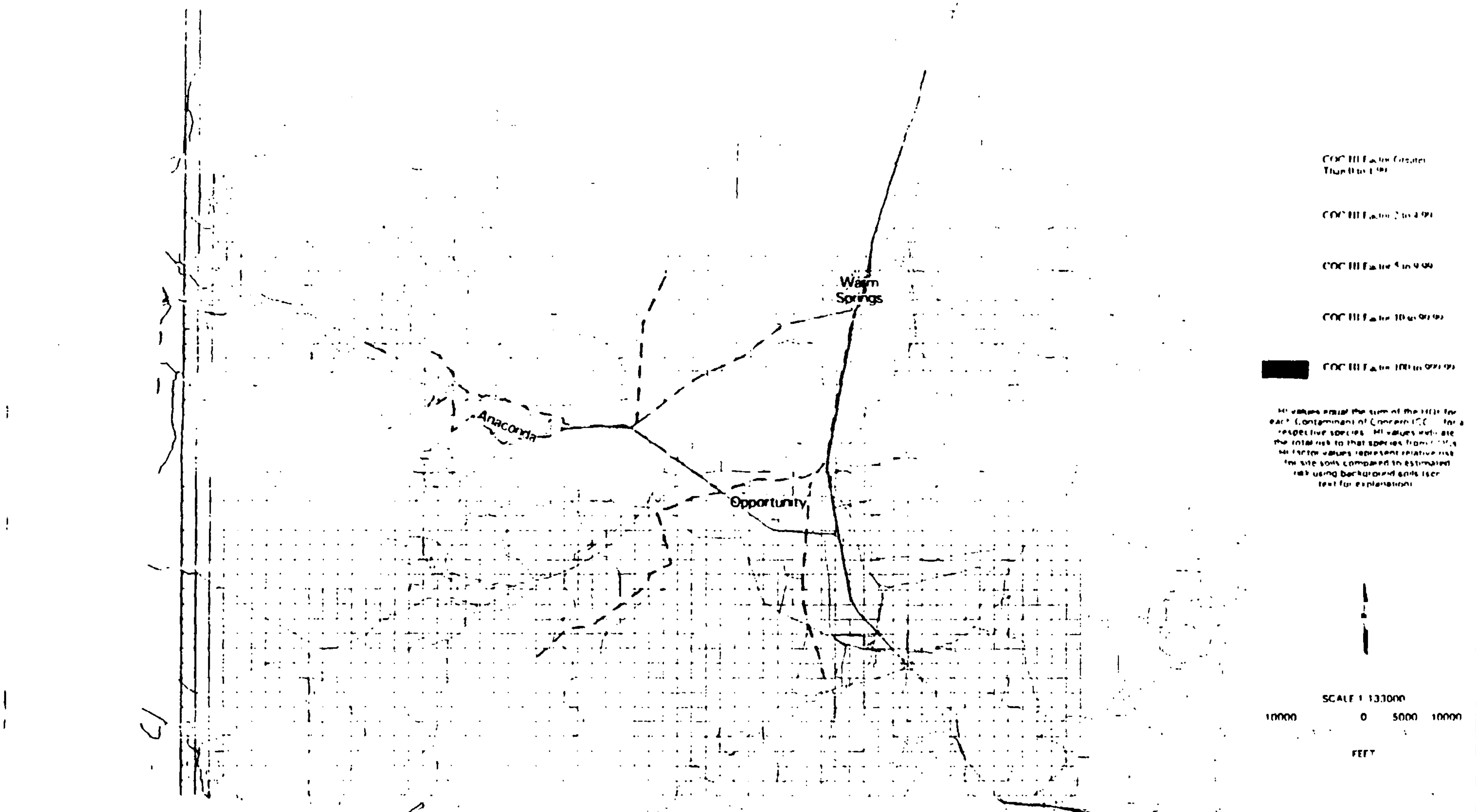
American Kestrel HI Factor Values
(NOAEL)
HI Ratio to Background HI

Figure 2A



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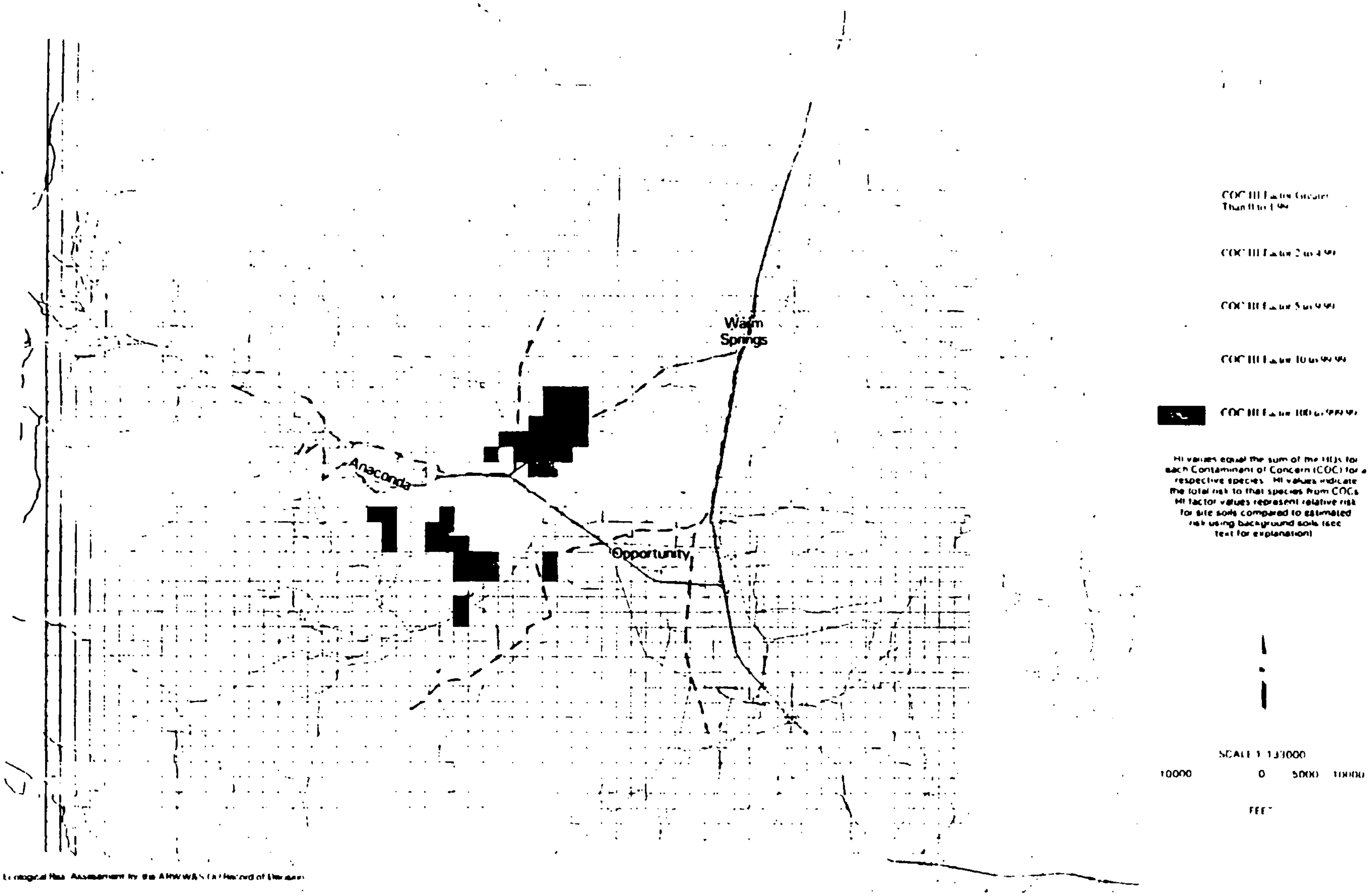
American Kestrel HI Factor Values
(LOAEL)
HI Ratio to Background HI Value

Figure 2B

1998
best hi rod map_hi



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American Kestrel HI Factor Values
(NOAEL)
Subtracting Background HI Value

Figure 2C

HI values equal the sum of the HQs for each Contaminant of Concern (COC) for a respective species. HI values indicate the total risk to that species from COCs. HI factor values represent relative risk for site soils compared to estimated risk using background soils (see text for explanation).

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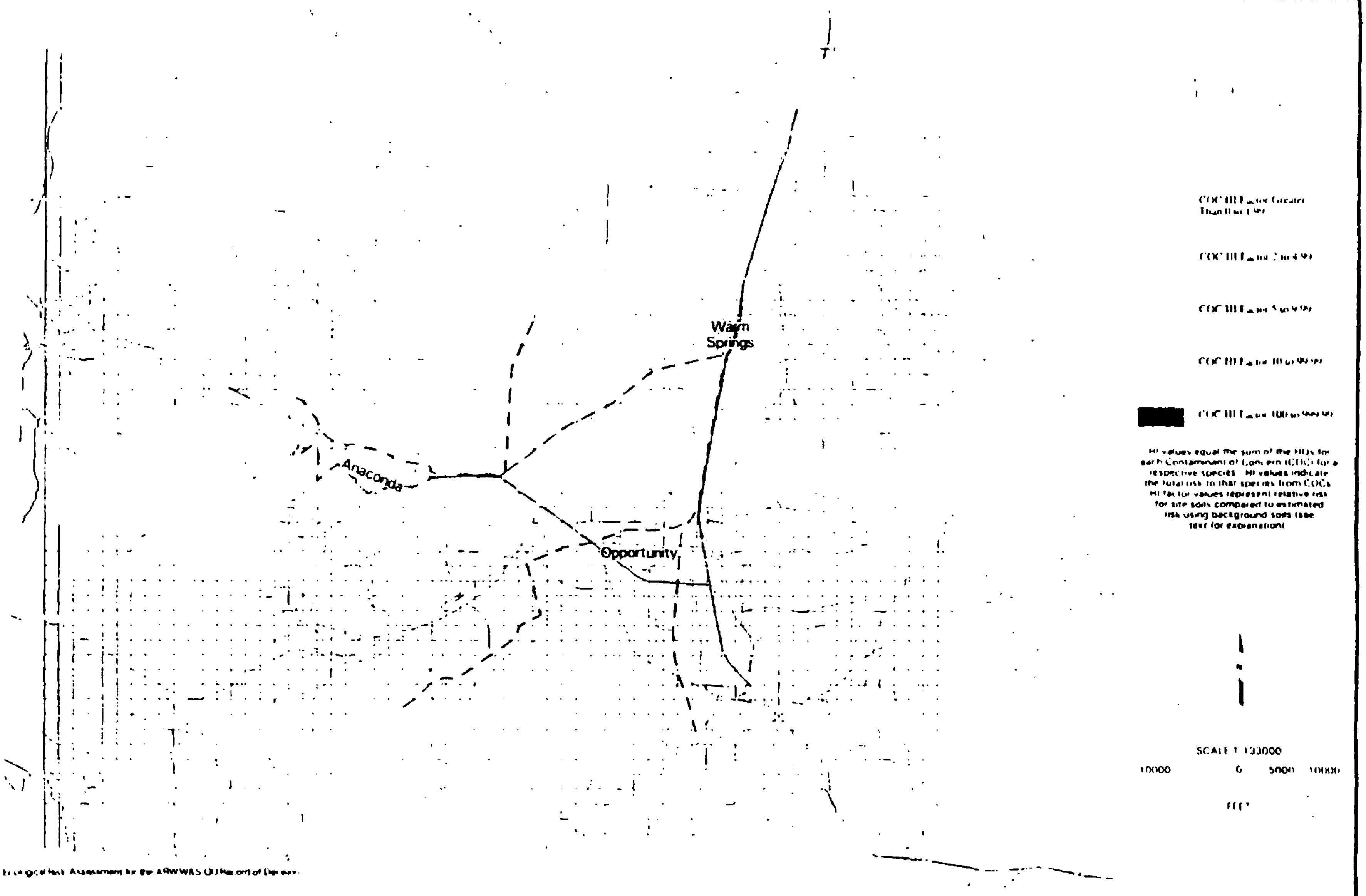
American Kestrel HI Factor Values
(LOAEL)
Subtracting Background HI Value

Figure 2D



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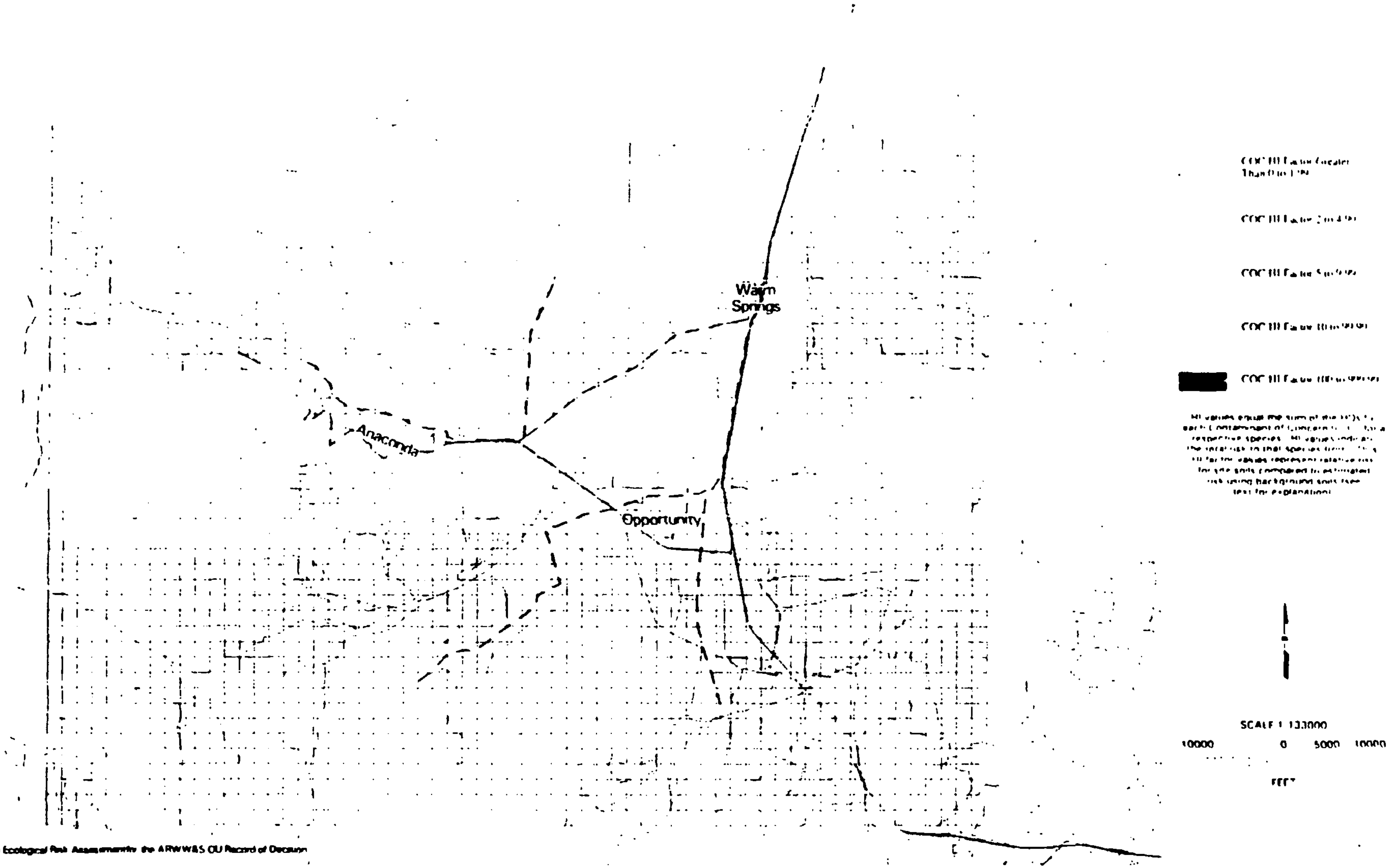
White Tailed Deer HI Factor Values
(NOAEL)
HI Ratio to Background HI

Figure 3A



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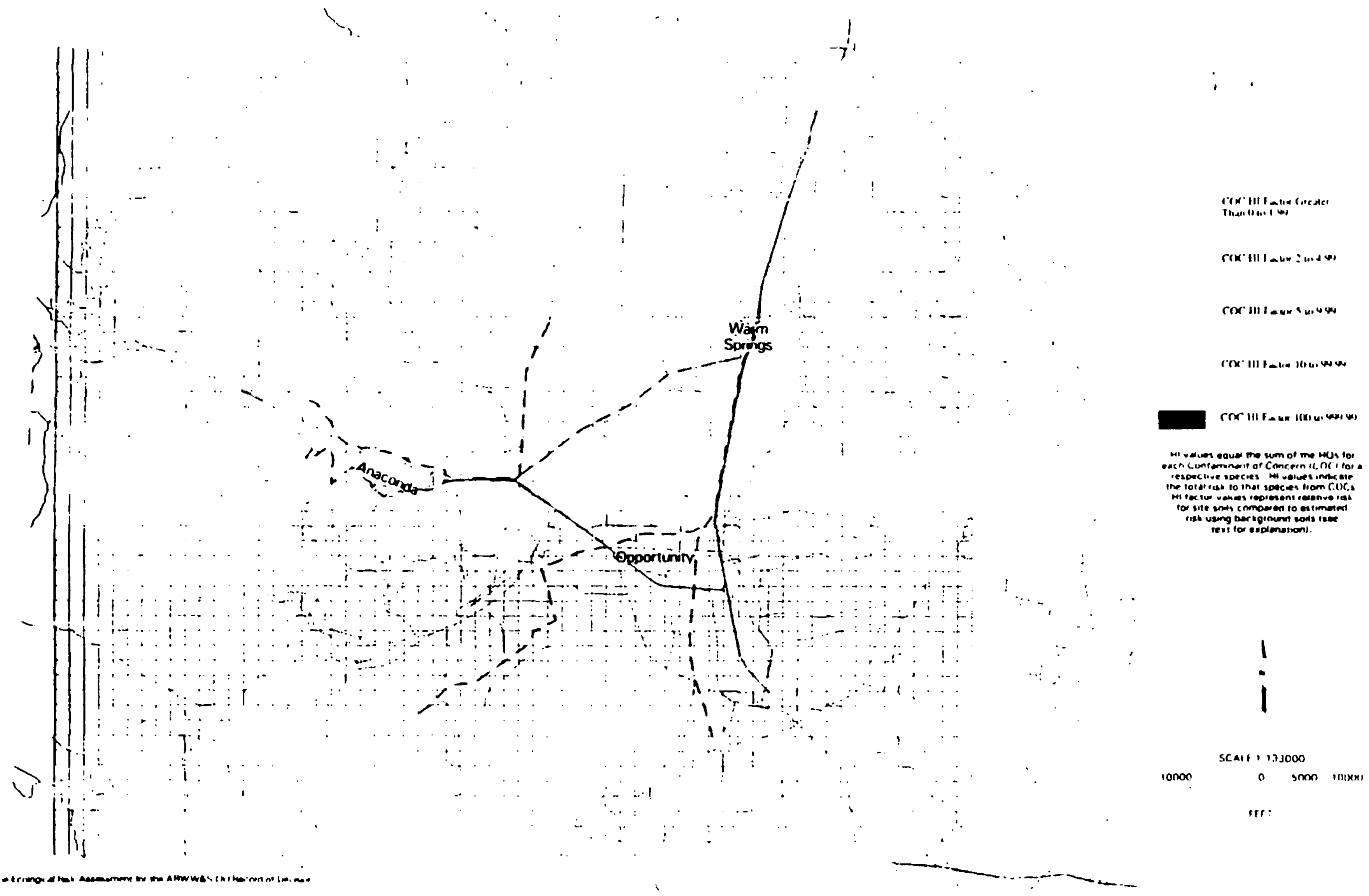
White Tailed Deer HI Factor Values
(LOAEL)
HI Ratio to Background HI

Figure 3B

[illegible]-1998



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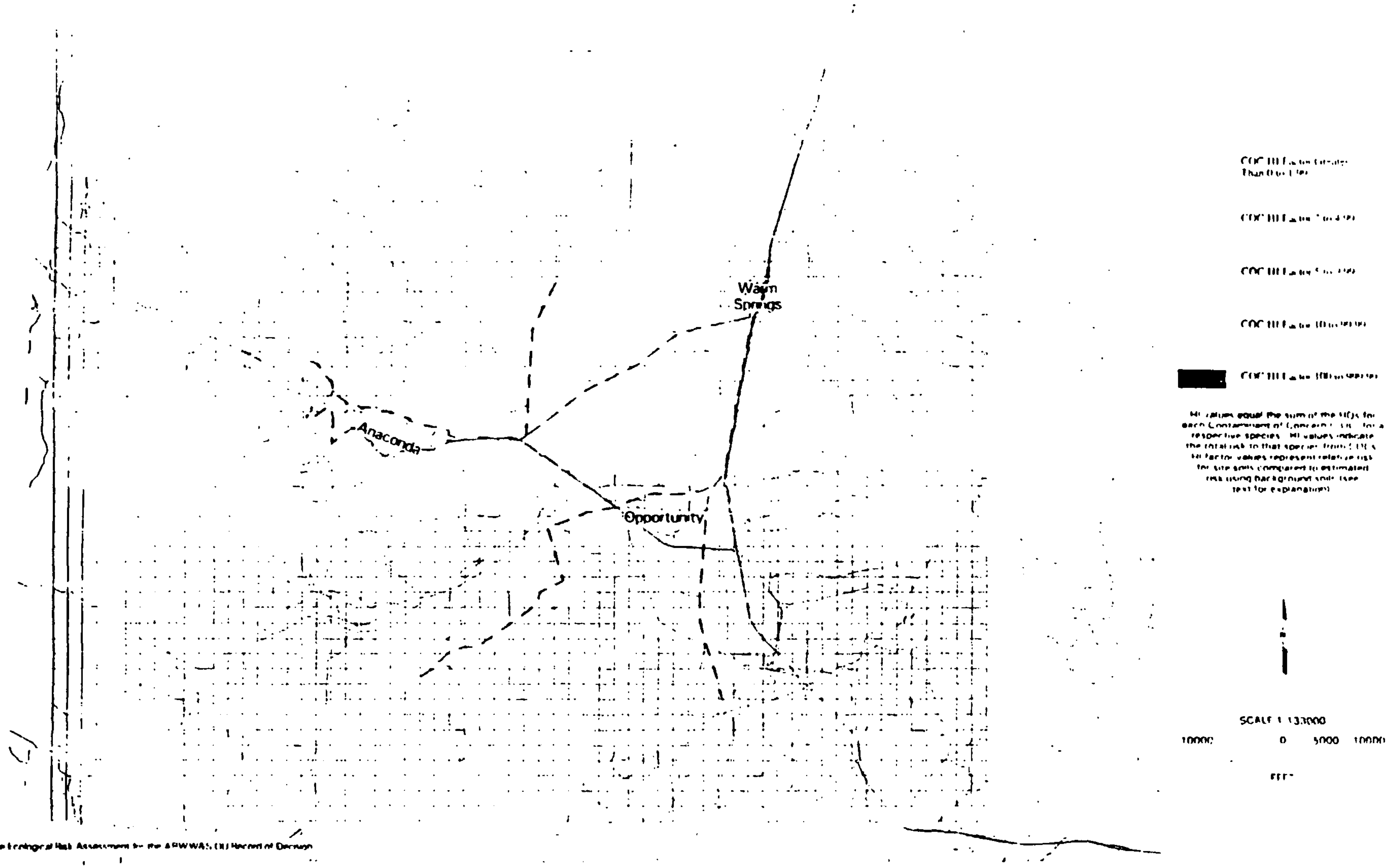
White Tailed Deer HI Factor Values
(NOAEL)
Subtracting Background HI

Figure 3C



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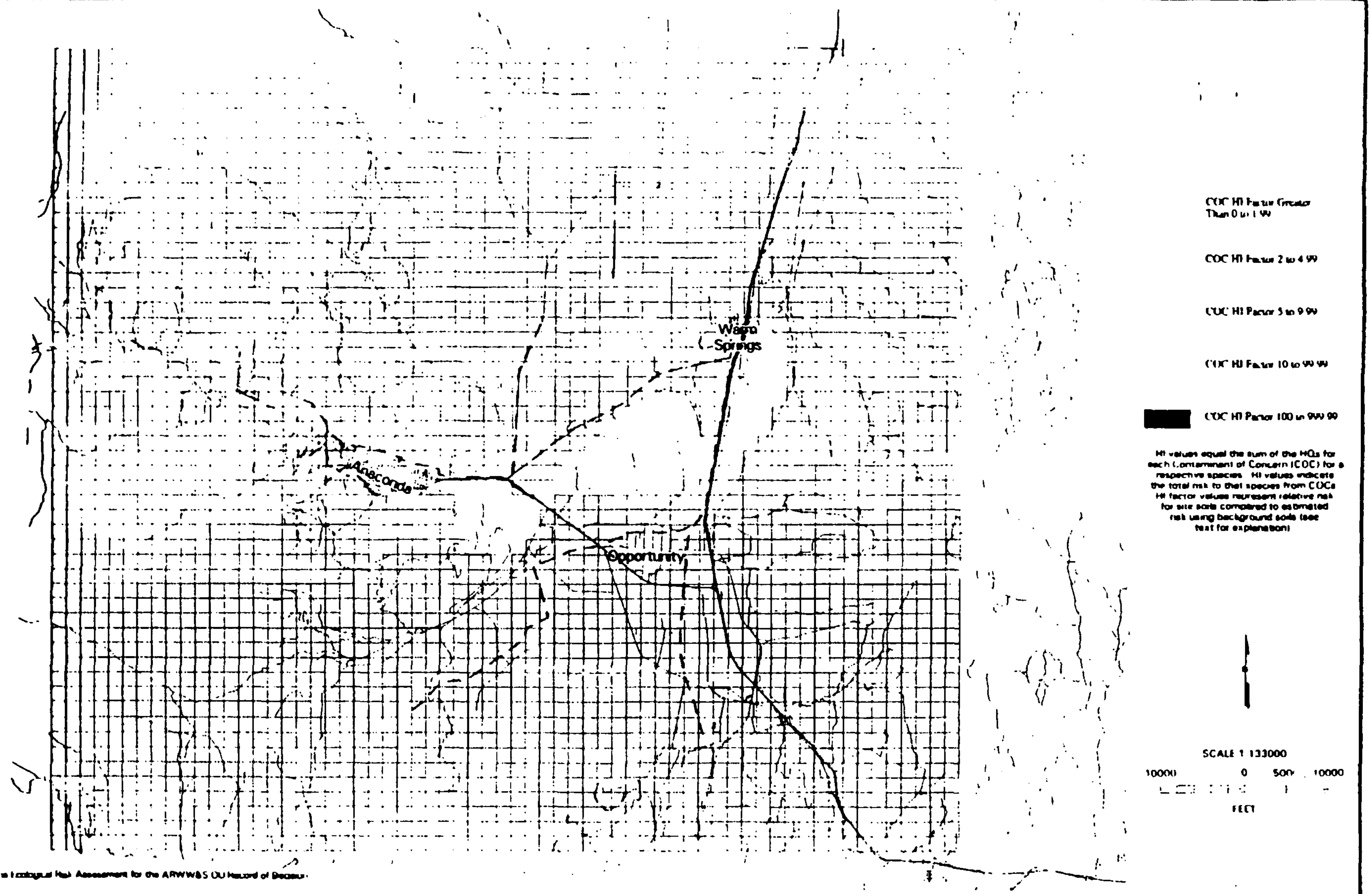
White Tailed Deer HI Factor Values
(LOAEL)
Subtracting Background HI

Figure 3D

1998
deer hal ron map_h



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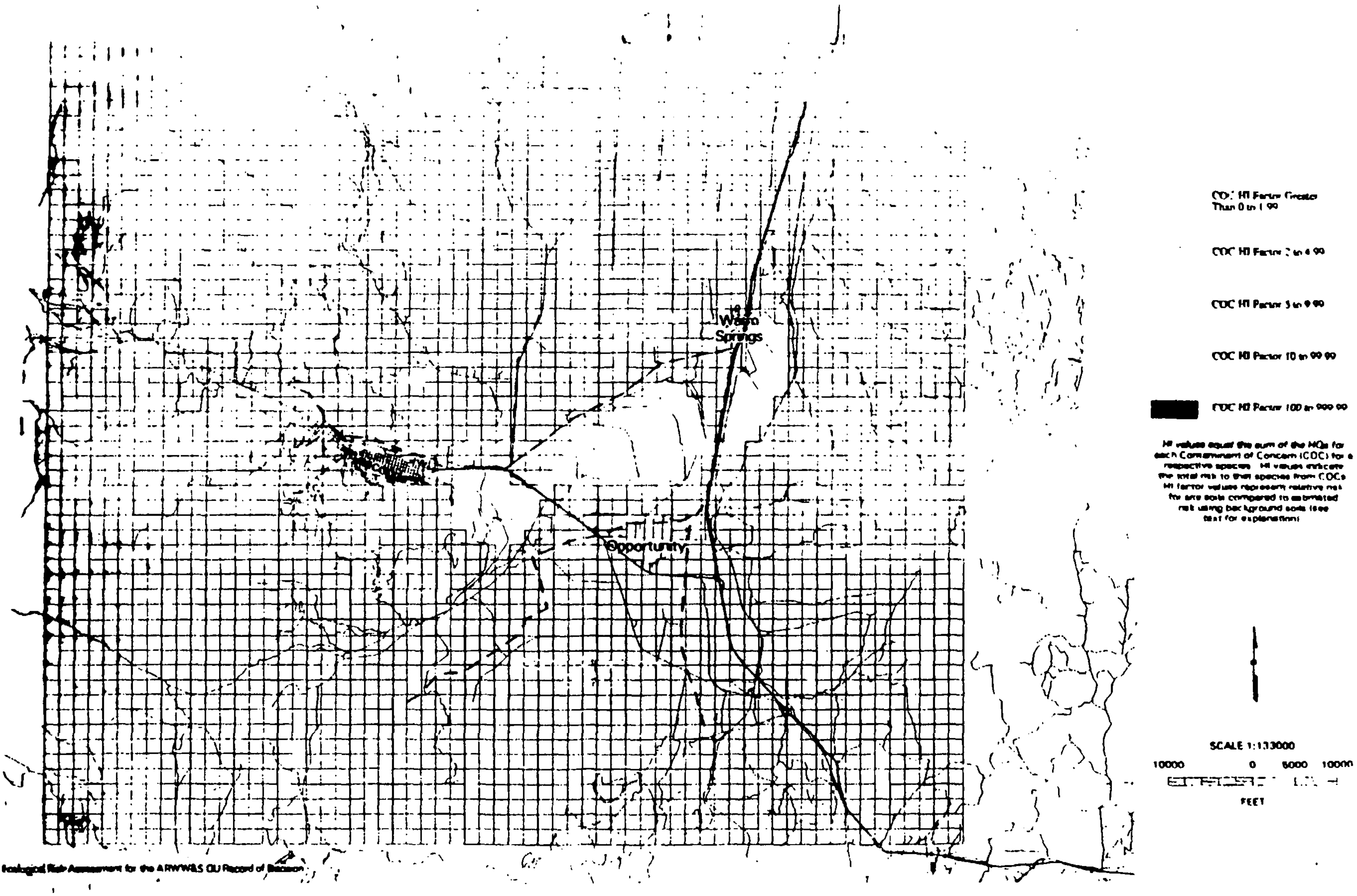
Deer Mouse HI Factor Values
(NOAEL)
HI Ratio to Background HI

Figure 4A



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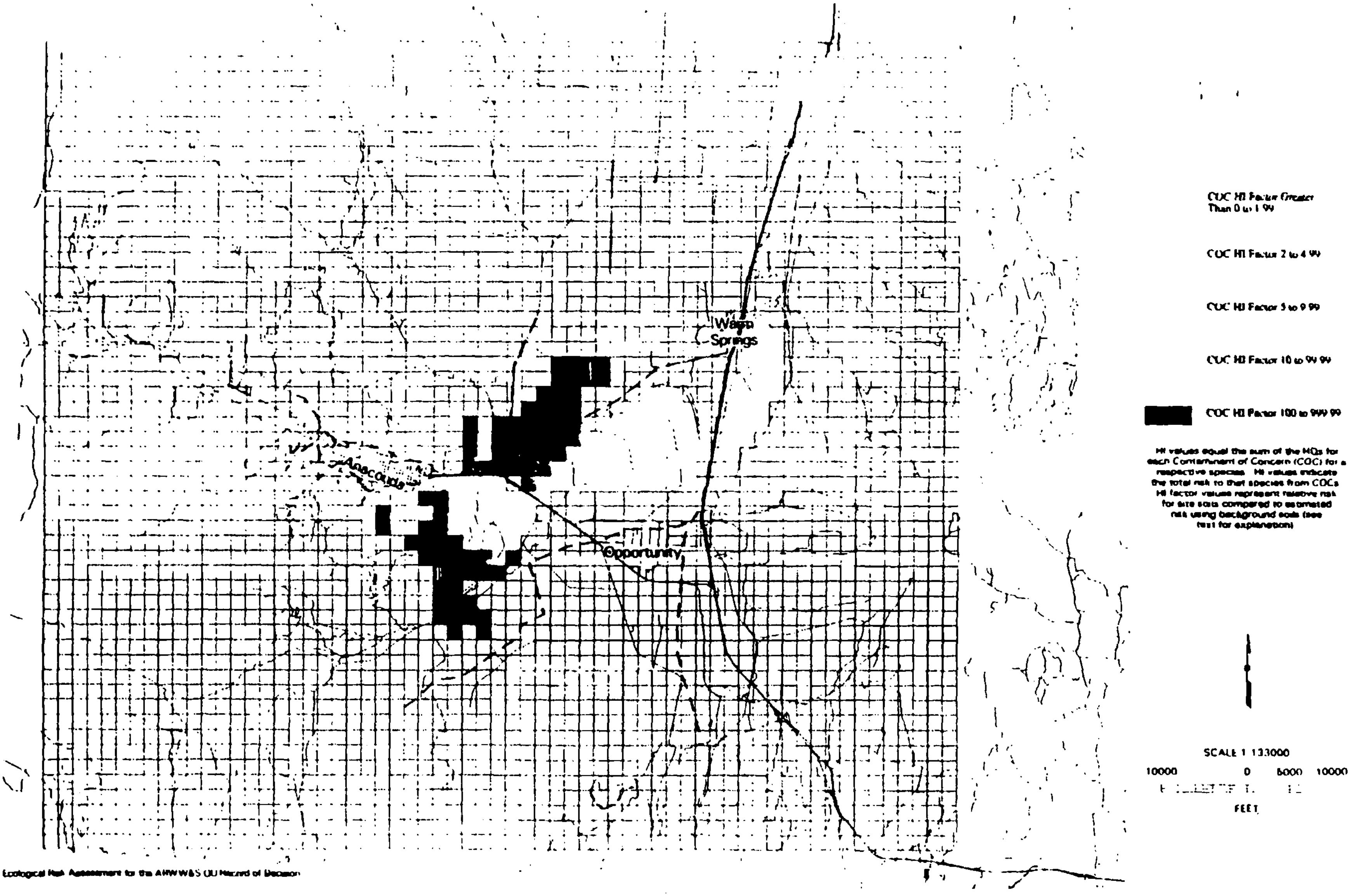
Deer Mouse HI Factor Values (LOAEL) HI Ratio to Background HI

Figure 48



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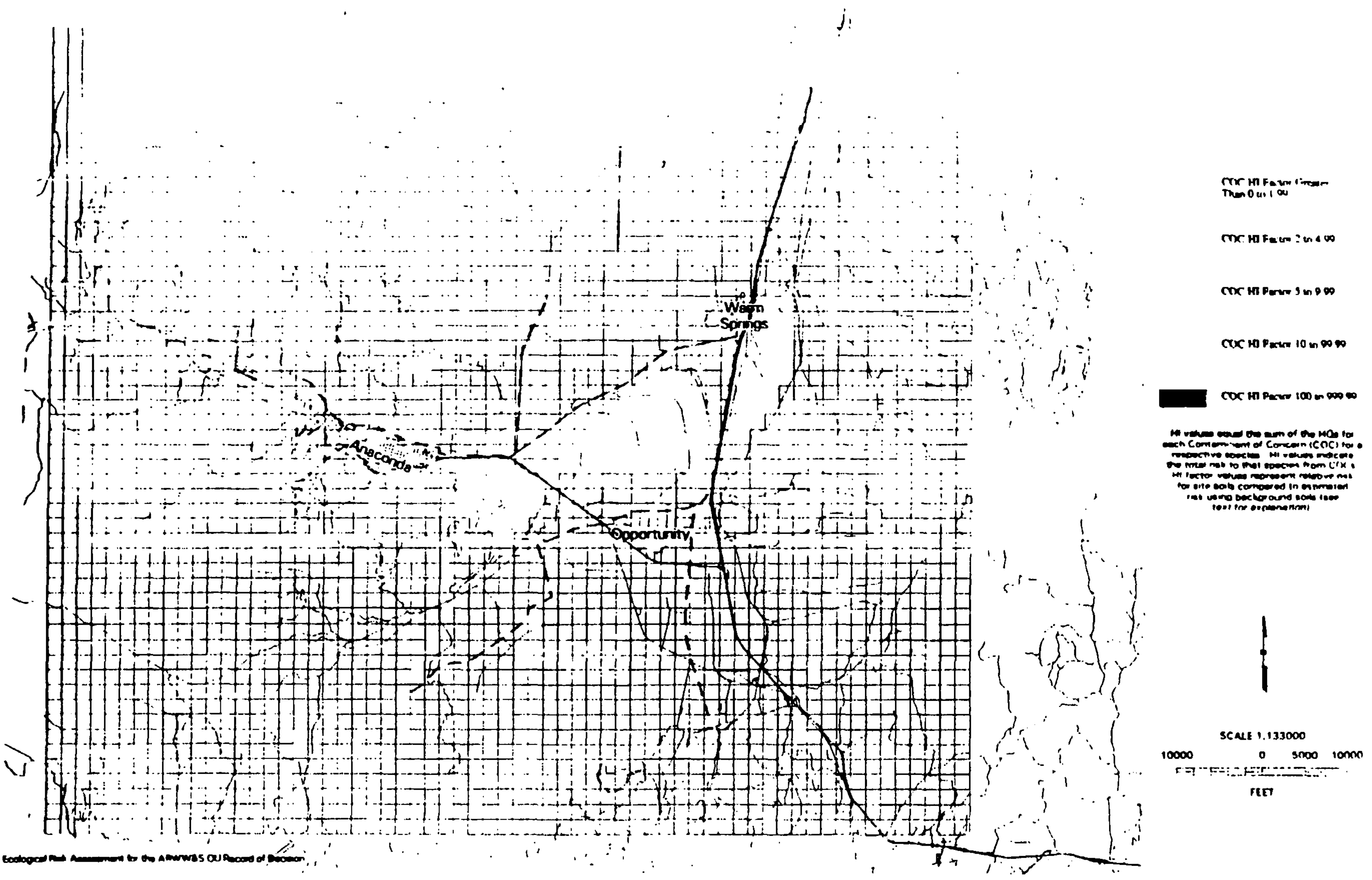
Deer Mouse HI Factor Values
(NOAEL)
Subtracting Background HI

Figure 4C



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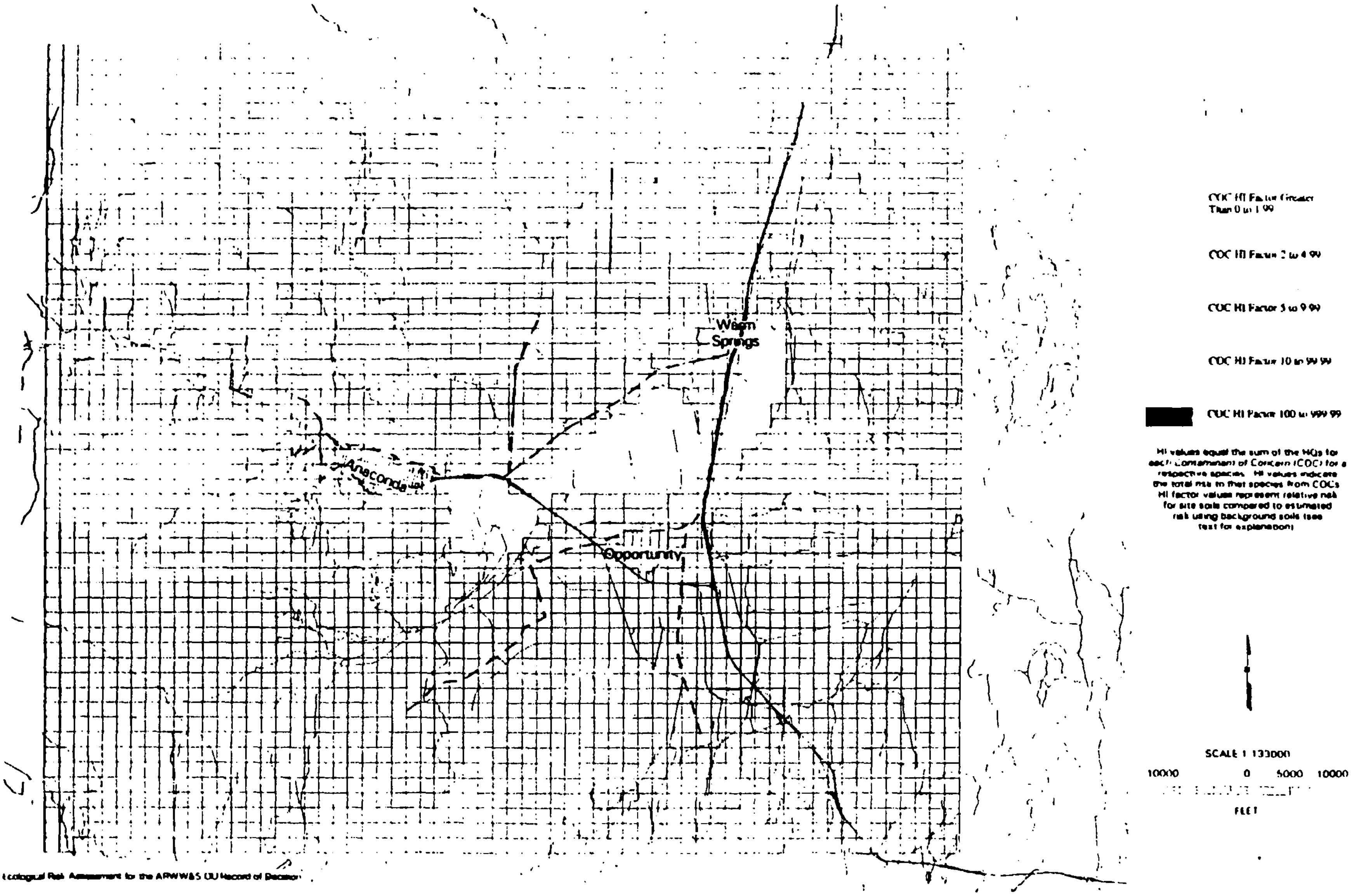
Deer Mouse HI Factor Values
(LOAEL)
Subtracting Background HI

Figure 40



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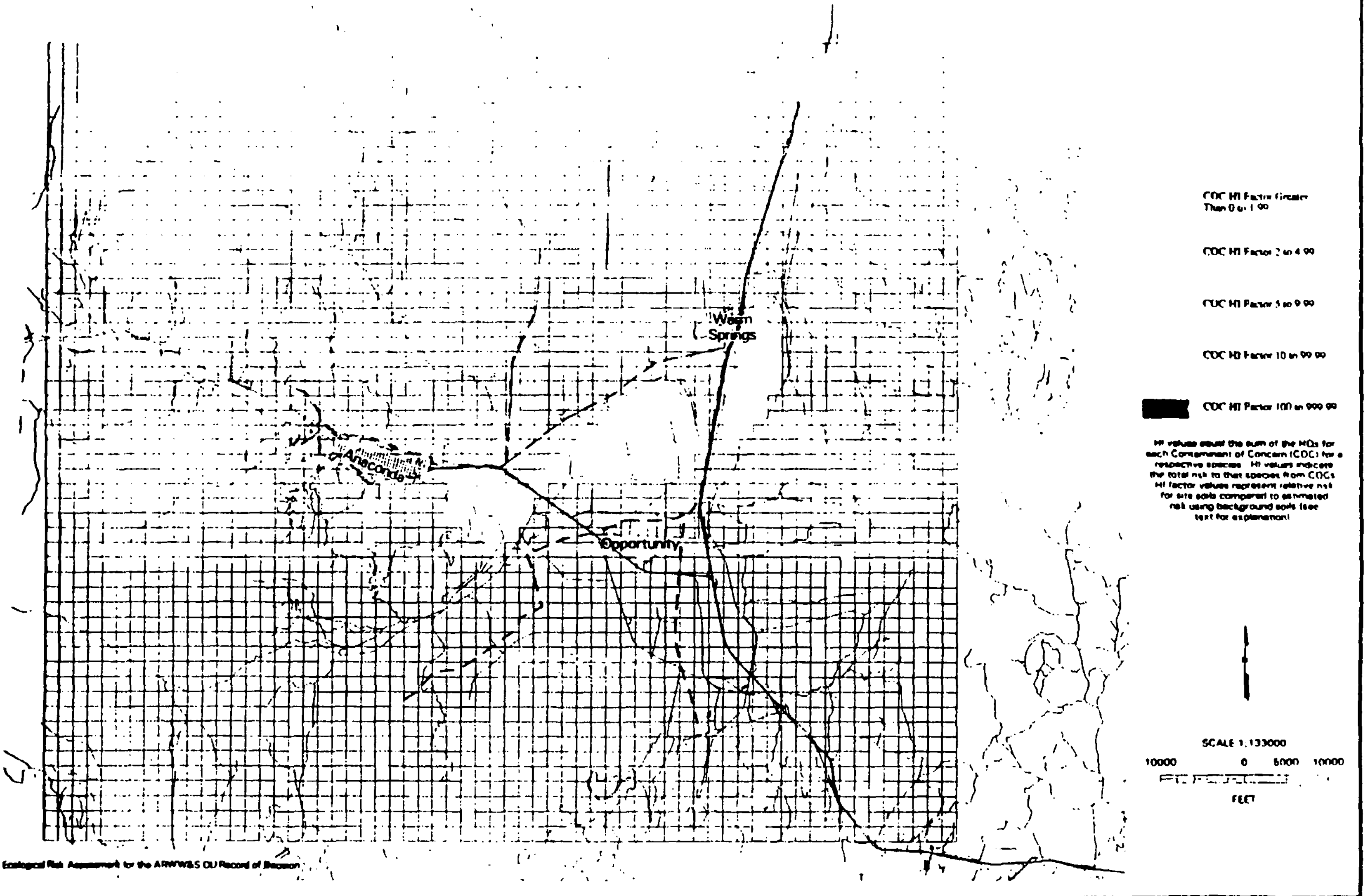
Red Fox HI Factor Values (NOAEL) HI Ratio to Background HI

Figure 5A

JOB
fox hrs rod map lyt



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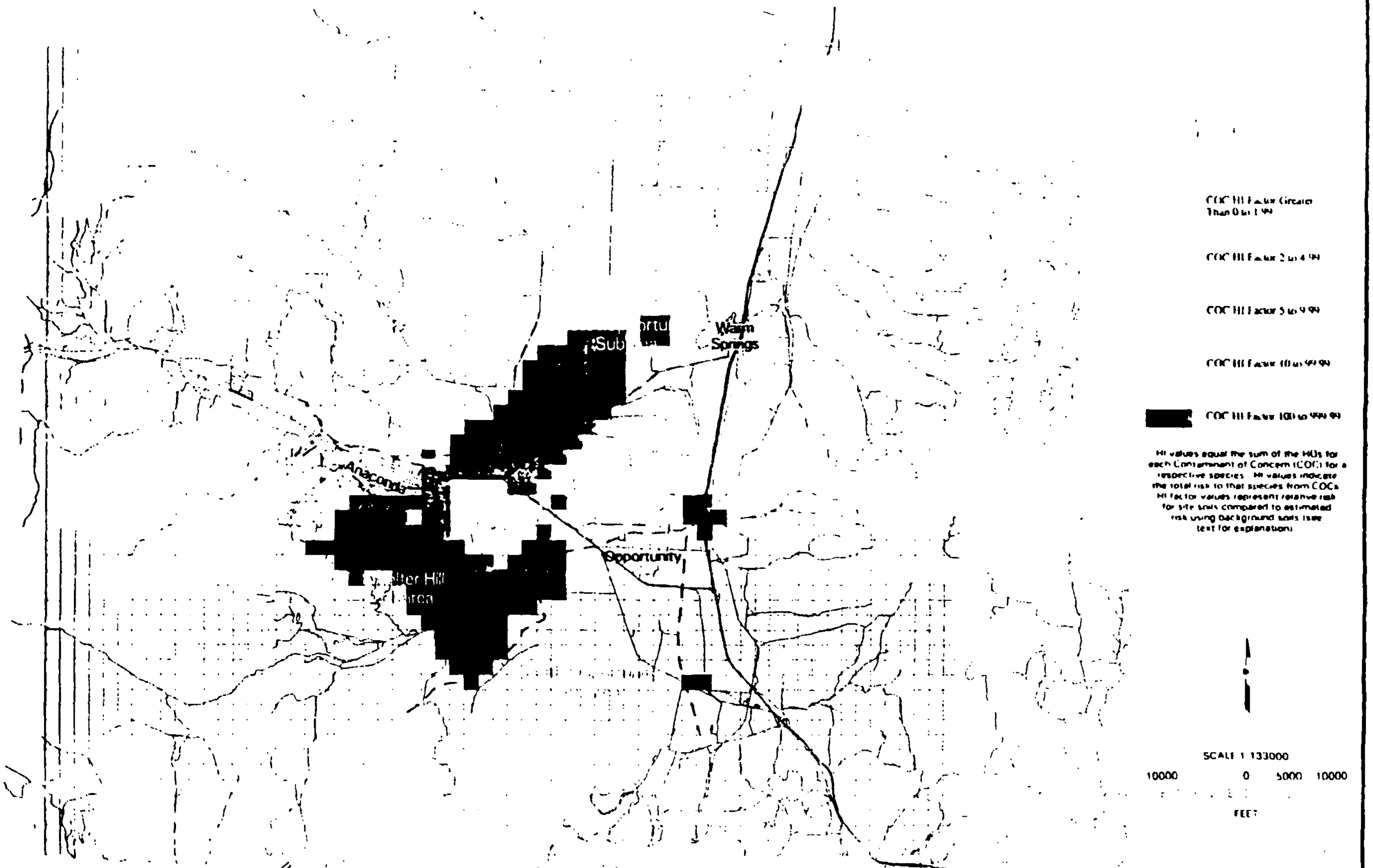
Red Fox HI Factor Values
(LOAEL)
HI Ratio to Background HI

Figure 5B



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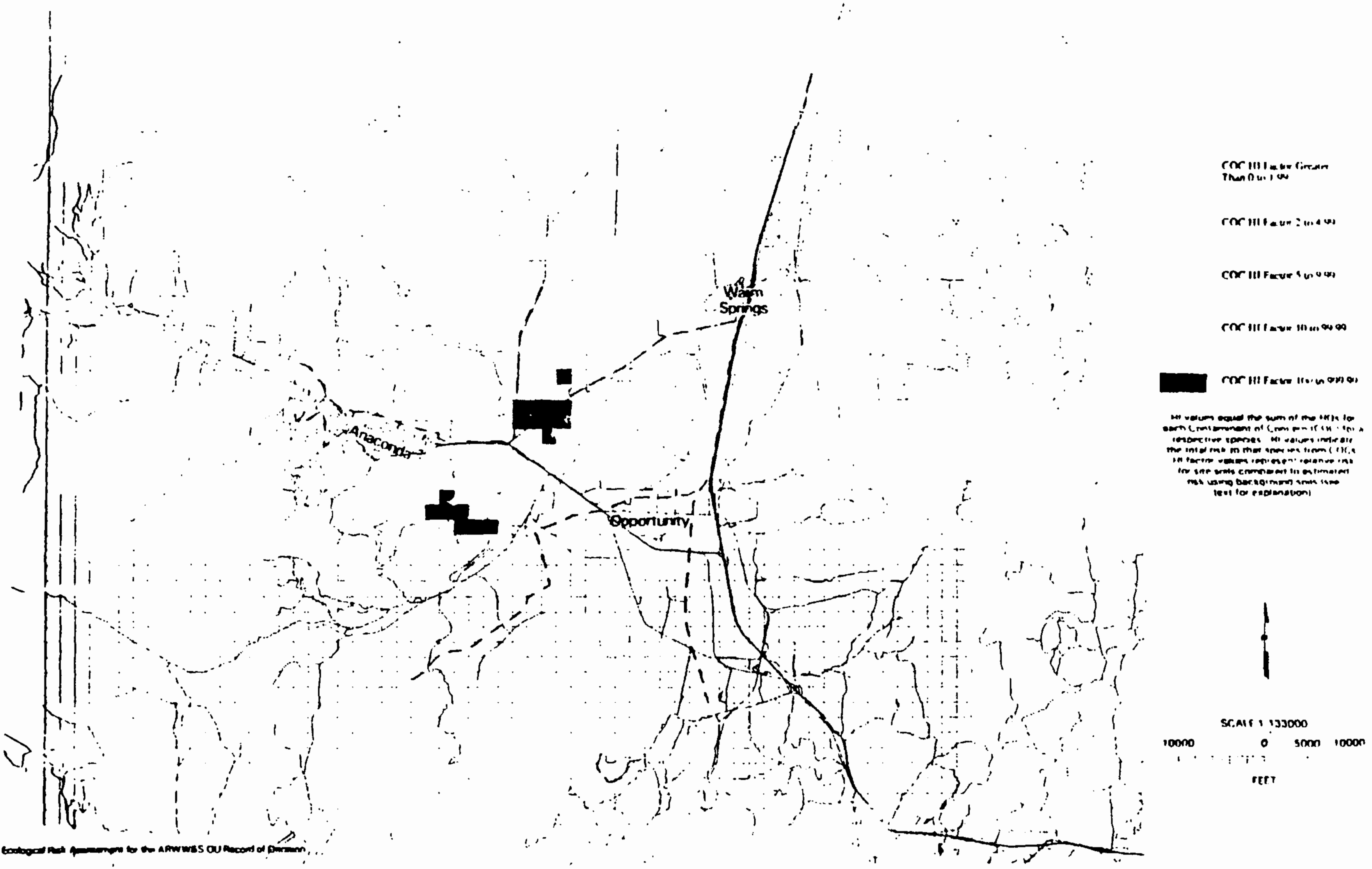
Red Fox HI Factor Values
(NOAEL)
Subtracting Background HI

Figure 5C



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September 1999

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Red Fox HI Factor Values (LOAEL) Subtracting Background HI

Figure 5D

ATTACHMENT 1

Hoff and Henningsen Abstract

The Toxicologist

An Official Publication of the Society of Toxicology

and

Abstract Issues of

TOXICOLOGICAL SCIENCES

An Official Journal of the Society of Toxicology
Published by Academic Press, Inc.

Abstracts of the
37th Annual Meeting

Volume 42, Number 1-S
March 1998

basic hydrolysis (44.7 ± 15.3 pg/mg Hb). This procedure seems to be more effective for the detection of DNB-Hb adducts and is a simple and effective method for the detection and quantitation of Hb adducts of DNB and TNB. (This abstract does not necessarily reflect USEPA/USArmy policy)

1676 USE OF A FECAL TESTOSTERONE BIOMARKER IN CADMIUM EXPOSED MICE.

J Billitti, B Lasley, and B Wilson. *University of California at Davis, CA.*

A specific acute effect of the heavy metal cadmium is testicular necrosis. In this study cadmium was used to validate the application of fecal testosterone levels as a biomarker of adverse effects on male reproduction. Maximum testosterone levels were obtained from 18 *Peromyscus maniculatus* using a subcutaneous injection of human chorionic gonadotropin (hCG) to stimulate Leydig cells. Feces were collected at 20, 24, and 28 hours after hCG injection, dried, weighed, extracted and testosterone measured using a competitive ELISA. Three groups of six mice each were injected subcutaneously with saline, 0.8 mg/kg and 2.0 mg/kg cadmium chloride in saline. Ten days following treatment, maximal testosterone levels were determined after hCG stimulation. Blood was taken by cardiac puncture and the testes removed. Blood testosterone levels, testis weights, testicular sperm head counts, and histological evaluations were performed. The correlation coefficient between blood and feces testosterone levels was 0.73. Fecal testosterone, testis weight, and sperm head counts decreased with increased cadmium exposure, demonstrating the validity of this reproductive biomarker as a noninvasive tool to study reproduction.

1677 A NEW INTERPRETATION OF THE ACUTE AQUATIC TOXICITY OF ORGANOPHOPHORUS PESTICIDES BASED ON A CRITICAL TARGET DOSE (CTD) APPROACH.

K C H M Legierse, H J M Verhaar, W H J Vaes and J L M Hermens. *Research Institute of Toxicology (RITOX), Utrecht University, Utrecht, The Netherlands.* Sponsor: B Kroes.

Organophosphorus pesticides (OPs) belonging to the phosphorothionates are generally believed to exhibit their toxic action via the inhibition of AChE after their metabolic transformation into their active oxon-analogues. In this study, we propose a toxicity model, which is mainly based on the following assumptions: 1) lethality is related to a fixed AChE inhibition percentage, 2) the oxon-analogues bind covalently and irreversibly to the AChE receptor, and 3) the metabolic activation of the OP follows first-order kinetics. Under these conditions, lethality is related to a critical amount of oxon-molecules bound to AChE, the "Critical Target Dose" (CTD). This CTD is proportional to the time-integrated whole-body concentration of the OP, which is described as the area-under-the-curve (AUC_{wb}) of the first-order one-compartment bioconcentration model. In addition, CTD is described as a function of the area-under-the-curve in the aqueous phase of the organism (AUC_a). The models were validated on basis of experimental 2–14 d LC50 and LBB (lethal body burden) data for chlorthion (3-chloro-4-nitrofenyldimethylphosphorothionate) in the pond snail and the results were compared with a description of the data on the basis of the classical critical body residue (CBR) concept. In contrast to the CBR, which failed to describe the data, the CTD model based on AUC_a was perfectly capable to describe the LC50(t) data. The LBB(t) data, which showed a decrease in time, were also in correspondence with the model. These results indicate that the target of chlorthion is located in the aqueous phase of the pond snail. In conclusion, the study clearly demonstrates the restricted applicability of the CBR concept and supplies an alternative model for compounds that exhibit their toxic action through an irreversible receptor interaction.

1678 AN LC_{50} VS. TIME MODEL FOR RECEPTOR-MEDIATED AQUATIC TOXICITY: CONSEQUENCES FOR BIOCONCENTRATION KINETICS AND RISK ASSESSMENT.

H J M Verhaar[1], K C H M Legierse[1], W de Wolf[2], S Dyer[2], W Seinen[1], and J L M Hermens[1]. [1]*RITOX, Utrecht University, Utrecht, the Netherlands;* [2]*the Procter & Gamble Company, Brussels, Belgium and Cincinnati, OH.* Sponsor: R Kroes.

For aquatic toxicants that work by so-called nonpolar narcosis, it is generally acknowledged that the Critical Body Residue at death, as a surrogate dose metric for the amount of target that has interacted with the toxicant, is constant. This constancy is not only maintained across exposure times, but also across different (narcosis) compounds, as well as species. We present here an alternative model, applicable to toxicants with irreversible or slowly reversible target interactions (which includes the nonspecific reactive toxicants), that implies that for these compounds, there is no constant CBR. The model also shows that for each single species-compound combination, the Critical Area Under the Curve (CAUC) is constant and independent of exposure time. These findings will have profound consequences for the interpretation of experimental toxicity data (such as ,6h LC_{50} values) in risk assessment. Among other things, it shows us that for receptor-mediated toxicity, LC_{50} vs. time values may decrease long after bioconcentration steady state has been achieved. It also shows us that for e.g. carbamates the incipient LC_{50} will be severely underestimated when using the familiar models based on just bioaccumulation kinetics.

1679 EXTRAPOLATING TOXICITY REFERENCE VALUES IN TERRESTRIAL AND SEMI-AQUATIC WILDLIFE SPECIES USING UNCERTAINTY FACTORS.

D Hoff and G Henningsen. *US EPA Region VIII, Denver, CO.*

A fundamental component in all ecotoxicological risk assessments is the determination of xenobiotic doses, resulting from exposures to site-specific ecological receptors, that constitute scientifically valid NOAELs (no-observable-adverse-effects-level) for endpoints related to population sustainability. Unfortunately, toxicological data in wildlife literature are not available for most compounds, and extrapolations of toxic doses must be performed across species and study designs. Four main techniques have been used for interspecific and study extrapolations of toxic responses to xenobiotics in wildlife species: body weight-to-surface scaling factors, physiologically-based pharmacokinetic models (PBPK), assuming equal toxic responses among similar species, and application of uncertainty factors. The use of uncertainty factors has current advantages over the other methods, which are discussed along with examples of extrapolations for heavy metal toxicity. Four primary sources of uncertainty are quantified in the proposed extrapolation scheme: taxonomic relationships, study duration, study endpoints, and site-specific modifications. The concept is that there is no uncertainty applied for chronic reproductive studies in the species of concern. This method provides a structure for consistently extrapolating the most scientifically defensible, applicable study NOAELs/LOAELs to receptors of concern.

1680 AN INTERACTIONS-BASED PHYSIOLOGICAL TOXICOKINETIC MODEL FOR CHEMICAL MIXTURES.

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The available data on binary interactions are yet to be considered within the context of mixture risk assessments because of our inability to predict the effect of a third or a fourth chemical in the mixture on the interacting binary pairs. Physiologically-based toxicokinetic (PBTK) models represent a framework that can be used for simultaneously predicting the multiple interactions at any level of complexity. The objective of the present study was to develop an interactions-based model for simulating the toxicokinetics of the components of a quaternary mixture of volatile organics [Dichloromethane (D), Toluene (T), Ethylbenzene (E), and *meta*-Xylene (X)]. The methodology consisted of: (i) obtaining the validated individual chemical PBTK models from the literature, (ii) interconnecting all individual chemical PBTK models at the level of liver on the basis of mechanism of binary chemical interactions (e.g., competitive, non-competitive or uncompetitive metabolic inhibition), and (iii) comparing the *a priori* predictions of the interactions-based model to corresponding experimental data. The analysis of blood kinetics data from exposure to all binary combinations of T, X, D, and E was suggestive of competitive metabolic inhibition as the plausible interaction mechanism. The metabolic inhibition constant (K_i) for each binary combination was quantified and incorporated within the mixture PBTK model. The binary interactions-based PBTK model for the mixture predicted adequately the kinetics of all four components of the mixture in the rat (100 ppm each of T, X, D and E, 4 hr exposure). The results of the present study suggest that data on the interactions at the binary level alone are required for predicting the kinetics of components in complex mixtures.

Extrapolating toxicity reference values in terrestrial and semi-aquatic wildlife species using uncertainty factors.

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Abstract

A fundamental component in most ecological risk assessments is the estimation of xenobiotic doses in site-specific ecological receptors leading to a scientifically defensible no observable adverse effects level (NOAEL) on population sustainability. Unfortunately, literature on direct wildlife toxicity data is rarely available for most contaminants, and intertaxon extrapolations of toxicity must be completed. Four principle techniques have been used for inter-specific extrapolation of toxic responses to xenobiotics in wildlife species: 1) scaling factors, 2) physiologically-based pharmacokinetic models (PBPK), 3) assuming equal toxicity among similiar species, and 4) uncertainty factors. The use of uncertainty factors and its current advantages over the other methods are discussed in this paper with specific applications of inter-specific extrapolations of heavy metals. Four sources of uncertainty are quantified in the extrapolation: taxonomic relationship, study duration, study endpoint and site specific modifications. This method provides the skeletal structure for extrapolating the most scientifically defensible, applicable study to an exposed receptor of concern.

Introduction

Problem: Lack of accuracy and consistency in historic Toxicity Reference Values (TRVs) used for EPA quantitative ecotoxicological risk assessment

Consequences: Large time and financial resources to improve, or were accepted by risk managers who made poorer decisions that were either over- or under-protective

Approach by EPA R8 Toxicologist to Help Resolve:

Follow sound science & EPA guidelines: 1992 Framework and 1997 "ERAGS" (ERT)
Extrapolation options: none, body-surface scaling, PBPK models, uncertainty factors
R8's TRV approach with study-selection criteria and a 4-step "balanced" UCF scheme
Examples described: assumes adequate Problem Formulation & Sampling/Analyses

Solicit Feedback and Possible Coordinated Support

Discuss pros & cons, practicalities, other options or tiers (Screening vs quantitating risks)

Ecotoxicology Database of "key" and "candidate" literature reports for use by EPA or others; National consortium effort is starting

Problem Definition:

A major task of ecological risk assessors is to estimate doses of xenobiotics in wildlife which may lead to "excess risks" of deleterious effects on population sustainability.

Wildlife receptors (800 Breeding birds and 380 mammals) are important biological components of ecological systems potentially at risk on many EPA Superfund Sites

Superfund Sites are contaminated with solvents, heavy metals, chlorinated hydrocarbons, pesticides, radionuclides and other hazardous compounds

Thousands of combinations, therefore, occur among biological and chemical species

Select the "most applicable" and strongest published literature on field or laboratory
studies of dose-responsive toxicity for each chemical contaminant of ecological concern (COC) and receptor of concern (ROC) combination, to serve as the ecotoxicological bench mark dose

TRV Goal = Extrapolate to both a chronic NOAEL of serious non-lethal toxicity for "screening HQs", and to a chronic LOAEL for "risk-based HQs" that impact population sustainability or community integrity.

TOXICOLOGICAL Considerations for TRVs

Study Metrics: dose (preferred), tissue residue, dietary concentration, media concentration

Study Designs (evaluate with adequate team of expertise):

field vs lab data, or both
species' or strain's similarities and differences in toxicologic response (toxicodynamics)
study controls (habitat or housing, diet and nutrition, natural disease, age, genders, other)
exposure routes and vehicles influences
multiple doses with TD-range determined (NOAEL, TDlow, TD50, etc.), vs single doses
relevant target-tissue endpoints with toxic mechanism (toxicokinetics and toxicodynamics)
biomarkers of exposure (non-toxic) vs effect (toxic)
chronicity: longer exposures during critical time-stages usually generate lowest safe doses
differential diagnosis and confounders (incremental response and cause-and-effect)
zooepidemiologic resolution (ability to detect, as well as to the confirm absence of, an effect)
statistical power of a study: groups' sample sizes, magnitude of response, heterogeneity

Relevant TRV Applications:

site-specific data are often strongest (in-situ tests, cause-and-effect linkages)
direct/indirect reproductive endpoints relate best to population sustainability
similar taxonomic relationships and exposures extrapolate with more certainty
adverse response (scale, incidence, severity) relates more to population impacts

Uncertainty Factor Protocol for Ecological Risk Assessment: Toxicological Extrapolations to Wildlife Receptors

Basis for Uncertainty	**Uncertainty Value Assigned**
A. Intertaxon Variability Extrapolation Category	
Same species	1
Same genus, different species	2
Same family, different genus	3
Same order, different family	4
Same class, different order	5
Same phylum, different class	generally too far to extrapolate
B. Exposure Duration Extrapolation Category	
Chronic studies where toxicant attains pseudo-steady-state generally >30 days for aquatic species and reproductive endpoints, and usually >90 days for terrestrial species and other endpoints	1
Subchronic studies where toxicant has not attained steady-state generally 10 days for aquatic species and reproductive endpoints, and usually 30 days for terrestrial species and other endpoints	3

While myraids of combinations may occur; relatively few studies are available to determine toxicological benchmark values, and years of generalized toxicity testing is practically impossible and many times ethically irresponsible

Furthermore, most of the more recent studies describe molecular, mechanistic toxicological interactions and biomarkers that are not always related to reproductive or other endpoints directly related to population sustainability

Current Extrapolation Methodologies

Body-Scaling:

Primarily based on methodology for deriving human carcinogenic slope factors, and non-carcenogenic RF D's from animal data by interspecific metabolic normalization proportional to body surface area

Scaling factors for the animal/human extrapolations are generally based on the single endpoint of carcinogenicity

Toxicity of xenobiotics in any species is better correlated with chemical / physiological receptor interactions than metabolism alone

Physiologically Based Pharmacokinetic (Pharmacodnmic) Modeling:

Potentially, the best methodology for extrapolation, but has very intensive physiological data needs to make accurate predictions

Molecular mechanisms of toxicity, and their related potency. are fully understood for only a handful of compounds that we must deal with.

No extrapolation manipulations:
(as NOAELs and LOAELS are applied directly from similar species)

For example: Toxicity of copper in cattle, sheep, and goats of reproductive endpoints range from 0.03 - 0.1 mg Cu / kg body weight; therefore, mule deer NOAELS were set at 0.05

Hazard quotients developed using this method, however, do not provide risk managers with a straightforward understanding of the uncertainty associated with the estimate of risk

Applying Uncertainty Factors:
(Division of NOAELs and LOAELs, reported in toxicological literature, by a numerical factor)

Useful for estimating the uncertainty of inter-specific extrapolation

Historic use is rooted in human health extrapolations from animal studies in which an application of a factor of 100 has been used to convert lethal doses to safe doses and a factor of 10 to convert LOAELs to NOAELs

Application of large multiple UCFs may rapidly lead to overly conservative NOAELs

Arbitrary application of UCF values is not based on sound toxicologically derived rational

Uncertainty Factor Protocol for Ecological Risk Assessment

Toxicological Extrapolations to Wildlife Receptors
Approach by EPA R8 Ecotoxicologists:

Subacute studies generally 4-9 days for aquatic species and reproductive endpoints, and usually 7-29 days for terrestrial species and other endpoints		5
Acute studies usually 1-3 days for aquatic and 1-6 days for terrestrial (avoid)		10
Peracute studies -- usually <1 day and single exposures	(don't use)	15

C. Toxicologic Endpoint Extrapolation Category

		Non-Lethal mild	vs Lethal severe
No observed effects level	NOEL:	.75 to 1	2
No observed adverse effect level (»ED01)	NOAEL:	1 to 2	3
Lowest observed effects level	LOEL:	2 to 3	5
Lowest observed adverse effects level (»ED10)	LOAEL:	3 to 5	10
Frank effects level (»ED50)	FEL:	5 to 10	15

D. Modifying Factor Category

Threatened, or listed, and endangered species - L = 1.25, T = 1.5, E = 2	1 to 2
Relevance of endpoint to ecological health - population sustainability, incidence and severity	1 to 2
Extrapolating from lab to field or between - relative reality of field conditions vs lab control	.5 to 2
Study conducted with relevant co-contaminants - in situ or test actual media vs ignore major interactants	.5 to 2
Endpoint is mechanistically clear vs unclear - plausibly applied to ROC vs less plausible effect	1 to 2
Study species is either highly sensitive or highly resistant - if known, can adjust for ROC response	.5 to 2
Ratios used to estimate whole body burden from tissue or egg - mostly used for tissue residue comparisons	1 to 2
Intraspecific variability - susceptibility differences due to age, gender, developmental	1 to 2
Other applicable modifiers - define and present convincing scientific evidence for adjustment	.5 to 2

TRVs = Study Dose ÷ Total UCFs above, Total UCFs = A x B x C x D, where D = d1 x d2 x d3 ... x dn

Note, that under this uncertainty factor (UCF) scheme, R8 ecotoxicologists advise: 1) quantitate HQs only if total UCFs are < 100; 2) report HQs as semi-quantitative (low, medium, or high hazards) when total UCFs are < 500 but >100; and 3) qualitatively (presence or absence) assess hazards if UCFs are >500. When faced with less-than-fully quantitative HQs, either attempt to do better literature searches or identify and conduct studies to fill data-gaps that will possibly reduce toxicological uncertainties.

3 Products Compiled by EPA R8 Ecotoxicologists:

1. *Summary TRV tables* (see spreadsheet);

Key-Study's design and doses, ecotoxicological strength-of-study criteria, evaluation sheets on studies
UCFs described and defined, specific category UCF, and total uncertainty, and thus confidence in TRV
Chronic TRVs for estimated NOAEL and LOAEL: media-specific for COC and ROC

2. Exposure Tables

To convert dietary concentrations into doses for TRV development (kg food / kg BW-d) and back to RBCs (risk-based concentrations in media for ROC), use study's information if available, or EPA 1993 Exposure Factors Handbook values, or defensible literature

3. RBC Tables

HIs from summed HQs with similar toxicology
Ranges of HIs or HQs can be used to screen or to quantitate risks
Confidence of RBCs described from TRVs, Exposure factors, and media sampling

GOAL = to best derive chronic dose-responses of population-relevant endpoints Toxicity Reference Values (TRV) for selected receptors of concern (ROCs, represent related species) that are exposed to toxic contaminants released into environmental media; a chronic dose-response toxicity study with a ecologically relevant endpoint in the species of concern may have no TRV uncertainty!

GENERAL Considerations Related to Problem Formulation

ROCs: selected as representative of a trophic level, or feeding guild, primarily using 3 criteria: Natural history suggests high probability of exposure to COCs, Toxicological sensitivity of ROC to COCs, Keystone species within foodweb, greater sensitivity to stressor, and key position in a local community

COCs: nature (what, when) and extent (where, how much) of toxic stressors is understood: need representative sampling of the contacted contaminated media over space and time to delineate integrated exposure to ROCs; need to sample reference areas for background concentrations and incremental contributions to doses; should know geochemical form plus fate and transport

Exposure: a site conceptual model with all exposure pathways should be constructed to:
evaluate all pertinent routes of intake by ROCs consider all contaminated media that ROCs contact. Include food webs for bioaccumulation of COCs show fate and transport of COCs and from sources to ROCs

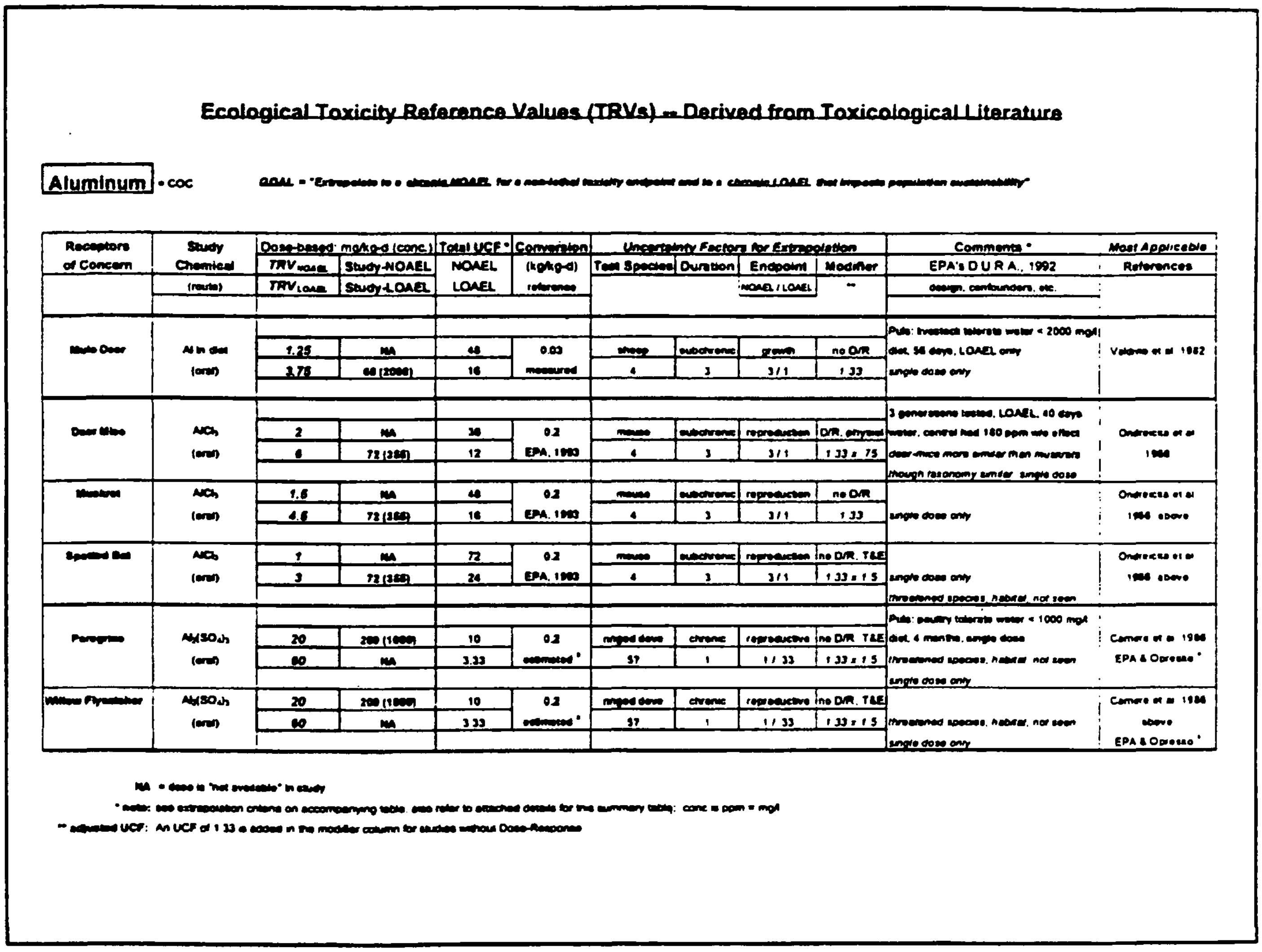
Summary

USEPA Region 8 continues to propose this UCF scheme at NPL sites within the region as we seek peer review in the ongoing effort to improve and modify wildlife interspecific methodology for extrapolations. Currently, the proposed method appears to be protective while maintaining a reasonable approach between two philosophical bounds: no correction for interspecific extrapolation, and arbitrary application of UCFs leading to highly conservative TRVs. Most importantly, it provides a "balanced" structure for searching and applying toxicity information in a transparent manner.

Finally, EPA guidance and sound science dictate that TRV-based HQs must be professionally balanced and interpreted (spatial, temporal, and population scales) with field effects data (which can also vary greatly in quality and relevance) to credibly assess ecological risk in terms of both excessiveness and reduction of exposure to achieve sufficient safety of exposed populations.

CONCLUSION

The intent of this scheme is a way to "normalize" all available toxicity daa, for a ROC/COC combination, based on the ectoxicologicol normalization of the study and it's applicaton at a specific site.



Ecological Toxicity Reference Values (TRVs) -- Derived from Toxicological Literature

Aluminum = COC

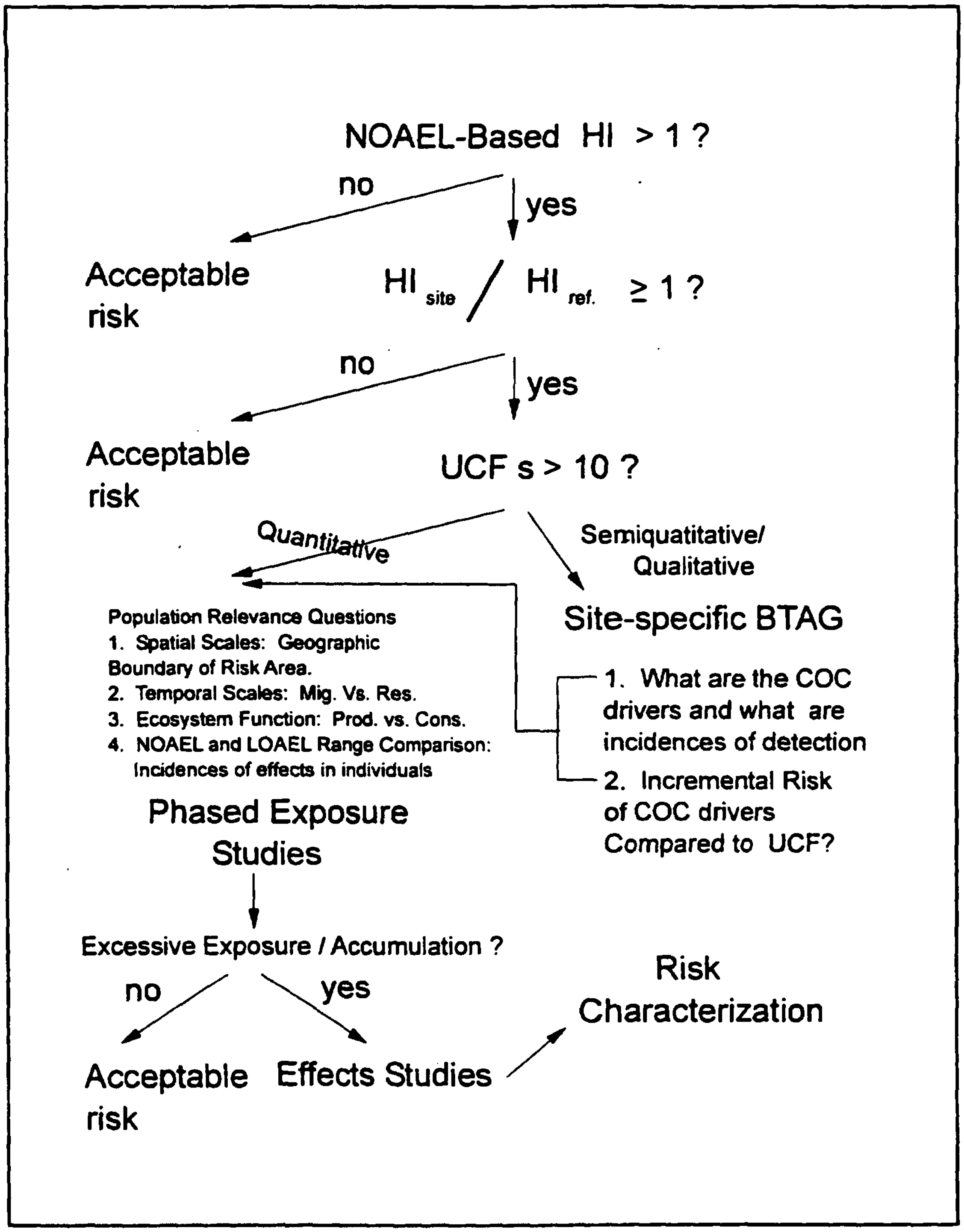
GOAL = "Extrapolate to a chronic NOAEL for a non-lethal toxicity endpoint and to a chronic LOAEL that impacts population sustainability"

Receptors of Concern	Study Chemical (route)	Dose-based: mg/kg-d (conc.) TRV NOAEL / TRV LOAEL	Study-NOAEL / Study-LOAEL	Total UCF * NOAEL / LOAEL	Conversion (kg/kg-d) reference	Uncertainty Factors for Extrapolation: Test Species	Duration	Endpoint NOAEL / LOAEL	Modifier **	Comments * EPA's D U R A., 1992 design, confounders, etc.	Most Applicable References
Mule Deer	Al in diet	1.25	NA	48	0.03	sheep	subchronic	growth	no D/R	Puls: livestock tolerate water < 2000 mg/l diet, 56 days, LOAEL only	Valdivia et al 1982
	(oral)	3.75	68 (2000)	16	measured	4	3	3 / 1	1 33	single dose only	
Deer Mice	$AlCl_3$	2	NA	36	0.2	mouse	subchronic	reproduction	D/R, physical	3 generations tested, LOAEL, 40 days water, control had 180 ppm w/o effect	Ondreicka et al
	(oral)	6	72 (388)	12	EPA, 1988	4	3	3 / 1	1 33 x .75	deer-mice more similar than muskrats though taxonomy similar single dose	1966
Muskrat	$AlCl_3$	1.6	NA	48	0.2	mouse	subchronic	reproduction	no D/R		Ondreicka et al
	(oral)	4.8	72 (388)	16	EPA, 1988	4	3	3 / 1	1 33	single dose only	1966 above
Spotted Bat	$AlCl_3$	1	NA	72	0.2	mouse	subchronic	reproduction	no D/R, T&E		Ondreicka et al
	(oral)	3	72 (388)	24	EPA, 1988	4	3	3 / 1	1 33 x 1 5	single dose only threatened species, habitat, not seen	1966 above
Peregrine	$Al_2(SO_4)_3$	20	200 (1000)	10	0.2	ringed dove	chronic	reproductive	no D/R T&E	Puls: poultry tolerate water < 1000 mg/l diet, 4 months, single dose	Carriere et al 1986
	(oral)	60	NA	3.33	estimated *	57	1	1 / 33	1 33 x 1 5	threatened species, habitat not seen single dose only	EPA & Opresko *
Willow Flycatcher	$Al_2(SO_4)_3$	20	200 (1000)	10	0.2	ringed dove	chronic	reproductive	no D/R, T&E		Carriere et al 1986 above
	(oral)	60	NA	3 33	estimated *	57	1	1 / 33	1 33 x 1 5	threatened species, habitat, not seen single dose only	EPA & Opresko *

NA = dose is "not available" in study

* note: see extrapolation criteria on accompanying table, also refer to attached details for this summary table; conc is ppm = mg/l

** adjusted UCF: An UCF of 1 33 is added in the modifier column for studies without Dose-Response


NOAEL-Based HI > 1 ?
no
yes
Acceptable risk
HI site / HI ref. ≥ 1 ?
no
yes
Acceptable risk
UCF s > 10 ?
Quantitative
Semiquatitative/ Qualitative
Site-specific BTAG
Population Relevance Questions
1. Spatial Scales: Geographic Boundary of Risk Area.
2. Temporal Scales: Mig. Vs. Res.
3. Ecosystem Function: Prod. vs. Cons.
4. NOAEL and LOAEL Range Comparison: Incidences of effects in individuals
1. What are the COC drivers and what are incidences of detection
2. Incremental Risk of COC drivers Compared to UCF?
Phased Exposure Studies
Excessive Exposure / Accumulation ?
no
yes
Acceptable risk
Effects Studies
Risk Characterization

ATTACHMENT 2

TRV Literature

EPA Region VIII
Denver, CO

Ecosystems Protection and Remediation Division

Feb 1997
2 Pages

Uncertainty Factor Protocol for Ecological Risk Assessment

Toxicological Extrapolations to Wildlife Receptors

Approach: Select the "most applicable" published literature on field or laboratory studies of dose-responsive toxicity for each chemical contaminant of ecological concern (COC) and receptor of concern (ROC) combination. Obtain the categorical information below to properly extrapolate a selected study's toxicological design and findings to both chronic no-observable-adverse-effect-level (NOAEL) and low-observable-adverse-effect-level (LOAEL) doses as "toxicological reference values" (TRV). Use the extrapolated TRV_{NOAEL} and TRV_{LOAEL} to help develop a range (coupled with the 95% UCL C-term and with the CTE to RME exposure ranges) of dose-based hazard quotients (HQs), with the intent being that HQs <NOAELs pose no excess risk and HQs >LOAELs begin to pose more of a population risk. Note, that under this uncertainty factor (UCF) scheme, R8 toxicologists advise: quantitate HQs only if total UCFs are ≤100, report HQs as semi-quantitative (low, medium, or high hazards) when total UCFs are ≤500 but >100, and qualitatively (presence or absence) assess hazards if UCFs are >500. When faced with less-than-fully quantitative HQs, either attempt to do better literature searches or identify and conduct studies to fill data-gaps that will possibly reduce toxicological uncertainties. Tissue residue data (vs doses) are scarcer and usually less informative for extrapolations. Dietary concentrations must be converted to doses. Finally, EPA guidance and sound science dictate that TRV-based HQs must be professionally balanced and interpreted (spatial, temporal and population scales) with field effects data (which can also vary greatly in quality and relevance) to credibly assess ecological risk in terms of both excessiveness and reduction of exposure to achieve sufficient safety of local exposed populations. **TRV Goal** = Extrapolate to a <u>chronic NOAEL</u> with non-lethal toxicity for HQ development and to a <u>chronic LOAEL</u> that relates to impacts on population sustainability.

Basis for Uncertainty	Uncertainty Value Assigned
A. **Intertaxon** Variability Extrapolation Category	
Same species	1
Same genus, different species	2
Same family, different genus	3
Same order, different family	4
Same class, different order	5
Same phylum, different class	generally too far to extrapolate
B. **Exposure Duration** Extrapolation Category	
<u>Chronic</u> studies where toxicant attains pseudo-steady-state - generally >30 days for aquatic species and reproductive endpoints, and usually >90 days for terrestrial species and other endpoints	1
<u>Subchronic</u> studies where toxicant has not attained steady-state - generally ≥10 days for aquatic species and reproductive endpoints, and usually ≥30 days for terrestrial species and other endpoints	3
<u>Subacute</u> studies - generally 4-9 days for aquatic species and reproductive endpoints, and usually 7-29 days for terrestrial species and other endpoints	5
<u>Acute</u> studies -- usually 1-3 days for aquatic and 1-6 days for terrestrial	10 (avoid)
<u>Peracute</u> studies -- usually <1 day and single exposures	15 (don't use)

C. **Toxicologic Endpoint** Extrapolation Category

Note: if reported, use the study's NOAEL and LOAEL for TRVs, else use the ratios below to estimate a non-lethal NOAEL and LOAEL from the study report of other endpoints; only use the NOEL and LOEL (non-toxic) adjustments "if" the study also looked for adverse (toxic) effects, else consider as OAELs. Use professional ecotoxicologic judgement to decide on population importance of non-lethal severity.

	Non-Lethal mild		vs	Lethal severe	
No observed effects level	NOEL:	.75	to	1	2
No observed adverse effect level ($\approx ED_{01}$)	**NOAEL**:	1	to	2	3
Lowest observed effects level	LOEL:	2	to	3	5
Lowest observed adverse effects level ($\approx ED_{10}$)	**LOAEL**:	3	to	5	10
Frank effects level ($\approx ED_{50}$)	FEL:	5	to	10	15

D. **Modifying** Factor Category

Use professional ecotoxicological judgement to consider need for none, some or all modifiers, and give rationale (maximum deviations need definitive data); note that a value of "1" specifies no modification, and that these (up to 2-decimals) multipliers are combined with UCF divisors above to generate a TRV.

Threatened, or listed, and endangered species - L = 1.25, T = 1.5, E = 2	1 to 2
Relevance of endpoint to ecological health - population sustainability, incidence and severity	1 to 2
Extrapolating from lab to field or between - relative reality of field conditions vs lab control	.5 to 2
Study conducted with relevant co-contaminants - *in situ* or test actual media vs ignore major interactants	.5 to 2
Endpoint is mechanistically clear vs unclear - plausibly applied to ROC vs less plausible effect	1 to 2
Study species is either highly sensitive or highly resistant - if known, can adjust for ROC response	.5 to 2
Ratios used to estimate whole body burden from tissue or egg - mostly used for tissue residue comparisons	1 to 2
Intraspecific variability - substantial susceptibility differences due to age, gender, developmental	1 to 2
Other applicable modifiers - define and present convincing scientific evidence for adjustment	.5 to 2

-- **TRV = Study Dose ÷ Total UCFs,** Total UCFs = A x B x C x D, where $D = d_1 \times d_2 \times d_3 ... \times d_n$

-- **To convert dietary concentrations into doses** for TRV development (kg food / kg BW-d), use study information if available, or EPA 1993 Exposure Factors Handbook values, or valid literature

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Ecological Toxicity Reference Values (TRVs) - Derived from Toxicological Literature

ARSENIC =COC

GOAL = *"Extrapolate to a chronic NOAEL for a non-lethal toxicity endpoint and to a chronic LOAEL that impacts sustainability"*

Receptors of Concern	Study Chemical	Dose-based: mg/kg-d (conc.in ppm)		Total UCF	Conversion	Uncertainity Factors for Extrapolation				Comments	Most Applicable
	(route)	TRV_{NOAEL}	Study-NOAEL	NOAEL	(kg/kg-d)	Test Species	Duration	Endpoint	Modifier	EPA's D.U.R.A., 1992	Reference
		TRV_{LOAEL}	Study-LOAEL	LOAEL	reference			(NOAEL/LOAEL)		design, confounders, etc.	
White-tailed deer	Potassium arsenate	0.125	0.5	4	Not required	Sheep	chronic	Lowered body weight	none	Gelatin capsule, 3 animals	James et al., 1968
	(capsule)	0.38	NA	1.32		4	1	1/.33	1		
Deer Mice	Sodium arsenite	0.6	0.6 (5)	1	0.12	mouse	Chronic	Reproduction	none	3 generations	Pershagen and Vahter 1979
	(diet)	1.8	NA	0.33	Sax & Lewis, 1989	1	1	1/.33	1		
	Arsenic-soluble salt	0.04	0.04 (5)	1	0.0075	Charles River CD Mice	Chronic	Reproduction	none	Drinking water; 3 generations	Schroeder & Mitchner, 1971
	(water)	0.12	NA	0.33	ORNL 1996	1	1	1/.33	1		
Red Fox	Sodium arsenite	0.12	0.6 (5)	5	0.12	mouse	Chronic	Reproduction	none	3 generations	Pershagen and Vahter 1979
	(diet)	0.36	NA	1.65	Sax & Lewis, 1989	5	1	1/.33	1		
	Arsenite	0.01	0.04 (5)	5	0.0075	Charles River CD Mice	Chronic	Reproduction	none	Drinking water; 3 generations	Schroeder & Mitchner, 1971
	(water)	0.02	NA	1.65	ORNL 1996	5	1	1/.33	1		

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Ecological Toxicity Reference Values (TRVs) - Derived from Toxicological Literature

Receptors of Concern	Study Chemical	Dose-based: mg/kg-d (conc. in ppm)		Total UCF	Conversion	Uncertainity Factors for Extrapolation				Comments	Most Applicable
	(route)	TRV$_{NOAEL}$	Study-NOAEL	NOAEL	(kg/kg-d)	Test Species	Duration	Endpoint	Modifier	EPA's D.U.R.A., 1992	Reference
		TRV$_{LOAEL}$	Study-LOAEL	LOAEL	reference			(NOAEL/LOAEL)		design, confounders, etc.	
Mink	Sodium arsenite	0.12	0.6 (5)	5	0.12	mouse	Chronic	Reproduction	none	3 generations	Pershagen and Vahter 1979
	(diet)	0.36	NA	1.65	Sax & Lewis, 1989	5	1	1/.33	1		
	Arsenite	0.01	0.04 (5)	5	0.0075	Charles River CD Mice	Chronic	Reproduction	none	Drinking water; 3 generations	Schroeder & Mitchner, 1971
	(water)	0.02	NA	1.65	ORNL 1996	5	1	1/.33	1		
Shrew	Sodium arsenite	1	1 (5)	1	0.12	mouse	Chronic	Reproduction	none	3 generations	Pershagen and Vahter 1979
	(diet)	3.03	NA	1	Sax & Lewis, 1989	1	1	1/.33	1		
	Arsenic-soluble salt	0.04	0.04 (5)	1	0.0075	Charles River CD Mice	Chronic	Reproduction	none	Drinking water 3 generations	Schroeder & Mitchner, 1971
	(water)	0.12	NA	0.33	ORNL 1996	1	1	1/.33	1		

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Ecological Toxicity Reference Values (TRVs) - Derived from Toxicological Literature

Receptors of Concern	Study Chemical	Dose-based: mg/kg-d (conc.in ppm)		Total UCF	Conversion	Uncertainity Factors for Extrapolation				Comments	Most Applicable
	(route)	TRV_{NOAEL}	Study-NOAEL	NOAEL	(kg/kg-d)	Test Species	Duration	Endpoint	Modifier	EPA's D.U.R.A., 1992	Reference
		TRV_{LOAEL}	Study-LOAEL	LOAEL	reference			(NOAEL/LOAEL)		design, confounders, etc.	
Mallard	Sodium arsenate	17.5	17.5(100)	1	0.175	Mallard	Chronic	Reproduction, growth	none	2 pairs (24 ducks)/diet; 4 diet	Stanley et al. 1994
	(diet)	70	70(400)	1	Camardese et al. 1990	1	1	1	1	4 diets; 8 weeks	
Robin	Copper acetoarsenite	13.3	40 (33)	3	1.2	Brown-headed cowbird	Chronic	Mortality	Chemical form	4 conc; 6 months	NAS 1977
	(diet)	24	120 (99.8)	5	Robin; EPA 1993	3	1	3/5	0.33		
	Sodium arsenate	3.5	17.5(100)	5	0.175	Mallard	Chronic	Reproduction, growth	none	12 pairs (24 ducks)/diet;	Stanley et al. 1994
	(diet)	14	70(400)	5	Camardese et al. 1990	5	1	1	1	4 diets; 8 weeks	
	Arsenic pentoxide	1.4	7 (40)	5	0.175	White Leghorn hens	Chronic	Egg production	none	NOAEL determined by broken line regression	Hermayer et al., 1977
	(diet)	4.24	NA	1.65	Sax & Lewis, 1985	5	1	1/0.33	1		
Kestrel	Copper acetoarsenite	13.3	40 (33)	3	1.2	Brown-headed cowbird	Chronic	Mortality	Chemical form	4 conc; 6 months	NAS 1977
	(diet)	24	120 (99.8)	5	Robin; EPA 1993	3	1	3/5	0.33		
	Sodium arsenate	3.5	17.5(100)	5	0.175	Mallard	Chronic	Reproduction, growth	none	12 pairs (24 ducks)/diet;	Stanley et al. 1994
	(diet)	14	70(400)	5	Camardese et al. 1990	5	1	1	1	4 diets; 8 weeks	
	Arsenic pentoxide	1.4	7 (40)	5	0.175	White Leghorn hens	Chronic	Egg production	none	NOAEL determined by broken line regression	Hermayer et al., 1977

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Ecological Toxicity Reference Values (TRVs) - Derived from Toxicological Literature

Receptors of Concern	Study Chemical	Dose-based: mg/kg-d (conc. in ppm)		Total UCF	Conversion	Uncertainty Factors for Extrapolation				Comments	Most Applicable
	(route)	TRV_{NOAEL}	Study-NOAEL	NOAEL	(kg/kg-d)	Test Species	Duration	Endpoint	Modifier	EPA's D.U.R.A., 1992	Reference
		TRV_{LOAEL}	Study-LOAEL	LOAEL	reference			(NOAEL/LOAEL)		design, confounders, etc.	
	(diet)	4.24	NA	1.65	Sax & Lewis, 1985	5	1	1/0.33	1		
Heron	Copper acetoarsenite	13.3	40 (33)	3	1.2	Brown-headed cowbird	Chronic	Mortality	Chemical form	4 conc; 6 months	NAS 1977
	(diet)	24	120 (99.8)	5	Robin; EPA 1993	3	1	3/5	0.33		
	Sodium arsenate	3.5	17.5(100)	5	0.175	Mallard	Chronic	Reproduction, growth	none	12 pairs (24 ducks)/diet;	Stanley et al. 1994
	(diet)	14	70(400)	5	Camardese et al. 1990	5	1	1	1	4 diets; 8 weeks	
	Arsenic pentoxide	1.4	7 (40)	5	0.175	White Leghorn hens	Chronic	Egg production	none	NOAEL determined by broken line regression	Hermayer et al., 1977
	(diet)	4.24	NA	1.65	Sax & Lewis, 1985	5	1	1/0.33	1		

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Ecological Toxicity Reference Values (TRVs) - Derived from Toxicological Literature

CADMIUM =COC   GOAL = *"Extrapolate to a chronic NOAEL for a non-lethal toxicity endpoint and to a chronic LOAEL that impacts sustainability"*

Receptors of Concern	Study	Dose-based: mg/kg-d (conc. in ppm)		Total UCF	Conversion	Uncertainity Factors for Extrapolation				Comments	Most Applicable
	Chemical	TRV_{NOAEL}	Study-NOAEL	NOAEL	(kg/kg-d)	Test Species	Duration	Endpoint	Modifier	EPA's D.U.R.A., 1992	Reference
	(route)	TRV_{LOAEL}	Study-LOAEL	LOAEL	reference			(NOAEL/LOAEL)		design, confounders, etc.	
White-tailed Deer	Cadmium sulfate	0.09	0.37 (12.3)	4	0.03	Lambs	Chronic	Reproduction	none	4 conc; 8 animals/diet; 149 days (pre- & postpartum exposure) [no effects observed]	Mills and Dalgarno 1972
	(diet)	0.28	NA	1.32	Doyle et al. 1974	4	1	1/0.33	1		
	Cadmium chloride	0.11	0.45 (15)	4	0.03	Lambs	Chronic	Weight gain	none	4 doses used, 6 animals/dose (No effect on testes weight or spermatogenesis)	Doyle et al., 1974
	(diet)	0.22	0.9 (30)	4	(measured)	4	1	1	1		
	Cadmium sulfate	0.064	0.256	4	not required	Sheep	Chronic	Reproduction	none	3 doses, 8 animals/dose 278 days (pre- and postpartum) [no effects observed]	Dalgarno, 1980
	(oral)	0.19	NA	1.32		4	1	1/.33	1		
Deer Mice	Cadmium chloride	0.83	2.5 (31)	3	0.08	Albino rats	Chronic	Growth	none	6 treatments; 100 days	Wilson et al. 1941
	(diet)	1.7	5.0 (62)	3	ORNL 1996	3	1	1/1	1		
	Cd salts	0.15	(NA)	3	0.046	CR CD mice	Chronic	Reproduction	none	Drinking water; 3 generations	Schroeder & Mitchneer 1971
	(aqueous)	0.46	0.46 (10)	1	ORNL 1996	1	1	3/1	1		
Red Fox	Cadmium chloride	0.5	2.5 (31)	5	0.08	Albino rats	Chronic	Growth	none	6 treatments; 100 days	Wilson et al. 1941
	(diet)	1	5.0 (62)	5	ORNL 1996	5	1	1/1	1		
	Soluble cadmium salts	0.03	NA	15	0.046	Charles River CD Mice	Chronic	Reproduction	none	Drinking water;	
	(aqueous)	0.09	0.46 (10)	5	ORNL 1996	5	1	3/1	1	3 generations	Schroeder & Mitchner, 1971
Shrew	Cadmium in food source	8	8	1	not required	Shrews	Chronic	Tissue concentrations	none	At least 10 animals per season and location	Ma et al., 1991
	(oral)	16	16	1		1	1	1	1	dose=cadmium in diet	

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Ecological Toxicity Reference Values (TRVs) - Derived from Toxicological Literature

Receptors of Concern	Study	Dose-based: mg/kg-d (conc. in ppm)		Total UCF	Conversion	Uncertainty Factors for Extrapolation				Comments	Most Applicable
	Chemical	TRV_{NOAEL}	Study-NOAEL	NOAEL	(kg/kg-d)	Test Species	Duration	Endpoint	Modifier	EPA's D.U.R.A., 1992	Reference
	(route)	TRV_{LOAEL}	Study-LOAEL	LOAEL	reference			(NOAEL/LOAEL)		design, confounders, etc.	
										field study	
Mink	Cadmium chloride	0.5	2.5 (31)	5	0.08	Albino rats	Chronic	Growth	none	6 treatments; 100 days	Wilson et al. 1941
	(diet)	1	5.0 (62)	5	ORNL 1996	5	1	1/1	1		
	Soluble cadmium salts	0.03	NA	15	0.046	Charles River CD Mice	Chronic	Reproduction	none	Drinking water;	
	(aqueous)	0.09	0.46 (10)	5	ORNL 1996	5	1	3/1	1	3 generations	Schroeder & Mitchner, 1971

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Ecological Toxicity Reference Values (TRVs) - Derived from Toxicological Literature

Receptors of Concern	Study	Dose-based: mg/kg-d (conc. in ppm)		Total UCF	Conversion	Uncertainty Factors for Extrapolation				Comments	Most Applicable
	Chemical	TRV_{NOAEL}	Study-NOAEL	NOAEL	(kg/kg-d)	Test Species	Duration	Endpoint	Modifier	EPA's D.U.R.A., 1992	Reference
	(route)	TRV_{LOAEL}	Study-LOAEL	LOAEL	reference			(NOAEL/LOAEL)		design, confounders, etc.	
Mallard	Cadmium Chloride	1.56	1.56 (17.3)	1	0.09	Mallard	Chronic	Reproduction	none	4 doses, 20 animals/dose	White & Finley, 1978
	(diet)	21.5	21.5 (239)	1	measured	1	1	1	1		
Robin	Cadmium Chloride	0.31	1.56 (17.3)	5	0.09	Mallard	Chronic	Reproduction	none	4 doses, 20 animals/dose	White & Finley, 1978
	(diet)	4.3	21.5 (239)	5	measured	5	1	1	1		
	Cadmium acetate	0.28	1.4(8)	5	0.175	White Leghorn hens	Chronic	Egg production, fertility	none	NOAEL determined by broken line regression	Hermayer et al., 1977
	(diet)	3.5	17.5 (100)	5	Sax & Lewis, 1989	5	1	1/1	1		
Kestrel	Cadmium Chloride	0.31	1.56 (17.3)	5	0.09	Mallard	Chronic	Reproduction	none	4 doses, 20 animals/dose	White & Finley, 1978
	(diet)	4.3	21.5 (239)	5	measured	5	1	1	1		
	Cadmium acetate	0.28	1.4(8)	5	0.175	White Leghorn hens	Chronic	Egg production, fertility	none	NOAEL determined by broken line regression	Hermayer et al., 1977
	(diet)	3.5	17.5 (100)	5	Sax & Lewis, 1989	5	1	1/1	1		
Heron	Cadmium Chloride	0.31	1.56 (17.3)	5	0.09	Mallard	Chronic	Reproduction	none	4 doses, 20 animals/dose	White & Finley, 1978
	(diet)	4.3	21.5 (239)	5	measured	5	1	1	1		
	Cadmium acetate	0.28	1.4(8)	5	0.175	White Leghorn hens	Chronic	Egg production, fertility	none	NOAEL determined by broken line regression	Hermayer et al., 1977
	(diet)	3.5	17.5 (100)	5	Sax & Lewis, 1989	5	1	1/1	1		

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Ecological Toxicity Reference Values (TRVs) - Derived from Toxcological Literature

COPPER =COC GOAL = "*Extrapolate to a chronic NOAEL for a non-lethal toxicity endpoint and to a chronic LOAEL that impacts sustainability*"

Receptors of Concern	Study Chemical (route)	Dose-based: mg/kg-d (conc. in ppm)		Total UCF	Conversion	Uncertainity Factors for Extrapolation				Comments	Most Applicable
		TRV_{NOAEL}	Study-NOAEL	NOAEL	(kg/kg-d)	Test Species	Duration	Endpoint	Modifier	EPA's D.U.R.A., 1992	Reference
		TRV_{LOAEL}	Study-LOAEL	LOAEL	reference			(NOAEL/LOAEL)		design, confounders, etc.	
White-tailed Deer	Naturally occurring copper in forage	1.24	0.62 (20)	0.5	0.031	Deer	Chronic	Copper deficiency	none	22 domesticated deer displayed Cu deficiency (NOAEL = Minimum dietary requirement)	Wilson 1989
		3.1	NA	0.2	Mautz et al. 1978	1	1	0.5/0.2	1		
	Cuprous Iodide	0.25	NA	20	not required	Sheep	Chronic	Mortality	Sensitive species/ Exposure route	4 sheep; 1 dose; gelatin capsule 14 weeks	Sutter et al. 1958
	(capsule)	0.81	4.9	6		4	1	10/3	0.5		
	Copper sulfate	0.02	3.03 FEL(181.79)	150	NA	Sheep	Subchronic	Haemolysis/ death	Sensitive species	1 dose, 8 animals/dose	Ishmael et al., 1971
	(oral solution)	0.06	3.03 FEL(181.79)	50		4	5	15/5	0.5		
Deer Mice	Copper sulfate	4.4	40 (500)	9	0.08	Albino rats	Subchronic	Growth	none	5 diets; 4 weeks	Boyden et al. 1937
	(diet)	8.9	80 (1000)	9	(ORNL 1996)	3	3	1/1	1		
	Copper gluconate	0.17	NA	9	0.12	C57BL/6J mice	Chronic	Reduction of lifespan	none	3 doses; lifetime exposure; number of animals/dose not reported	Massie & Aiello, 1984
	(water)	0.5	1.5 (12.7)	3	Sax & Lewis, 1989	3	1	3/1	1		
Red Fox	Copper sulfate	5.9	17.7 (110.5)	3	0.16	Mink	Chronic	Reproductive success	none	4 doses, 24 animals/dose	Aulerich et al., 1982
	(diet)	8.6	25.7 (160.5)	3	EPA, 1993	3	1	1/1	1		
Shrew	Copper sulfate	4.4	40 (500)	9	0.08	Albino rats	Subchronic	Growth	none	5 diets; 4 weeks	Boyden et al. 1937
	(diet)	8.9	80 (1000)	9	(ORNL 1996)	3	3	1/1	1		
	Copper gluconate	0.17	NA	9	0.12	C57BL/6J mice	Chronic	Reduction of lifespan	none	3 doses; lifetime exposure; number of animals/dose not reported	Massie & Aiello, 1984
	(water)	0.5	1.5 (12.7)	3	Sax & Lewis, 1989	3	1	3/1	1		
Mink	Copper sulfate	17.7	17.7(110.5)	1	0.16	Mink	Chronic	Reproductive success	none	4 doses; 24 animals/dose	Aulerich et al., 1982

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Ecological Toxicity Reference Values (TRVs) - Derived from Toxcological Literature

Receptors of Concern	Study Chemical (route)	Dose-based: mg/kg-d (conc. in ppm)		Total UCF	Conversion	Uncertainity Factors for Extrapolation				Comments	Most Applicable
		TRV_{NOAEL}	Study-NOAEL	NOAEL	(kg/kg-d)	Test Species	Duration	Endpoint	Modifier	EPA's D.U.R.A., 1992	Reference
		TRV_{LOAEL}	Study-LOAEL	LOAEL	reference			(NOAEL/LOAEL)		design, confounders, etc.	
	(oral)	25.7	25.7 (160.5)	1	EPA, 1993	1	1	1	1		
Mallard	Copper oxide	5.4	26.9 (403)	5	0.067	Chicks	Chronic	Growth	none	12 doses, 20 animals/dose	Mehring et al., 1960
	(oral)	10	49.9 (749)	5	measured	5	1	1	1		
Robin	Copper oxide	5.4	26.9 (403)	5	0.067	Chicks	Chronic	Growth	none	12 doses, 20 animals/dose	Mehring et al., 1960
	(oral)	10	49.9 (749)	5	measured	5	1	1	1		
Kestrel	Copper oxide	5.4	26.9 (403)	5	0.067	Chicks	Chronic	Growth	none	12 doses, 20 animals/dose	Mehring et al., 1960
	(oral)	10	49.9 (749)	5	measured	5	1	1	1		
Heron	Copper oxide	5.4	26.9 (403)	5	0.067	Chicks	Chronic	Growth	none	12 doses, 20 animals/dose	Mehring et al., 1960
	(oral)	10	49.9 (749)	5	measured	5	1	1	1		

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Ecological Toxicity Reference Values (TRVs) - Derived from Toxcological Literature

LEAD =COC

GOAL = *"Extrapolate to a chronic NOAEL for a non-lethal toxicity endpoint and to a chronic LOAEL that impacts sustainability"*

Receptors of Concern	Study Chemical (route)	Dose-based: mg/kg-d (conc. in ppm)		Total UCF	Conversion	Uncertainty Factors for Extrapolation				Comments	Most Applicable Reference
		TRV_{NOAEL}	Study-NOAEL	NOAEL	(kg/kg-d)	Test Species	Duration	Endpoint	Modifier	EPA's D.U.R.A., 1992	Reference
		TRV_{LOAEL}	Study-LOAEL	LOAEL	reference			(NOAEL/LOAEL)		design, confounders, etc.	
White-tailed Deer	Elemental Lead	1.13	4.5	4	not required	Sheep	Chronic	Reproduction	none	3 diets, 10 animals/diet; 6 months	Carson et al., 1973
	(diet)	3.41	NA	1.32		4	1	1/.33	1		
	Elemental Lead	1.13	4.5	4	not required	Sheep	Chronic	Learning behavior	none	2 doses, 10 animals/dose	Carson et al, 1974
	(diet)	3.41	NA	1.32		4	1	1/.33	1		
	Lead acetate	0.25	5	20	not required	Sheep	Subchronic	Reproduction/ mortality	none	2 doses in gelatin capsules, 2 animals/dose	James et al. 1966
	(capsule)	0.45	9	20		4	5	1/1	1		
Deer Mice	Lead acetate	2.2	20 (250) [NOAEL=3908 ppm Pb in ingested soil]	9	0.08	Rats	Subchronic	Growth	none	10 animals/diet; low Ca diet = max Pb uptake; 5 diets (+ 6 additional diets with Pb-soil); 4 weeks	Freeman et al. 1992
	(diet)	6.7	NA	3	ORNL, 1996	3	3	1/0.33	1		
	Soluble lead salt	0.65	NA	9	0.12	Charles River CD Mice	Chronic	Reproduction	none	Drinking water;	Schroeder & Mitchner, 1971
	(water)	1.67	5.0 (25)	3	Sax & Lewis, 1989	3	1	3/1	1	3 generations	
Red Fox	Lead acetate	0.42	1.2 (52)	3	0.024	Dogs	Chronic	Reproduction, growth	none	4 diets; 2-4 animals/diet;	Horwitt & Cowgill
	(diet)	0.82	2.4(102)	3	ORNL 1996	3	1	1/1	1	prenatal exposure + 7 months	1939
	Lead carbonate	0.25	NA	12	not required	Dogs	Chronic	Neurological disorders	none	6 doses, 1 animal/dose	Staples, 1955
	(capsule)	0.75	3	4		4	1	3/1	1		

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Ecological Toxicity Reference Values (TRVs) - Derived from Toxcological Literature

Receptors of Concern	Study Chemical (route)	Dose-based: mg/kg-d (conc. in ppm)		Total UCF	Conversion (kg/kg-d) reference	Uncertainty Factors for Extrapolation				Comments	Most Applicable Reference
		TRV_{NOAEL}	Study-NOAEL	NOAEL		Test Species	Duration	Endpoint	Modifier	EPA's D.U.R.A., 1992	
		TRV_{LOAEL}	Study-LOAEL	LOAEL				(NOAEL/LOAEL)		design, confounders, etc.	
Shrew	Lead acetate	2.2	20 (250) (NOAEL+3908 ppm Pb in ingested soil)	9	0.08	Rats	Subchronic	Growth	none	10 animals/diet; low Ca diet = max Pb uptake;	Freeman et al. 1992
	(diet)	6.7	NA	3	(ORNL 1996)	3	3	1/0.33	1	8 diets (+ 8 additional diets with Pb-soil); 4 weeks	
	Lead	6.2	NA	3	not required	Shrews	Chronic	Tissue concentrations	none	Number of animals unknown	Ma et al., 1991
	(diet)	18.6	18.6	1		1	1	3/1	1	dose=lead in diet	
	Soluble lead salt	0.66	NA	9	0 12	Charles River CD Mice	Chronic	Reproduction	none	Drinking water;	Schroeder & Mitchner, 1971
	(water)	1.87	5.0 (25)	3	Sax & Lewis, 1989	3	1	3/1	1	3 generations	
										field study	
Mink	Lead acetate	0.42	1.2 (60)	3	0.024	Dogs	Chronic	Reproduction, growth	none	4 diets; 2-4 animals/diet;	Horwitt & Cowgill
	(diet)	0.82	2.4(102)	3	(ORNL 1996)	3	1	1/1	1	prenatal exposure + 7 months	1939
	Lead carbonate (capsule)	0 25	NA	12	not required	Dogs	Chronic	Neurological disorders	none	6 doses, 1 animal/dose	Staples, 1955
		0.75	3	4		4	1	3/1	1		
Mallard	Lead acetate	1.47	4.4 (25)	3	0.176	Leghorn hens	Chronic	Egg production	none	3 doses, 10 animals/dose	Edens & Garlich, 1983
	(diet)	2.93	8.8 (50)	3	Sax & Lewis, 1989	3	1	1	1		
	Lead nitrate	0.18	0.18 (1.76)	1	0.1	Mallard	Chronic	ALAD suppression	none	4 doses, 20 animals/dose	Finley & Dieter, 1976
	(diet)	0.52	0.52 (5.13)	1	measured	1	1	1	1		
	Lead Oxide	22	110(630)	5	0.175	White leghorn hens	Chronic	Reproduction	none	4 doses, 4 animals/dose	Hermayer et al., 1977
	(diet)	66.7	NA	1.65	Sax & Lewis, 1989	5	1	1/.33	1	broken line regression analysis	
Robin	Lead acetate	0.88	4.4 (25)	5	0.175	Leghorn hens	Chronic	Egg production	none	3 doses, 10 animals/dose	Edens & Garlich, 1983
	(diet)	1.76	8 8 (50)	5	Sax & Lewis, 1989	5	1	1	1		

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Ecological Toxicity Reference Values (TRVs) - Derived from Toxcological Literature

Receptors of Concern	Study	Dose-based: mg/kg-d (conc. in ppm)		Total UCF	Conversion	Uncertainity Factors for Extrapolation				Comments	Most Applicable
	Chemical	TRV_{NOAEL}	Study-NOAEL	NOAEL	(kg/kg-d)	Test Species	Duration	Endpoint	Modifier	EPA's D.U.R.A., 1992	Reference
	(route)	TRV_{LOAEL}	Study-LOAEL	LOAEL	reference			(NOAEL/LOAEL)		design, confounders, etc.	
	Lead Oxide	22	110(630)	5	0.175	White leghorn hens	Chronic	Reproduction	none	4 doses, 4 animals/dose	Hermayer et al., 1977
	(diet)	66.7	NA	1.65	Sax & Lewis, 1989	5	1	1/.33	1	broken line regression analysis	
Kestrel	Lead acetate	0.88	4.4 (25)	5	0.175	Leghorn hens	Chronic	Egg production	none	3 doses, 10 animals/dose	Edens & Garlich, 1983
	(diet)	1.76	8.8 (50)	5	Sax & Lewis, 1989	5	1	1	1		
	Elemental lead	14.5	14.5 (50)	1	0.29	Kestrels	Chronic	Reproduction	none	3 diets; 32 kestrels (16 pair)/diet; 6 months (pre- and post-parturation)	Pattee 1984
	(diet)	43.9	NA	0.33	Koplin et al. 1980	1	1	1/0.33	1		
	Lead Oxide	22	110(630)	5	0.175	White leghorn hens	Chronic	Reproduction	none	4 doses, 4 animals/dose	Hermayer et al., 1977
	(diet)	66.7	NA	1.65	Sax & Lewis, 1989	5	1	1/.33	1	broken line regression analysis	
	Lead acetate	0.005	NA	15	0.078	Japanese Quail hens	Chronic	Egg production	none	4 doses, 20 animals/dose	Edens & Garlich, 1983
	(diet)	0.016	0.078 (1)	5	EPA, 1993 (northern bobwhite)	5	1	3/1	1		
Heron	Lead acetate	0.88	4.4 (25)	5	0.175	Leghorn hens	Chronic	Egg production	none	3 doses, 10 animals/dose	Edens & Garlich, 1983
	(diet)	1.76	8.8 (50)	5	Sax & Lewis, 1989	5	1	1	1		
	Lead Oxide	22	110(630)	5	0.175	White leghorn hens	Chronic	Reproduction	none	4 doses, 4 animals/dose	Hermayer et al., 1977
	(diet)	66.7	NA	1.65	Sax & Lewis, 1989	5	1	1/.33	1	broken line regression analysis	
	Lead acetate	0.005	NA	15	0.078	Japanese Quail hens	Chronic	Egg production	none	4 doses, 20 animals/dose	Edens & Garlich, 1983
	(diet)	0.016	0.078 (1)	5	EPA, 1993 (northern bobwhite)	5	1	3/1	1		

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Ecological Toxicity Reference Values (TRVs) - Derived from Toxicological Literature

ZINC =COC GOAL = *"Extrapolate to a chronic NOAEL for a non-lethal toxicity endpoint and to a chronic LOAEL that impacts sustainability"*

Receptors of Concern	Study Chemical (route)	Dose-based: mg/kg-d (conc. in ppm)		Total UCF	Conversion	Uncertainty Factors for Extrapolation			Modifier	Comments	Most Applicable
		TRV_{NOAEL}	Study-NOAEL	NOAEL	(kg/kg-d)	Test Species	Duration	Endpoint	.	EPA's D.U.R.A., 1992	Reference
		TRV_{LOAEL}	Study-LOAEL	LOAEL	reference			(NOAEL/LOAEL)		design, confounders, etc.	
White-tailed Deer	Zinc oxide	7.5	30 (1000)	4	0.03	Sheep	Chronic	Growth	none	9 diets; 6 to 10 animals/diet;	Ott et al. 1966
	(diet)	15	60 (2000)	4	Doyle et al. 1974	4	1	1/1	1	10 weeks; 2 experiments	
	Zinc sulfate	1.25	5	4	not required	Sheep	Chronic	Reproduction, blood & liver effects	none	1 dose gelatin capsule, 4 animals/dose	James et al., 1966
	(capsule)	3.79	NA	1.32		4	1	1/.33	1	[no adverse effects observed]	
Deer Mice	Zinc oxide	40	120 (2000)	3	0.06	Rats	Chronic	Fetal development	none	2 doses, at least 10 animals/dose	Schlicker & Cox, 1968
	(diet)	80	240 (4000)	3	Sax & Lewis, 1989 and study	3	1	1	1		
Red Fox	Zinc sulfate	78.5	314	4	not required	Mink	Chronic	Survivability	none	4 doses, 12 animals/dose	Aulerich et al. 1991
	(diet)	237.9	NA	1.32		4	1	1/.33	1	[no adverse effects observed]	
	Zinc sulfate	34.2	137 (1000)	4	0.137	Mink	Chronic	Reproduction, growth	none	2 diets; 14 adults/diet; 18 weeks (pre- and postpartum exposure)	Bleavins et al. 1983
	(diet)	103.8	NA	1.32	(ORNL 1996)	4	1	1/.33	1	[no adverse effects observed]	
	Zinc oxide	24	120 (2000)	5	0.06	Rats	Chronic	Fetal development	none	2 doses, at least 10 animals/dose	Schlicker & Cox, 1968
	(diet)	48	240 (4000)	5	Sax & Lewis, 1989 and study	5	1	1	1		
Shrew	Zinc oxide	40	120 (2000)	3	0.06	Rats	Chronic	Fetal development	none	2 doses, at least 10 animals/dose	Schlicker & Cox, 1968
	(diet)	80	240 (4000)	3	Sax & Lewis, 1989 and study	3	1	1	1		
	Zinc sulfate	62 8	314	5	not required	Mink	Chronic	Survivability	none	4 doses, 12 animals/dose	Aulerich et al. 1991
	(diet)	190 3	NA	1.65		5	1	1/ 33	1	[no adverse effects observed]	
Mink	Zinc sulfate	314	314 (1570)	1	not required	Mink	Chronic	Survivability	none	4 doses, 12 animals/dose	Aulerich et al. 1991
	(diet)	952	NA	0.33		1	1	1/.33	1	[no adverse effects observed]	

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Ecological Toxicity Reference Values (TRVs) - Derived from Toxicological Literature

Receptors of Concern	Study	Dose-based: mg/kg-d (conc. in ppm)		Total UCF	Conversion	Uncertainty Factors for Extrapolation			Modifier	Comments	Most Applicable
	Chemical	TRV_{NOAEL}	Study-NOAEL	NOAEL	(kg/kg-d)	Test Species	Duration	Endpoint		EPA's D.U.R.A., 1992	Reference
	(route)	TRV_{LOAEL}	Study-LOAEL	LOAEL	reference			(NOAEL/LOAEL)		design, confounders, etc.	
	Zinc sulfate	137	137 (1000)	1	0.137	Mink	Chronic	Reproduction, growth	none	2 diets; 14 adults/diet; 18 weeks (pre- and postpartum exposure)	Bleavins et al. 1983
	(diet)	411	NA	0.33	ORNL 1996	1	1	1/.33	1	[no adverse effects observed]	
Mallard	Zinc acetate	88	440 (2512)	5	0.175	White leghorn hens	Chronic	Reproduction	none	4 doses, 4 animals/dose	Hermayer et al., 1977
	(diet)	350	1750 (10000)	5	Sax & Lewis, 1989	5	1	1/1	1		
	Zinc carbonate	17.5	17.5 (312)	1	0.056	Mallard	Chronic	Mortality	none	5 doses, 6 animals/dose	Gasaway & Buss, 1972
	(diet)	69.5	208 (3722)	3	Nagy 1987	1	1	1/3	1		

DRAFT

Ecological Toxicity Reference Values (TRVs) - Derived from Toxicological Literature

Receptors of Concern	Study Chemical (route)	Dose-based: mg/kg-d (conc. in ppm)		Total UCF	Conversion	Uncertainity Factors for Extrapolation			Modifier	Comments	Most Applicable
		TRV_{NOAEL}	Study-NOAEL	NOAEL	(kg/kg-d)	Test Species	Duration	Endpoint		EPA's D.U.R.A., 1992	Reference
		TRV_{LOAEL}	Study-LOAEL	LOAEL	reference			(NOAEL/LOAEL)		design, confounders, etc.	
Robin	Zinc acetate	88	440 (2512)	5	0.175	White leghorn hens	Chronic	Reproduction	none	4 doses, 4 animals/dose	Hermayer et al., 1977
	(diet)	350	1750 (10000)	5	Sax & Lewis, 1989	5	1	1/1	1		
	Zinc carbonate	17.5	17.5 (312)	1	0.056	Mallard	Chronic	Mortality	none	5 doses, 6 animals/dose	Gasaway & Buss, 1972
	(diet)	69.5	208 (3722)	3	Nagy 1987	1	1	1/3	1		
Kestrel	Zinc acetate	88	440 (2512)	5	0.175	White leghorn hens	Chronic	Reproduction	none	4 doses, 4 animals/dose	Hermayer et al., 1977
	(diet)	350	1750 (10000)	5	Sax & Lewis, 1989	5	1	1/1	1		
	Zinc carbonate	17.5	17.5 (312)	1	0.056	Mallard	Chronic	Mortality	none	5 doses, 6 animals/dose	Gasaway & Buss, 1972
	(diet)	69.5	208 (3722)	3	Nagy 1987	1	1	1/3	1		
Heron	Zinc acetate	88	440 (2512)	5	0.175	White leghorn hens	Chronic	Reproduction	none	4 doses, 4 animals/dose	Hermayer et al., 1977
	(diet)	350	1750 (10000)	5	Sax & Lewis, 1989	5	1	1/1	1		
	Zinc carbonate	17.5	17.5 (312)	1	0.056	Mallard	Chronic	Mortality	none	5 doses, 6 animals/dose	Gasaway & Buss, 1972
	(diet)	69.5	208 (3722)	3	Nagy 1987	1	1	1/3	1		

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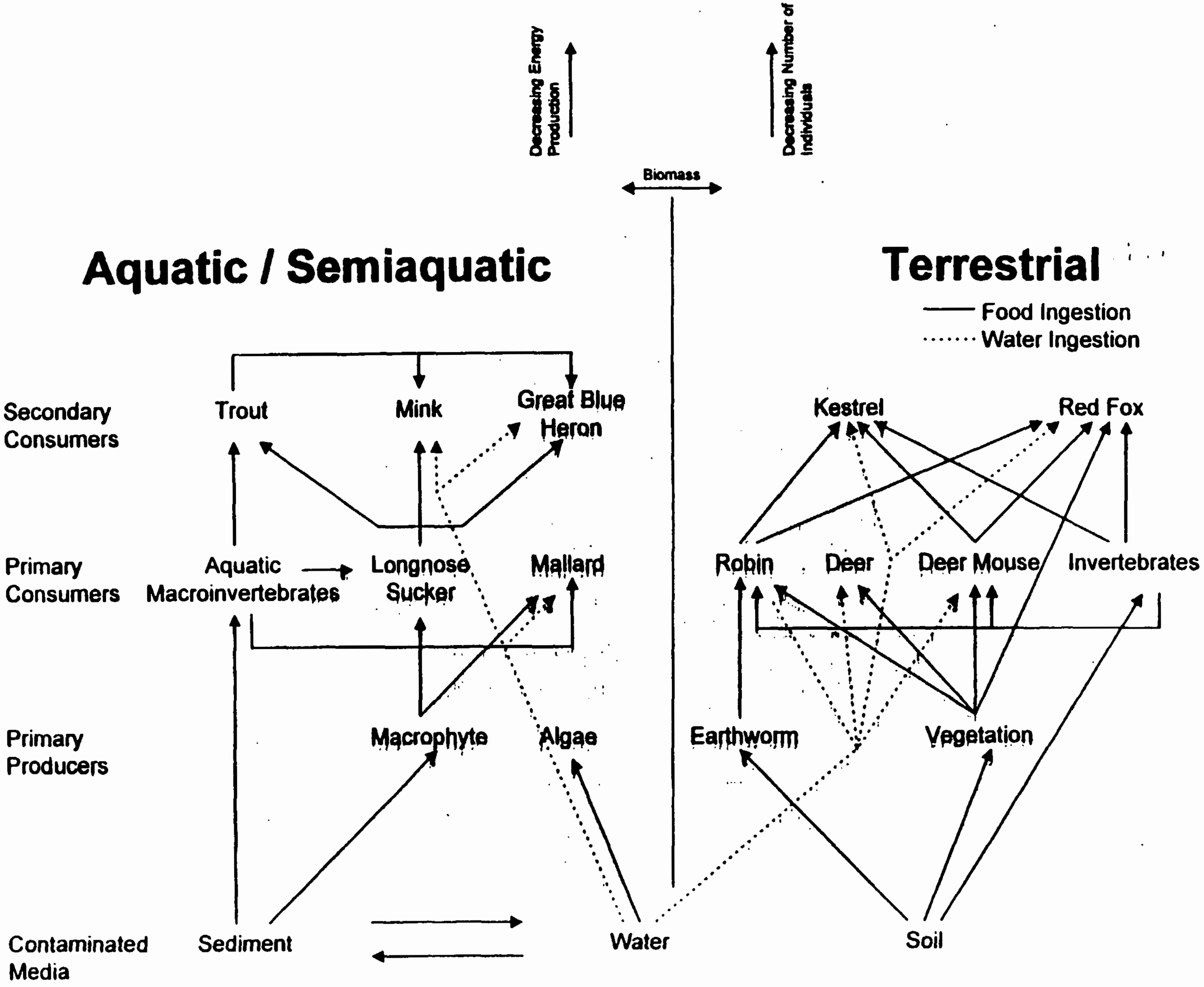
ATTACHMENT 3

Food Web Diagram



Food Web Diagram Showing the Potential for Food Chain Exposures to Ecological Receptors at the Anaconda Smelter NPL Site

APPENDIX C

Land Reclamation Evaluation System

TABLE OF CONTENTS

1.0 REMEDIAL OBJECTIVES

1.1 INTRODUCTION

During the Feasibility Study process, land reclamation was selected as the remedial alternative for major portions of the Anaconda Regional Water, Waste and Soil Operable Unit (ARWW&S OU) (CDM 1997a). The reduction of risk and the protection of ecological systems is to be accomplished through the establishment of self-sustaining assemblages of plant species capable of the following:

- stabilizing soils from erosion;
- minimizing transport of contaminants to surface and ground waters;
- maximizing water usage through evapotranspiration;
- providing wildlife habitat, and;
- accelerating plant successional processes.

The purpose of this guidebook is to define a process for determining which areas at the site will receive some type of land reclamation and, to the extent possible, the most appropriate reclamation techniques and intensity level to apply. To accomplish this goal, existing information for risk assessments, remedial action objectives, and selected remedial alternative is required. Utilizing the statutory requirements as a backdrop, field evaluations of each potential reclamation area is required. Field work will employ the decision making tool described herein (i.e., the Land Reclamation Evaluation System), which integrates guidance criteria, a quantitative scoring system of existing vegetation communities and potential for contaminant movement, and modifying factors. The result is a site specific ranking of the need for reclamation and spatial delineation of preliminary remedial units.

1.2 REMEDIAL ACTION OBJECTIVES

The Preliminary Remedial Action Objectives (PRAOs) for the ARWW&S OU were developed as part of the Draft Feasibility Study (CDM 1997), and included summaries of both human health and ecological risks, and the identification of potential Applicable or Relevant and Appropriate Requirements (ARARs). Remedial action objectives identified (CDM 1997) for High Arsenic Soils, Sparsely Vegetated Areas, Groundwater and Surface Water are as follows:

For the High Arsenic Soils and Sparsely Vegetated Soils, remedial actions must protect human health by preventing human ingestion of, inhalation of dust from, or direct contact with, waste sources, tailings, and groundwater where such contact would pose an unacceptable risk for the designated land use. Soil action levels for arsenic have been established at 1000 mg/kg for recreational/open space, 500 mg/kg for commercial/industrial use, and 250 mg/kg for residential land use.

Risk reduction for the protection of ecological systems is to be accomplished through the establishment of a self-sustaining assemblage of plants species capable of stabilizing the soil against erosion and minimizing transport of contaminants to surface and groundwater, maximizing water usage, providing wildlife habitat, and accelerating successional processes.

Restoration of contaminated Groundwater to its beneficial use is technically impractical for the bedrock aquifer in the Stucky Ridge and Smelter Hill areas (CDM Federal 1997). The selected remedial action will 1) prevent migration of contaminated water from the Technical Impracticability (TI) zone, 2) prevent exposure to contaminated groundwater within the TI zone, and 3) provide the basis to evaluate future risk reduction.

The remedial action objective for Surface Waters is to protect beneficial use through source-control measures thereby attaining Montana ambient quality standards.

1.3 ALTERNATIVE DESCRIPTIONS

Remedial alternatives were assembled in the draft Feasibility Study (CDM Federal 1997) to address solid (soils and waste) and water (surface and ground) media. Alternatives that include some component of land reclamation include the following:

- Capping
- Soil Cover
- Reclamation
    - Level I
    - Level II
    - Level III
- Partial Reclamation
- Reclamation/Soil Cover
- Removal
- Partial Removal

1.4 SELECTED REMEDIAL ALTERNATIVES

The remedial alternative for major portions of the ARWW&S OU is Land Reclamation. Reclamation levels were defined in the Draft Feasibility Study (CDM 1997) as follows:

Level I land reclamation includes the application of only basic agricultural technologies and standard agricultural seeding of soils and waste areas. Generally, no physical or chemical soil amendments would be used; however, a limited amount of lime may be used to adjust the pH of the surface soil. Level I reclamation could require seeding. Surface tilling (if needed) would typically precede mechanical seeding (drill or broadcast), mechanical interseeding, or hand broadcast seeding; fertilizing and mulching. Level I reclamation includes hand planting of shrubs and trees. Level I also includes land reclamation management practices (RRU 1997) that allow minimally impacted areas to recover on their own through natural successional processes.

Level II land reclamation employs the use of an appropriate mixing implement (modified Baker plow or equivalent) to incorporate limited amendments such as calcium carbonate, manure, and/or calcium hydroxide into the solid waste. This level of reclamation will generally be used in areas of shallow contamination. This plowing may reach a depth of up to 2 feet. Seeding, fertilization, and mulching would be applied under Level II reclamation.

Level III land reclamation is the most intensive and will be used in areas of high soil contamination or significant depth of waste material, such as that found on tailings ponds. This level will employ a mixer (Bomag or equivalent) to incorporate Level II soil amendments and lime into the soil or waste prior to seeding, planting, fertilization and mulching.

While the levels of reclamation discussed above form a perspective of increasing remedial intensity in response to progressively lower levels of ecological function, the complexity of the site dictates that reclamation alternatives be spatially adapted to field observed conditions. In the tailing impoundments, large areas are often characterized by similar reclamation techniques. In contrast, contaminated soils in upland areas are often interspersed with spatially varied ecological conditions. Recognizing that land reclamation intensity is a technology continuum and parallels the continuum of ecological function found within the ARWW&S OU, some distinct scientific approach is required to implement the reclamation intensity appropriate to each area.

2.0 LAND RECLAMATION DECISION PROCESS AND THE LRES

2.1 THE RECLAMATION DECISION PROCESS

A multi-faceted process is used to determine which areas within the ARWWS OU will receive land reclamation and the level of that reclamation. The major components of this process are listed below and discussed in detail in the following sections.

- Reviewing remedial action objectives and selected remedial alternatives involving land reclamation technologies.

- Reviewing existing data, maps, aerial photos and ecological risk determinations, and delineate the area to which land reclamation may be applied. These areas are defined as **Reconnaissance Areas**, and are generally on the order of 100 to 500 acres in size.

- Conducting field reconnaissance to score COC transport and vegetation characteristics (on the order of 5 to 20 acres) using the Quantitative Criteria portion of the LRES.

- Assessing the Modifying Criteria (or factors) to delineate areas of common characteristics. The delineation of the Reconnaissance Areas are then revised, including combining some areas, and termed the **Preliminary Remedial Units**. These area on the order of 5 to several hundred acres in size.

- Evaluating each Preliminary Remedial Unit using the LRES Decision Diagrams, and selecting the remedial alternative and level of land reclamation (where possible) appropriate to each Unit.

- Validating the selected reclamation alternative for its compatibility with LRES Guidance and Modifying Criteria, and whether it satisfies the remedial action objectives and goals.

- Identifying priority remedial action areas.

- Identifying data types required to prepare preliminary remedial design for the priority areas.

2.1 THE LAND RECLAMATION EVALUATION SYSTEM

The LRES is a decision-making tool designed to help the decision makers determine what remedial action (and intensity level of land reclamation) should be applied at the ARWW&S OU. This system contains several components: 1) a description of potential human and ecological risk, followed by an assessment of the nine National Contingency Plan guidance criteria; 2) a quantitative scoring system for the existing vegetation communities and the potential for COC transport; 3) an identification of modifying factors that may play significant roles in the determination of whether a specific land area is to receive remediation; and, 4) decision diagrams to help guide the decision makers in identifying remedial actions and levels of reclamation intensity.

2.3 PART 1: GUIDANCE CRITERIA OF THE LRES

The Guidance Criteria portion of the LRES is shown below. It addresses human and ecological risk in terms of COC concentrations, pathways of contaminant movement, potential receptors, and control strategies to reduce risks. This portion of the LRES also addresses the nine CERCLA criteria as described below.

Human Risk

COC and Concentration(s)
Exposure Pathway(s)
Controls In-Place to Reduce Risk

Ecological Risk

COC and Concentration(s)
Receptor(s)
Exposure Pathway(s)
Controls In-Place to Reduce Risk

CERCLA Guidance

Overall Protection of Health and Environment
Compliance with ARARs
Permanence of Present Condition
Effectiveness (ecological function) of Present Condition
Toxicity, Mobility, and Volume of Waste
Public Acceptance of Present Condition
Cost of Present Condition
Cost of Remediation
Implementability of Remedial Treatment

2.4 PART 2: QUANTITATIVE CRITERIA AND FIELD PROCEDURE OF THE LRES

Quantitative Criteria for Vegetation and Soil Parameters

The second portion of the LRES is a quantitative scoring of the existing vegetation community and the potential for COC transport. This scoring system was field truthed through an iterative validation process conducted at the ARWW&S OU during the summer of 1997 and the spring of 1998; additional refinements to this system will be conducted during the 1998 field season. The quantitative scoring is used to prepare individual and composite scores of the vegetation and COC transport characteristics for a particular area.

Vegetation Community (100 point maximum)

1. **Percent Vegetation Coverage** (use either method)
(Perennial, non-weedy, forbs and shrubs)

Canopy Coverage	Point Intercept	Points
>80	60+	25
76 to 80	56 to 60	20 to 25
60 to 75	46 to 55	16 to 19
40 to 59	31 to 45	11 to 15
20 to 39	16 to 30	6 to 10
10 to 19	7 to 15	1 to 5
< 10	< 6	0

2. **Uniformity of Vegetative Cover**
(rocky areas not counted)

	Points
Very uniform	10
Cover varies, but no significant barren areas	8
Small (<6m^2), infrequent barren areas	6
Small, frequent barren areas and/or large (>6m^2), infrequent barren areas	4
Large, frequent barren areas	2

3. **Evidence of Reproduction**
(Perennial, non-weedy forbs and shrubs)

		Points
A.	NEW PLANTS OR STEMS	
	Common	12
	Some occurring	8
	Not common	5
	None observed	0
B.	SEEDHEAD PRODUCTION	
	Seedheads abundant (on most plants/stems)	3
	Seedheads common (on ≈50% plants/stems)	2
	Seedheads infrequent (on <25% plants/stems)	1
	No seedheads	0

4. **Plant Litter Accumulation**

	Points
Negligible (ground not obstructed)	0
Light (<20% of ground obstructed)	5
Moderate (≈40% of ground obstructed)	10
Heavy (≈70% of ground obstructed)	15
Extreme (>90% of ground obstructed)	5

5. **Community Dominance/Evenness**
(Perennial, non-weedy, forbs and shrubs)* Points

One point for each dominant species (maximum of 5 points)

Sensitive species present? [Y] [N]
Tolerant species present? [Y] [N]
Climax species present? [Y] [N]

6. Estimated Plant Density**

Single Stem Plants Rhizomatous Species	Bunchgrasses and/or shrubs	
(stems/ft²)	(Plants/400 ft²)	Points
> 20		10
12 to 19		6-9
6 to 12		3-5
1 to 5		1-2
< 1		0

7. Richness

1 Point for each species identified in a 100-foot radius from the soil pit.
Maximum of 20 points

Potential for COC Transport (75 point maximum)

8. Current Water Erosion (BLM Classification)	Points
Stable	33-40
Slight	25-32
Moderate	17-24
Critical	8-16
Severe	0-8

9. pH - Soil	Points
6.5 to < 8.5	16-20
5.5 to 6.4	11-15
4.5 to 5.4	6-10
3.5 to 4.4	1-5
<3.5	0

10. Wind Erosion	Points
Low	15
Medium	8
High	0

11. Surface Tailings/Metal Salts	Points
None observed	0
Infrequent tailings/salts	-5
Frequent tailings/salts	-10
Extensive tailings/salts	-20

Field Procedures

Upon arrival at a particular site, field personnel will delineate the boundary of the area to be surveyed. This may be a relatively large **Reconnaissance Area** (50-200+ acres) or relatively small **Remedial Unit Area** (5-50 acre). Field personnel should walk the entire area and conduct a general reconnaissance; items to note include plant species (which should be noted on the field form during the walk through), the size and frequency of any barren areas, rocky areas, the amount of organic litter, evidence of surface water movement and erosion, surface salts, impacts from grazing and other anthropogenic causes, landscape morphology, potential for subirrigation, and use by wildlife. The land ownership map should also be consulted. Once the general survey is done, plant community characteristics should be scored.

For each vegetation parameter the field personnel should discuss the range of values observed throughout the surveyed area and estimate an average value for the entire area, and a low and high value. These estimates should be indicative of most, but not necessarily all, of the surveyed area since there may be areas with aberrant characteristics (e.g., well defined and localized barren patches) within the area surveyed. The range of values should be germane to at least 90 percent of the surveyed area and recorded on the field form (Attached).

Vegetation Coverage

Either the canopy coverage or point intercept method can be employed in estimating vegetation coverage. These are both common techniques and a good reference for them is Mueller-Dombois and Ellenberg (1974) or one can be found in the studies that these authors reference.

Using either method, field personnel should visually estimate (i.e., without the use of equipment) the coverage of perennial, non-weedy forb and shrub plant species; the coverage of trees is not counted. Field personnel should discuss the vegetation coverages observed throughout the surveyed area and make an average and a low/high estimate of vegetation coverage for the entire area. Field personnel should record the raw coverage scores on the field form and then adjust the raw scores, if necessary, depending on environmental conditions. The raw scores should be adjusted upward for conditions that would have lowered the potential coverage estimates (e.g., grazing, less than normal winter/spring precipitation, south-facing slope, significant rock cover or thin soil) or adjusted downward for conditions that would have increased the coverage estimates (e.g., subirrigation, higher than normal winter/spring precipitation, north-facing slope). The adjustment should not be more than 150 percent of the raw score.

Uniformity of Coverage

The relative uniformity of coverage of the perennial, non-weedy forb and shrub species should be assessed for all areas except those that are rocky or have erosion pavement. A range of points should be recorded that are applicable to the entire area surveyed (minus the rocky areas).

New Vegetation

This parameter has two parts: A. New Plants or Stems, and B. Seedhead Production. Most of the points (12 out of a possible 15) can be assigned to the new plants or stem parameter. The point distribution was separated this way because most rangeland plants reproduce regularly in a vegetative manner and not from seed. Much of the seed that is produced by rangeland plants is not viable due to factors such as inadequate growing conditions. Therefore, the mere presence of seedheads is not necessarily a good indicator of reproduction at a site. Conversely, the presence of abundant new plants and stems is a good indication of plant reproduction in a rangeland plant community.

Plant Litter Accumulation

Plant litter is important in protecting new seedlings from dessication by the sun and wind. It is also important in slowing surface water runoff and promoting infiltration. For these reasons, a maximum of 10 points can be awarded to a site that has a good accumulation of litter. However, less points should be given to a site where the accumulation of litter is excessive since too much litter insulates the soil surface and inhibits seedling germination and establishment.

Community Dominance/Evenness

This parameter provides an estimate of coverage distribution among the perennial, non-weedy forbs and shrubs in the community. Communities that are monocultures or have relatively few species processing most of the vegetation coverage rank low and would therefore receive few points. Conversely, communities where the vegetation coverage is spread among many species would score relatively high. The presence of sensitive, tolerant and climax species should be noted on the field form. Provided below are definitions of these plant categories; references are provided in Table A-1.

The **sensitive plant species** are those that Tom Keck of the Natural Resource Conservation Service used as indicators of smelting-related impacts. Dr. Keck conducted the soil survey for the Anaconda area and therefore has intimate knowledge of vegetation and soil conditions throughout the valley and foothills that include the ARWW&S OU. In addition, experience by CDM Federal and Reclamation Research Unit (MSU) staff confirm that these species, which should be present on these rangeland sites under climax conditions, appear to be sensitive to environmental perturbations.

Plant species that are **tolerant** of harsh environmental conditions are those that can be found on all rangeland sites and are often the only species found on severely impacted, high soil-metal sites near the Anaconda Smelter complex.

The **climax plant species** listed in Table A-1 are the dominant plant species on undisturbed rangeland sites in climax conditions at the ARWW&S OU. Observations by CDM Federal personnel during the past ten years indicate that these species are not the dominants, and are often not even present, in plant communities of the Anaconda area. However, many of these species have been observed at locations near the Fairmont Hot Springs resort, in German Gulch, at sites in the foothills seven or more miles north of Anaconda, and at high elevations west of Anaconda.

TABLE A-1

Sensitive, Tolerant and Climax Dominant Plant Species

Common Name	Latin Binomial	Reference
Sensitive Plant Species		
Rough fescue	*Festuca scabrella*	1, 2, 4, 5
Lupine	*Lupine spp.*	1, 4, 5
Idaho fescue	*Festuca idahoensis*	1, 4, 5
Heartleaf arnica	*Arnica cordifolia*	1
Strawberry	*Fragaria virginiana*	1
Tolerant Plant Species		
Redtop	*Agrostis alba*	1, 4, 5
Great basin wildrye	*Elymus cinereus*	1, 2, 4, 5
Baltic rush	*Juncus balticus*	4
Spotted knapweed	*Centaurea maculosa*	1, 4, 5
Wood's rose	*Rosa woodsii*	1, 2, 4
Sedge	*Carex spp.*	5
Western wheatgrass	*Agropyron smithii*	4, 5
Whitetop	*Cardaria draba*	1, 4, 5
Oregon grape	*Berberis repens*	1
Juniper	*Juniperus spp.*	1
Rabbitbrush	*Chrysothamnus spp.*	1
Douglas fir	*Pseudotsuga menziesii*	1
Limber pine	*Pinus flexilis*	1
Leafy spurge	*Euphorbia esula*	1
Tufted hairgrass*	*Deschampsia caespitosa*	1, 4, 5
Inland saltgrass*	*Distichlis stricta*	1, 5
Aspen*	*Populus tremuloides*	1, 5
Greasewood*	*Sarcobatus vermiculatus*	5
Canada thistle	*Cirsium arvense*	1, 4, 5
Canada bluegrass	*Poa compressa*	1, 4
Kentucky bluegrass	*Poa pratensis*	4
Climax Dominant Plant Species		
Bluebunch wheatgrass	*Agropyron spicatum*	3, 4
Rough fescue	*Festuca scabrella*	1, 3, 4
Green needlegrass	*Stipa viridula*	3, 4
Idaho fescue	*Idaho fescue*	1, 3, 4, 5

Common Name	Latin Binomial	Reference
Sticky geranium	*Geranium viscosissimum*	3, 4
Milkvetch	*Astragalus spp.*	3, 4
Lomatium	*Lomatium spp.*	3
Hairy goldenaster	*Heterotheca villosa*	3
Pussytoes	*Antennaria spp.*	3, 4
Phlox	*Phlox spp.*	3, 4
Buckwheat	*Eriogonum spp.*	3
Arrowleaf balsamroot	*Balsamorhiza sagittata*	3, 4
Snowberry	*Symphoricarpos spp.*	3
Skunkbush sumac	*Rhus trilobata*	3
Big sagebrush	*Artemisia tridentata*	3

[1] Referenced by Dr. Tom Keck, Natural Resource Conservation Service, Whitehall, Montana (personal communication; memo from S. Jennings to B. Rennick, June 5, 1998; Keck et al., Mapping Soil Impact Classes on Smelter Affected Lands).

[2] Personal communication with Dr. Frank Munshower, Montana State University, Bozeman.

[3] *Rangesite Description and Condition Guide, USDA-SCS-Montana, April 1982.* Northern Rocky Mountain valleys, foothills and mountains west of the continental divide in the 10-14 and 15-19 inch precipitation zones.

[4] Field observations by Bob Rennick, CDM Federal Programs Corporation, Helena, Montana.

[5] Reconnaissance conducted by the Reclamation Research Unit, *ARTS Phase I Final Report, 1993*

* Found on sites with specialized conditions such as a high water table or salty soils.

Estimated Plant Density

Plant density is important in the stabilization of rangeland sites and can be an indicator of the quality of the growing conditions. To estimate the density of species on a site, both single stem plants (i.e., stems from rhizomes and seedlings) and bunch-type plants should be evaluated. Rhizomatous species, such as western wheatgrass, should be estimated on a square-foot basis; trees, shrubs, and bunchgrass species should be estimated on a 400 square-foot basis. Recognizing that several different reproduction strategies may exist on a site having a variety of species, the estimator should assign points based upon the best compromise between the rhizomatous and single-stem species observed.

Community Richness

This parameter provides an estimate of the number of species inhabiting a site and is therefore an indication of the quality of growing conditions. Sites that have an abundance of plant species are generally considered to have relatively good growing conditions. Conversely, sites with few species have plant limiting factors such as relatively low pH or high soil metal concentrations, low soil moisture, or may be deficient in plant nutrients.

Scoring the Existing Potential for COC Transport

Current Water Erosion

Only current potential for erosion is evaluated using this metric. This LRES metric is an adaptation of a BLM classification system (Clark 1980), in which numerical scores are assigned for different degrees of erosion. This system allows for field observation of surface litter movement, surface rock movement, pedestal formation, flow patterns, rill and gully formation, and soil movement. Each of these observational classes is evaluated in the field and combined to determine the soil surface factor (SSF) for each field location. The SSF is then used to determine the erosion condition class and LRES points as follows:

- Stable, SSF value from1 - 20, LRES metric of 33 - 40 points;
- Slight, SSF value from 21- 40, LRES metric of 25 - 32 points;
- Moderate, SSF value from 41 - 60, LRES metric of 17 - 24 points
- Critical, SSF of 61 - 80, LRES metric of 8 - 16 points
- Severe, SSF 81 - 100, LRES metric of 0 - 8 points.

Soil pH

This is one of the most significant controlling factors in the solubility and mobility of metal contaminants in soil systems. The availability of these contaminants to biological receptors is dependent to a large degree on the pH of the soil. Field estimation of this parameter will be accomplished using method SS-09 (Clark Fork River Superfund Site Standard Operating Procedures (SOPs) ARCO 1992). Additionally, soil profile samples will be collected using the Clark Fork River Superfund Site Standard Operating Procedures (SOPs) ARCO 1992): SOP SS-1 for soil sampling from hand dug pits; SOP G-5 for packaging and shipping; and SOP G-8 for equipment decontamination. Appendix B provides copies of these SOPs and other applicable SOPs.

Wind Erosion

Movement of COCs via this pathway has not been well characterized within the OU. An exception to this is the PM10 data, but these only relate to human health concerns. Large expanses of barren landscapes currently exist and historical accounts of the Anaconda Minerals Company's efforts to suppress dust from tailings are well documented. Erosion caused by wind was evaluated in the ARTS treatability study, in which wind velocity was documented at several location, and air-entrained dust was collected and determinations of COC concentrations made (RRU 1997). In the LRES metric, wind erosion, or the potential for wind erosion at a site is scored as low for areas that are well vegetated or that are very rocky, medium for areas that support more plants, and high for areas that are barren, flat, and have soils or surface materials that are fine. Landscape position relative to the potential to be affected by wind must also be considered.

Surface Tailings/Metal Salts

Some areas within the OU that are barren of vegetation may also display visible tailings, and at certain times and under certain climatic condition, may exhibit metal salts on the surface soil. These conditions imply an enhanced potential for the movement of COC via surface water runoff into receiving waters. In addition, these visible tailings and metal salts may represent a phytotoxic environment. In the quantitative metrics the presence of tailings and/or salts at a location merits a negative score.

2.5 PART 3: MODIFYING CRITERIA

Modifying Criteria reflect the necessity of adjusting the remedial action to reflect site-specific concerns. For example, if transport of COCs to surface water is a compelling concern in a particular area, a more intensive and immediate reclamation alternative may be required. Conversely, in an area designated for historical preservation a less intensive reclamation alternative may be appropriate. The Modifying Criteria, which are listed below and on the field form (attached), are intended to allow flexibility in implementation of reclamation technology through observation of the unique conditions of a given site.

Modifying Criteria	**Remedial Concern?**	
	Yes	Unknown
Land Ownership	___	___
NRDA Issues		
Water Shed Boundaries	___	___
Weeds		
Soil Texture	___	___
Site Access	___	___
Steep Slopes	___	___
Existing Vegetation	___	___
Rock (outcrops or boulder)	___	___
Natural Vegetation Recovery		
Present density of grasses, forbs, trees, and shrubs	___	___
Potential for recovery (soil pH, fine soil particles, etc.)	___	___
Landscape Position	___	___
100-Year Flood plain	___	___
Surface Water	___	___
Sediment Transport	___	___
Groundwater	___	___
Vadose Zone Water	___	___
Storm Water Management	___	___
Current Land Use	___	___
End Land Use	___	___
Land Management Practices	___	___
Viewshed	___	___
Cultural and Historic Resources	___	___
Rare and Endangered Species	___	___

Institutional Controls ___ __________
Legal Restrictions (conservation easements, deed restrictions, etc.) ___ __________

Soil chemical data that are important modifying considerations are phytotoxicity (indicate Zone 1, 2, 3 or 4 from the Final BERA), total COC concentration, and acid generating potential (or knowledge of the acid base account).

2.6 PART 4: LRES DECISION DIAGRAMS

The Decision Diagrams (Figures 1 and 2, attached) are logic flowcharts intended to define which areas will receive a remedial action as defined by the LRES Quantitative Score. Areas with significant potential for natural recovery and eventual compliance with the remedial action objectives (RAOs) are slated for monitoring. Those areas requiring some level of reclamation are identified as requiring an action.

The alternatives table (Table 1, attached) provides the specifications and components for each alternative, and identifies under what environmental circumstances each alternative could be applied. Once all the environmental conditions are known, the perspective reclamation alternatives must be evaluated with respect to cost and meeting the remedial action objectives goals (RAOGs) in order to select the most appropriate alterative for implementation.

3.0 REFINEMENT OF THE LRES

During the summer of 1998 EPA will use the LRES at the Anaconda Smelter site to delineate Preliminary Remedial Units and determine what data are required to select a reclamation alternative for each unit. Refinements to the LRES will be made as necessary through the collective involvement of agency and PRP plant and soil scientists.

Table 1

Specifications and Applications for Remedial Alternatives
ARWW&S Operable Unit

RECLAMATION ALTERNATIVE	SPECIFICATIONS AND COMPONENTS	ALTERNATIVE APPLICABILITY										
		HIGH ARSENIC SOILS (> ACTION LEVEL)	ARSENIC ACTION LEVEL WOULD BE MET THROUGH TILLAGE?	ACID MATERIALS PRESENT	DEPTH OF CONTAMINATION		SLOPE CHARACTERISTICS				EXISTING VEGETATION SHOULD BE SAVED?	APPROPRIATE FOR USE NEAR SURFACE WATER
					Shallow	Deep	Rocky	Gentle	Steep	Difficult		
A. COVERSOIL												
A1 Coversoil	18" Soil*, Consolidation of Waste, Limerock Barrier (if necessary), Grading, Surface Water Control**, Seeding+***	✓	---	✓	✓	✓	✓	✓	---	---	---	✓
A2 Coversoil plus In-Situ Reclamation	18" Engineered Rooting Media* (i.e., combination of amendment application to existing ground surface followed by the application of at least 6" of coversoil), Consolidation of Waste, Grading, Surface Water Control, Seeding+	✓	---	✓	✓	✓	✓	✓	---	---	---	✓
B. VEGETATION IMPROVEMENT												
B1 Modified SAM	Interseeding, Scarification (or equivalent), Weed Control, Fertilization, Surface Water Controls	---	---	---	✓	---	✓	✓	✓	✓	✓	---
C. LOW INTENSITY IN-SITU RECLAMATION												
C1 Agricultural Tillage	6-12" Tillage with Moldboard Plow, Low Amendment Rates, Consolidation, No Soil Amendments, Seeding+, Grading, Surface Water Controls	✓	✓	---	✓	---	---	✓	✓	---	✓	✓

Table 1 (continued)

RECLAMATION ALTERNATIVE	SPECIFICATIONS AND COMPONENTS	ALTERNATIVE APPLICABILITY										
		HIGH ARSENIC SOILS (> ACTION LEVEL)	ARSENIC ACTION LEVEL WOULD BE MET THROUGH TILLAGE?	ACID MATERIALS PRESENT	DEPTH OF CONTAMINATION		SLOPE CHARACTERISTICS				EXISTING VEGETATION SHOULD BE SAVED?	APPROPRIATE FOR USE NEAR SURFACE WATER
					Shallow	Deep	Rocky	Gentle	Steep	Difficult		
D. MODERATE INTENSITY IN-SITU RECLAMATION												
D1 Surface Manipulation	Recontouring, Consolidation, No Soil Amendments, Seeding+, Grading, Surface Water Controls	---	—	---	✓	---	✓	✓	✓	✓	✓	—
D2 Deep Tillage	12-24" Tillage, Moderate Amendment Rates, Consolidation, Seeding+, Grading, Surface Water Controls	✓	✓	✓	✓	✓	✓	✓	✓	---	✓	✓
E. HIGH INTENSITY IN-SITU RECLAMATION												
E1 Deep Tillage	24" Tillage, High Amendment Rates, Consolidation, Seeding+, Grading, Surface Water Controls	✓	✓	✓	✓	✓	✓	✓	✓	---	✓	✓
F. STEEP SLOPE RECLAMATION												
F1 Seeding	Recontouring, Broadcast Seeding, Planting, Intensive Grading, Surface Manipulation for Surface Water Controls, Amendments (as necessary)	---	—	✓	✓	---	✓	✓	✓	✓	---	✓
F2 Modified PTSG	Plant Tree, Shrub, Grass Tubelings, Surface Water Controls, Low Amendment Rates (if necessary)	---	---	---	✓	---	✓	✓	✓	✓	✓	---
F3 Hydroseed+	Hydroseed and Hydromulch, Surface Water Controls, Low Amendment Rates (if necessary)	---	---	---	✓	---	✓	✓	✓	✓	✓	✓
R. ROCK (INDUSTRIAL) AMENDMENT												
G1 Rock Cover	> 6" of a permanent rock cover (e.g., limerock, pit-run, alluvium), Grading for Surface Water Control, Infiltration Controls	✓	—	✓	✓	✓	---	✓	---	---	---	---

Table 1 (continued)

Notes:

✓ = Applicable Alternative, — = Not Applicable,

* Successful reclamation of land contaminated by mining and ore-processing activities can be defined as the establishment of self-perpetuating plant communities capable of stabilizing the soil against wind and water erosion in perpetuity. To accomplish this, target values have been established for the physicochemical characteristics of coversoil used in land reclamation within the upper Clark Fork River Basin.

Depth: 18" thick of non-toxic rooting media (see below). This is the absolute minimum for the long-term success of the vegetation. Enough coversoil needs to be applied to account for settling, sloughing, and erosion.

Coarse fragment contents: Particles > 2 mm constitute < 45% (by volume) of the coversoil. Maximum rock size is 6" in diameter.

Texture: Sandy loam or finer (to have the proper water holding capacity). "Clays" are not acceptable.

pH: Between 6.5 and 8.5 for entire 18".

Metal concentrations: Coversoil guidelines: As<30, Cd<4, Cu<100, Pb<100, and Zn<250 mg/kg.

Organic matter: Coversoil or engineered media: >1.5% (by weight) of compacted organic matter in the upper 6".

Specific conductance: For coversoil or engineered rooting media: less than 4.0 mmhos/cm for entire 18".

Surface Manipulation: Rip, chisel plow, and/or disk plow to reduce the compaction caused by heavy machinery and achieve a moderately rough (by agricultural standards) seedbed. Plowing should be done as deep as possible, being careful not to disturb the underlying material.

** Surface Water Control include the implementation of dozer basins, pits, gouges, contour furrowing, etc. to prevent water erosion.

*** Seeding+ = seeding with adapted species, plus fertilization and mulching.

ANACONDA LAND RECLAMATION EVALUATION SYSTEM (LRES) FIELD FORM

FIELD TEAM: ______________________ DATE: __________ LOCATION/SITE: ______________ GPS COORDINATES E: ______________ N: ______________

VEGETATION COMMUNITY (100 point maximum)

1. Percent Vegetation Coverage* (use either method)

Canopy Coverage	Point Intercept	Point Score
>80	>60	25 pts
76 to 80	56 to 60	20-25 pts
60 to 75	46 to 55	16-20 pts
40 to 59	31 to 45	11-15 pts
20 to 39	16 to 30	6-10 pts
10 to 19	7 to 15	1-5 pts
< 10	< 6	0 pts

Raw Score (low - high)

Adjustment Factor**

Score (low - high)

2. Uniformity of Cover* (rocky areas not counted)

Very uniform	(10 pts)
Cover varies, but no significant barren areas	(8 pts)
Small (<6 m^2), infrequent barren areas	(6 pts)
Small, frequent barren areas and/or large (>6 m^2), infrequent barren areas	(4 pts)
Large, frequent barren areas	(2 pts)

Score (low - high)

3. Evidence of Reproduction*

A NEW PLANTS OR STEMS***

Common	(12 pts)
Some occurring	(8 pts)
Not common	(5 pts)
None observed	(0 pts)

A. ________

B SEEDHEAD PRODUCTION

Seedheads abundant (on most plants/stems)	(3 pts)
Seedheads common (on ≈50% plants/stems)	(2 pts)
Seedheads infrequent (on <25% plants/stems)	(1 pt)
No seedheads	(0 pts)

B ________

Score (low - high) (A+B)

4. Plant Litter Accumulation

Negligible (ground not obstructed)	(0 pts)
Light (<20% of ground obstructed)	(5 pts)
Moderate (≈40% of ground obstructed)	(10 pts)
Heavy (≈70% of ground obstructed)	(15 pts)
Extreme (>80% of ground obstructed)	(5 pts)

Score (low - high)

5. Community Dominance/Evenness*

1 point for each dominant species (maximum of 5 points)

Sensitive species present?	[Y]	[N]
Tolerant species present?	[Y]	[N]
Climax species present?	[Y]	[N]

Score (low - high)

6. Estimated Plant Density* (use both parameters)

Single Stem Plants Rhizomatous Species (stems/ft^2)	Bunchgrasses, Shrubs, or Trees (plants/400 ft^2)
>20	(10 pts)
12 to 19	(6-9 pts)
6 to 12	(3-5 pts)
1 to 5	(1-2 pts)
<1	(0 pts)

Score (low - high)

7. Community Richness*

1 point for each species identified in a 100-foot radius. Maximum of 20 points

Score (low - high)

SITE DESCRIPTION:

POTENTIAL FOR COC TRANSPORT (75 point maximum)

8. Current Water Erosion (BLM Classification)

Stable	(33- 40 pts)
Slight	(25-32 pts)
Moderate	(17-24 pts)
Critical	(8 -16 pts)
Severe	(0-8 pts)

% Slope ________

Score (low - high)

9. pH - Soil

7 0 to 8 0	(19-20 pts)
6.0 to 6.9	(15-18 pts)
5.0 to 5.9	(9-14 pts)
4.0 to 4.9	(5-8 pts)
3.0 to 3.9	(1-4 pts)
<3.0	(0 pts)

Surface ______________

Subsurface ______________

Score (low - high)

* Perennial, non-weedy forbs and shrubs

** Adjust raw score for site conditions (not to exceed 150%)
Increase for grazing, south slope, significant rock cover or thin soil, lower than average soil moisture, etc Decrease for higher than average soil moisture, subirrigation, north slopes, etc

*** Look for new plants from seed (including trees and shrubs), evidence of new shoots from rhizomatous plants, and tillering by bunchgrasses and shrubs

10. Wind Erosion

Low	(15 pts)
Medium	(8 pts)
High	(0 pts)

Score (low - high)

11. Surface Tailings/Metals Salts

Circle presence of tailings or salts (consider areal distribution and depth)

None observed	(0 pts)
Infrequent tailings/salts	(-5 pts)
Frequent tailings/salts	(-10 pts)
Extensive tailings/salts	(-20 pts)

Tailings depth ______________

Score (low - high)

SUMMARY OF SCORES

	Low	High
Vegetation Score	______	______
COC Transport Score	______	______

TOTAL SITE SCORE ______ ______

[illegible]ACONDA LAND RECLAMATION EVALUATION SYSTEM (LRES) FIELD FORM

DATE: __________ LOCATION/SITE: ________________ PHOTOGRAPHS: ROLL ____________ FRAME ____________

MODIFYING CRITERIA	COMMENTS	REMEDIAL CONSIDERATION		
		Y	N	U
Land Ownership				
Watershed Boundaries				
NRDA Land				
Weeds				
Soil Texture/Parent Material				
Site Access				
Steep Slopes				
Existing Vegetation				
Rock (outcrops or boulders)				
Natural Vegetation Recovery				
Landscape Position				
100-Year Floodplain				
Surface Water				
Sediment Transport				
Groundwater				
Vadose Zone Water				
Stormwater Management				
Current Land Use				
End Land Use				
Land Management Practices				
Viewshed				
Cultural and Historic Resources				
Rare and Endangered Species				
Institutional Controls				
Legal Restrictions (conservation easements, deed restrictions, etc.)				
OTHER				
	VALUE AND INFORMATION SOURCE			
Phytotoxicity Zone				
Total COC Concentrations				
Acid generating potential (Acid Base Account)				

IMPACT/CONDITION

Soil Survey Unit __________

NRCS Impact Class __________

LRES Relative Condition Class: __________

Potential Reclamation Alternative (see Table 4.1): __________

____

____

COMMENTS:

PLANT SPECIES OBSERVED:

Sensitive Plant Species[1]	Present
Festuca scabrella	
Lupine spp	
Festuca idahoensis	
Arnica cordifolia	
Fragaria virginiana	
Tolerant Plant Species[1]	
Agrostis alba	
Elymus cinereus	
Juncus balticus	
Centaurea maculosa	
Rosa woodsii	
Carex spp.	
Agropyron smithii	
Cardaria draba	
Euphorbia esula	
Deschampsia caespitosa	
Distichlis stricta	
Populus tremuloides	
Sarcobatus vermiculatus	
Berberis repens	
Juniperus spp.	
Chrysothamnus spp.	
Pseudotsuga menziesii	
Pinus flexilis	
Cirsium arvense	
Poa pratensis	
Poa compressa	
Climax Dominant Plant Species (other than the "Sensitives")	
Agropyron spicatum	
Stipa viridula	
Geranium viscosissimum	
Astragalus spp.	
Lomatium spp.	
Heterotheca villosa	
Antennaria spp.	
Phlox spp.	
Eriogonum spp.	

4.0 REFERENCES

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Clark. R. 1980. Erosion Condition Classification System. U.S. Dept. of Interior, Bureau of Land Management. Denver, CO. 47 p.

Mueller-Dombois and Ellenberg. 1974. *Aims and Methods of Vegetation Ecology.* John Wiley & Sons, New York.

PTI. 1992. Clark Fork River Superfund Site Investigations Data Management and Data Validation Plan. Prepared for ARCO. May.

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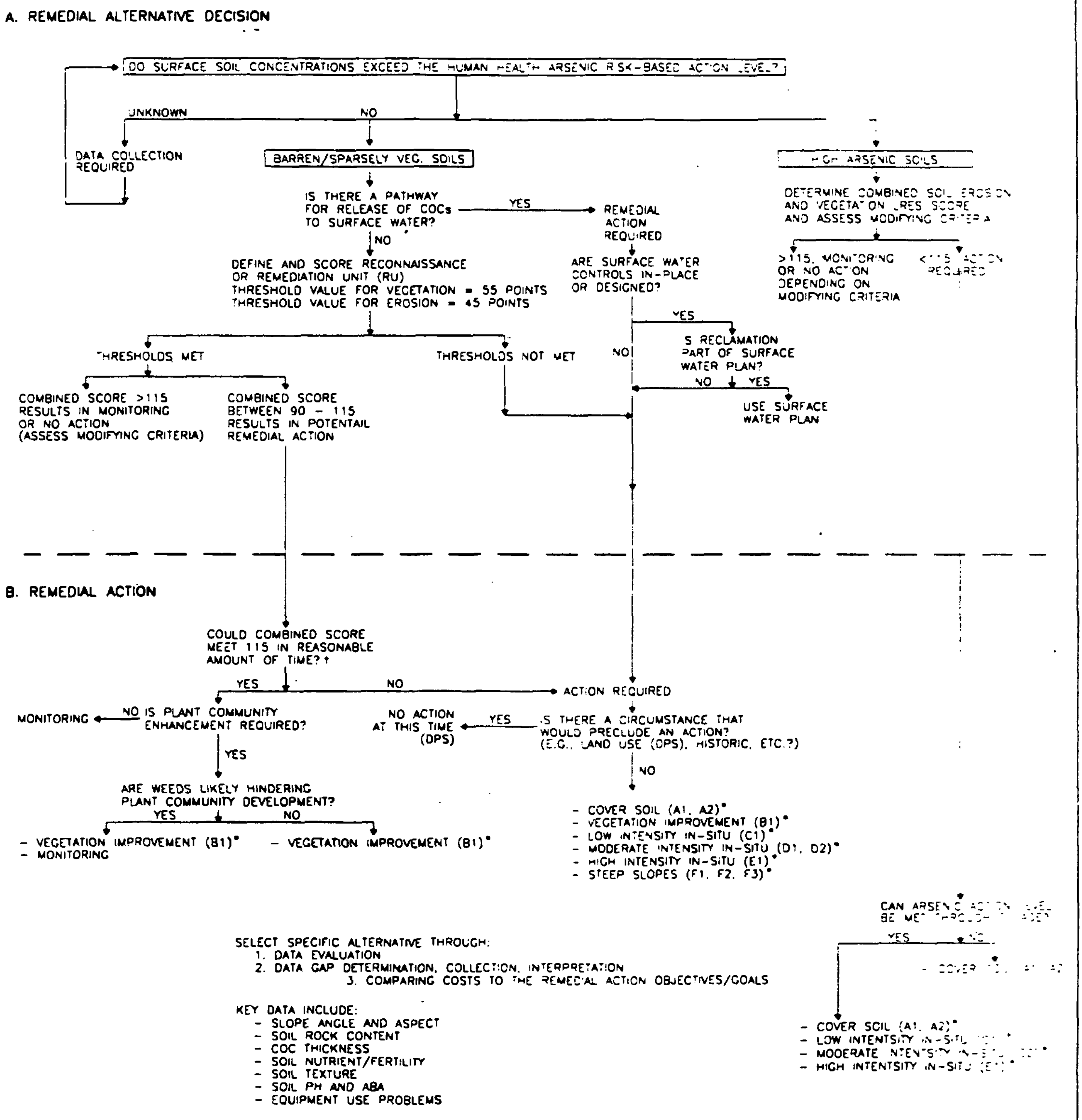
FIGURES

CONTAMINATED SOILS
LRES DECISION DIAGRAM
ANACONDA REGIONAL WATER, WASTE & SOILS OPERABLE UNIT

FIGURE 1



SELECT SPECIFIC ALTERNATIVE THROUGH:
1. DATA EVALUATION
2. DATA GAP DETERMINATION, COLLECTION, INTERPRETATION
3. COMPARING COSTS TO THE REMEDIAL ACTION OBJECTIVES/GOALS

KEY DATA INCLUDE:
- SLOPE ANGLE AND ASPECT
- SOIL ROCK CONTENT
- COC THICKNESS
- SOIL NUTRIENT/FERTILITY
- SOIL TEXTURE
- SOIL PH AND ABA
- EQUIPMENT USE PROBLEMS

† AS ASSESSED BY TECHNICAL EVALUATION TEAM

* POSSIBLE ALTERNATIVES; APPROPRIATENESS DEPENDS UPON THE ALTERNATIVE'S ABILITY TO MEET THE REMEIDIAL ACTION OBJECTIVES/GOALS.

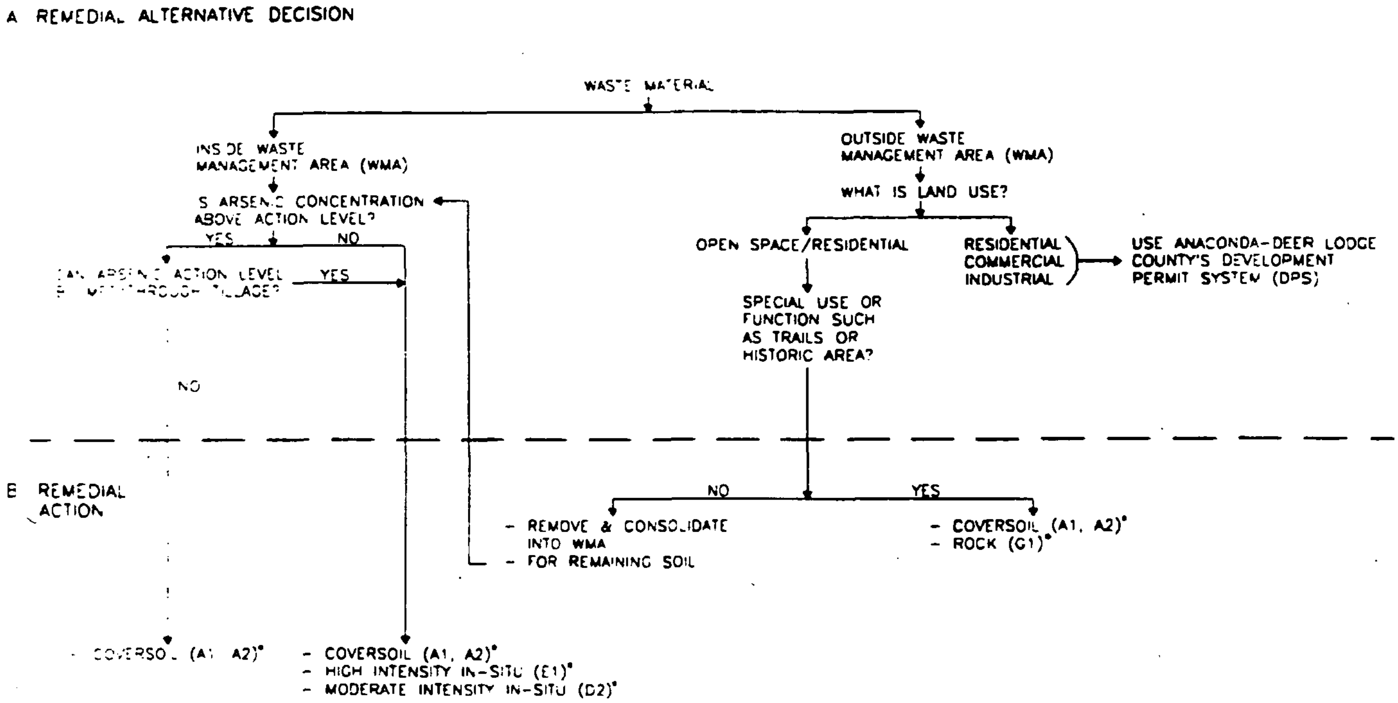
CDM Federal Programs

ARWW&S OU RECORD OF DECISION
SEPTEMBER 1998

DATE 8/24/98 | DRAWN BY [illegible]

WASTE MATERIAL
LRES DECISION DIAGRAM
ANACONDA REGIONAL WATER, WASTE & SOILS OPERABLE UNIT

FIGURE 2



SELECT SPECIFIC ALTERNATIVE THROUGH
1 DATA EVALUATION
2. DATA GAP DETERMINATION, COLLECTION, INTERPRETATION
3 COMPARING COSTSS TO THE REMEDIAL ACTION OBJECTIVES/GOALS

KEY DATA INCLUDE.
- SLOPE ANGLE AND ASPECT
- SOIL ROCK CONTENT
- COC THICKNESS
- SOIL NUTRIENT/FERTILITY
- SOIL TEXTURE
- SOIL PH AND ABA
- EQUIPMENT USE PROBLEMS

* POSSIBLE ALTERNATIVES. APPROPRIATENESS DEPENDS UPON THE ALTERNATIVE'S ABILITY TO MEET THE REMEIDIAL ACTION OBJECTIVES/GOALS.

CDM Federal Programs

ARWW&S OU RECORD OF DECISION
SEPTEMBER 1998

DATE: 8/24/98	DRAWN BY RB	REVIEWED BY BR

APPENDIX D

Addendum to Technical Impracticability Evaluations at the ARWW&S OU

TABLE OF CONTENTS

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LIST OF ABBREVIATIONS AND ACRONYMS

ADLC	Anaconda-Deer Lodge County
ARAR	Applicable or Relevant and Appropriate Requirement
ARCO	Atlantic Richfield Company
ARWW	Anaconda Regional Water and Waste
ARWW&S	Anaconda Regional Water, Waste, and Soils
bgs	below ground surface
DPS	Development Permit System
EA	Environmental Assessment
EAY	East Anaconda Yard
EPA	U.S. Environmental Protection Agency
FS	Feasibility Study
FWP	Montana Department of Fish, Wildlife, and Parks
IC	Institutional Control
mg/kg	milligram(s) per kilogram
μg/L	microgram(s) per liter
NPL	National Priorities List
NRDP	State of Montana Natural Resources Damage Program
OU	Operable Unit
ppm	parts per million
TI	Technical Impracticability
USGS	U.S. Geological Survey
WMA	Waste Management Area
XRF	X-Ray Fluorescence

1.0 INTRODUCTION

The purpose of this report is to update the U.S. Environmental Protection Agency's (EPA's) characterization of ground water contamination in the bedrock aquifer in Technical Impracticability (TI) zones at the Anaconda Regional Water, Waste, and Soils (ARWW&S) Operable Unit (OU) as a result of information collected at the ARWW&S OU during a field investigation of TI zones in 1997. Data collected during the 1997 Field Investigation at the ARWW&S OU are presented in the *1997 Field Activities Data Summary Report Anaconda Regional Water, Waste, and Soils Operable Unit Technical Impracticability Zone Boundaries* (ARCO 1997a).

An identification of TI zones in the bedrock aquifer at the ARWW&S OU was presented by EPA in the *Draft Feasibility Study (FS) Deliverable No. 3A, Ground Water Technical Impracticability Evaluation for the Anaconda Smelter NPL Site, Anaconda-Deer Lodge County, Montana, Anaconda Regional Water, Waste, and Soils Operable Unit* (ARWW&S OU FS Deliverable No. 3A) (EPA 1996a). The results of TI evaluations identified two regions of the shallow bedrock aquifer at the ARWW&S OU in which restoration of ground water to levels of dissolved arsenic below Montana Ground Water Quality Standards (§17.30.1003 ARM) is considered to be technically impracticable by EPA (Figure 1). EPA presented an analysis of the restoration potential and cost estimates for restoration of the bedrock aquifers found in Sections 3.1.6.5 (East Anaconda Yards), 3.2.8 (Smelter Hill and Mount Haggin), and 3.3.9 (Stucky Ridge) of FS Deliverable No. 3A (EPA 1996a). A summary of alternative restoration cost estimates is presented in Table 1.

At the conclusion of the restoration potential/restoration cost analysis presented in FS Deliverable No. 3A, the TI Evaluation review team recommended additional site characterization to better define the boundaries of the proposed TI zones. This TI Evaluation Addendum Report summarizes the aquifer site characteristics from the 1996 evaluation, presents analytical results and geologic and hydrologic data from the 1997 field investigation, and updates the characterization of the bedrock aquifers. This document is an addendum to the December 1996 *Draft Feasibility Study Deliverable No. 3A, Ground Water Technical Impracticability Evaluation* (EPA 1996a). The reader is referred to EPA (1996a) for additional background information and site evaluation.

The two regions where ground water restoration is considered impracticable by EPA are identified as the Smelter Hill TI Zone and the Stucky Ridge TI Zone. Within the Smelter Hill and Stucky Ridge TI Zones, arsenic is a contaminant of concern which occurs at levels above the Montana Water Quality Standard (18 μg/L) identified by EPA as an Applicable or Relevant and Appropriate Requirement (ARAR) for the ARWW&S OU. Ground water contamination in the bedrock aquifers in these areas is postulated to occur as a result of transport of arsenic via infiltration and deep percolation of precipitation through contaminated soil. Contamination of regional soils at the ARWW&S OU with arsenic and trace metals occurred as a result of aerial deposition of emissions from copper smelters located near Anaconda during the period of 1884 to 1980. Conclusions of a regional investigation of contaminated soil at the ARWW&S OU (ARCO 1997b) has indicated that concentrations of total arsenic and trace metals in surface soils are elevated and generally decrease with distance from the smelter stack located on Smelter Hill, and with depth in the soil profile. Previous studies which also focused on the extent of contamination of metals in regional soils at the site (Tetra Tech 1987) or impacts to vegetation from surficial soil contamination (Olson-Elliott 1975) presented similar conclusions.

2.0 SUMMARY OF TI EVALUATIONS IN 1996

The results of TI evaluations for the alluvial aquifer underlying the East Anaconda Yard (EAY), and the bedrock aquifers underlying portions of the Smelter Hill and Old Works/Stucky Ridge Subareas were presented by EPA in the ARWW&S OU FS Deliverable No. 3A. As a result of these evaluations, a TI waiver of the Montana Ground Water Quality Standard for arsenic (18 μg/L) was requested by EPA for the shallow bedrock aquifer in portions of the Smelter Hill and Old Works/Stucky Ridge Subareas (EPA 1996a).

2.1 EAST ANACONDA YARD AREA

A TI waiver is not requested by EPA for contamination of dissolved arsenic in the alluvial aquifer underlying the EAY. Based on conclusions of a TI evaluation of the alluvial aquifer underlying the EAY (EPA 1996a) , a relatively high level of uncertainty is recognized by EPA as to the identification of a primary loading source of arsenic to ground water in this portion of the ARWW&S OU. Three potential sources of ground water contamination to the alluvial aquifer are identified which include: 1) recharge of the alluvial aquifer by contaminated ground water in the shallow bedrock aquifer at the valley sidewall separating the EAY from Smelter Hill; 2) infiltration and deep percolation of precipitation through wastes (contaminated soil and buried wastes) in the EAY; and 3) infiltration and deep percolation of storm water runoff and snowmelt which contains elevated levels of arsenic (> 500 μg/L) and which flows onto the EAY from Walker Gulch, Slag Gulch, and Nazer Gulch. Elevated arsenic concentrations in ground water beneath the EAY may be related, in part, to all three of these potential sources of contamination.

A wide range of remedial alternatives for restoration of the alluvial aquifer underlying the EAY area have been considered by EPA in a detailed Feasibility Study for the ARWW&S OU (EPA 1997a). The remedial alternatives considered by EPA include full and partial removal of buried wastes located in the EAY; capping of wastes in the EAY area, and containment of contaminated ground water in the bedrock aquifer near the valley sidewall adjacent to the EAY; application of a soil cover over wastes in the Acid Plant area of the EAY; and containment of contaminated ground water in the bedrock aquifer using a network of ground water extraction wells and a ground water treatment system located adjacent to the valley sidewall for the EAY.

In its Proposed Plan for the ARWW&S OU, EPA has recommended a No Action alternative for the alluvial aquifer underlying the EAY area (EPA 1997b). EPA will leave buried wastes in place throughout the EAY area, thereby, EPA's proposed expansion of the Smelter Hill Waste Management Area (WMA) will encompass the EAY. The basis for EPA's recommendation is the presumption that a remedial action for restoration of the alluvial aquifer involving capping or a removal of buried wastes in the EAY will not achieve clean-up of ground water in the alluvial aquifer due to loading of arsenic from contaminated ground water in the upgradient bedrock aquifer on Smelter Hill. Furthermore, due to the complexities of ground water flow in the bedrock aquifer (a weathered and fractured aquifer in volcanic rocks with unpredictable components of vertical and horizontal flow), a remedial alternative involving containment of contaminated ground water in the bedrock aquifer would not effectively satisfy a clean-up of ground water in the adjacent alluvial aquifer. Since the EAY area is currently serviced by a water supply system from the city of Anaconda, ground water in the alluvial aquifer underlying the EAY area will not be used as a domestic water supply during future development. Institutional Controls (ICs) are in place to prohibit the use of ground water in this portion of the ARWW&S OU. Finally, a potentiometric surface map of the alluvial aquifer in the Warm Springs Creek Valley indicates ground water in the alluvial aquifer exiting the EAY area flows underneath a proposed WMAs defined by the Main Granulated Slag Pile and Anaconda Ponds (Figure 2). These wastes are also identified by EPA as a potential loading source of arsenic to ground water of the shallow alluvial aquifer system and may increase the magnitude of ground water contamination in the alluvial aquifer exiting the EAY, thus, minimizing the benefit of a ground water clean-up in the alluvial aquifer in this portion of the ARWW&S OU.

EPA's Proposed Plan for the ARWW&S OU has identified a series of three actions which may minimize loading of arsenic to the alluvial aquifer underlying the EAY area. These actions include the following: 1) development and implementation of a storm water management plan for the Smelter Hill and EAY areas which will minimize infiltration of storm water runoff in the EAY area; 2) completion of a soil cover for uncovered wastes and contaminated soil in the EAY area and backfilling low-lying areas in the EAY which are susceptible to ponding of surface water during storm events; and 3) re-vegetation of contaminated soil identified in certain portions of Smelter Hill (Walker Gulch, Slag Gulch, and Nazer Gulch) in an attempt to stabilize arsenic and trace metals contained in the soil profile (EPA 1997b). Contaminated soils on Smelter Hill are a potential source of ground water contamination to the bedrock aquifer upgradient of the EAY and a source of surface water contamination in drainages emanating from Smelter Hill to the EAY.

2.2 SMELTER HILL TI ZONE

As a result of a TI evaluation in 1996 for the bedrock aquifer underlying portions of the Smelter Hill and South Opportunity Subareas, the Smelter Hill TI Zone, which encompasses a total area of 8,975 acres was identified by EPA in the ARWW&S OU FS Deliverable No. 3A (EPA 1996a) (Figure 1). The Smelter Hill TI Zone identified in FS Deliverable 3A includes portions of the bedrock aquifer underlying the undisturbed area in the Smelter Hill, Aspen Hills, and Clear Creek area (4,892 acres), and a portion of the shallow bedrock aquifer located in the area south of Mill Creek in the vicinity of Cabbage Gulch and Willow Creek (4,083 acres). The bedrock aquifer in this area is described as an unconfined aquifer in fractured volcanic rocks (ryholitic tuff) of Tertiary age, and intrusive rocks (granitic composition) of late Cretaceous and Tertiary age. In addition, segments of the aquifer are located in a mixture of sedimentary (conglomerates, sandstones, shales, and limestones) and metamorphic rocks (quartzite) ranging in age from early Quaternary to PreCambrian age (PTI 1996). For the purpose of this evaluation, all ground water within the Smelter Hill TI Zone is included in the bedrock aquifer.

Data characterizing the lateral extent of ground water contamination in the bedrock aquifer are derived primarily from analytical results of ground water samples collected in 1992, 1993, 1995, and 1996 from springs and ground water seeps (19 total). This data provides sufficient evidence to suggest that ground water contamination in at least the shallow portion of the bedrock aquifer exhibits concentrations of dissolved arsenic greater than the Montana Ground Water Quality Standard for arsenic (18 $\mu g/L$) in an area encompassing at least 8,975 acres. The primary loading source for arsenic to ground water in the shallow bedrock aquifer in the Smelter Hill TI Zone is contaminated soils and smelter wastes. Arsenic levels in surface soils in the Smelter Hill TI Zone are estimated to range from 262 to 1,856 mg/kg (EPA 1996a).

The vertical extent of ground water contamination in the Smelter Hill TI Zone has been estimated from results of ground water samples collected from a monitor well pair (A1-BR) installed in the bedrock aquifer in the Smelter Hill Disturbed Area, and from results of ground water samples collected at two sites in which a shallow piezometer (WGP-2 and NGP-1) is co-located with a ground water spring. The data collected as a result of these investigations indicate the vertical extent of ground water contamination (arsenic greater than 18 $\mu g/L$) in the bedrock aquifer in the Smelter Hill TI Zone may range from approximately 20 feet to 115 feet below the top of the aquifer (EPA 1996a) and 20 to 250 feet below ground surface. Little data were available concerning the vertical extent of ground water contamination and these depths were not well defined at the time the report was written.

2.3 STUCKY RIDGE TI ZONE

The Stucky Ridge TI Zone encompasses a portion of the bedrock aquifer underlying approximately 3,622 acres located on Stucky Ridge, which is located north of the town of Anaconda, Montana (Figure 1). Based on analytical results from ground water samples collected from springs and ground water seeps (13 total), and a shallow piezometer (SRP-1), concentrations of dissolved arsenic in the shallow bedrock aquifer in the Stucky Ridge TI Zone are greater than the Montana Ground Water Quality Standard (18 $\mu g/L$). The bedrock aquifer in this portion of the ARWW&S OU varies from an unconfined aquifer in fractured Tertiary age volcanic rocks to an unconfined aquifer in sedimentary rocks (conglomerates and shale) of Quaternary to Tertiary and Cretaceous age. The vertical extent of ground water contamination in this area has been estimated to range from 10 to 20 feet below the top of the bedrock aquifer (EPA 1996a). Little data were available concerning the vertical extent of ground water contamination, and these depths were not well defined at the time the report was written. The primary loading source of arsenic to ground water in the bedrock aquifer underlying Stucky Ridge is contaminated soil and some smelter wastes. Arsenic levels in surface soils in the Stucky Ridge TI Zone are estimated to range from 120 to 940 mg/kg (EPA 1996a). Wastes containing high levels of arsenic and metals are identified by EPA in portions of the Upper and Lower Works structural areas (ARCO 1992).

2.4 UNCERTAINTIES IN 1996 TI EVALUATIONS

Uncertainties in the conclusions of a TI evaluation for the alluvial aquifer underlying the EAY are identified by EPA in ARWW&S OU FS Deliverable No. 3A (EPA 1996a). These uncertainties include the following:

- Concentrations of arsenic in pore water underlying areas of buried wastes and contaminated soils in the EAY area are not known. As a result, levels of arsenic in pore water underlying the Red Sands, the Disturbed Area of Smelter Hill, and the Opportunity Ponds were used in the 1996 TI evaluation to estimate the concentrations of arsenic in pore water underlying wastes in the EAY area during loading calculations. Concentrations of arsenic in pore water underlying wastes in other portions of the site exhibit very high variability; therefore, a wide range of arsenic levels in pore water (6.5 μg/L to 6,500 μg/L) were used in the 1996 evaluation. The absence of pore water sample results from areas of buried wastes in the EAY area is an important data gap in this evaluation;

- Concentrations of arsenic in the bedrock aquifer located along the valley sidewall intersecting the TI zone are based on ground water samples collected from one Anaconda Regional Water and Waste (ARWW) OU network monitor well (A2-BR), and one ground water sample collected from a temporary piezometer located in Nazer Gulch (NGP-1). The sample results collected from these two locations may not reflect actual levels of arsenic in the shallow bedrock aquifer located adjacent to the entire length of the valley sidewall of the EAY. The flux estimates of arsenic calculated by ARCO for sidewall valley recharge include a range of arsenic based on sample results collected from these two stations (167 to 2,410 μg/L); whereas, EPA's estimates rely on a constant level of arsenic in the bedrock aquifer based on the geometric mean (930 μg/L) of all samples collected from A2-BR. and NGP-1. As a result, significant uncertainty is recognized in the loading rate estimates for arsenic entering the alluvial aquifer from the bedrock aquifer as a result of limited water quality control in the vicinity of this flux boundary;

- The flux of arsenic exiting the alluvial aquifer at the downgradient boundary of the EAY is based on levels of arsenic observed in the alluvial aquifer at MW-210. A range of arsenic levels in the alluvial aquifer (70.8 to 102 μg/L) based on sample results collected at MW-210 was used by ARCO in their estimates of the flux of arsenic exiting the EAY area. EPA's estimates were based on the geometric mean concentration determined from ground water samples collected at MW-210 from 1992 to 1996. However, sample results collected at MW-210 may not represent the concentration range of arsenic in the alluvial aquifer exiting the entire length of the downgradient boundary of the EAY area;

- The geometry of the alluvial aquifer underlying the EAY is not defined. The elevation of the bedrock surface underlying the EAY has been extrapolated from relatively deep monitor well control located outside the boundary of the TI zone from wells (T1-D and T2-E) located in the Warm Springs Creek valley. The estimated elevation of the bedrock surface influences the projected thickness of the alluvial aquifer in the TI zone which is used in the water budget estimates for the alluvial aquifer underlying the EAY, and loading calculations for arsenic entering and exiting the EAY TI Zone. Because the aquifer geometry is not well defined, uncertainty exists in both the water budget and loading rates for arsenic presented in this analysis;

- Ground water flow paths in the EAY alluvial aquifer are poorly defined due to insufficient spatial data on water levels. Additional monitor wells would allow for a more accurate determination of flow paths for transport of arsenic in the alluvial aquifer system underlying the EAY;

- The estimate of hydraulic conductivity for the bedrock aquifer is derived from results of slug tests and packer tests collected from discrete intervals in the aquifer on Smelter Hill. Uncertainty is acknowledged in the representativeness of these results for estimating aquifer parameters for a fractured bedrock aquifer. Efforts to mitigate the uncertainty in the hydraulic conductivity of the bedrock aquifer in this evaluation include choosing a range of hydraulic conductivities (0.18 ft/day to 3.1 ft/day) for the aquifer which are based on results of aquifer tests completed in the fractured volcanic tuff located on Smelter Hill. However, uncertainty in the hydraulic conductivity of the bedrock aquifer adjacent to the sidewall valley of the EAY is recognized in the loading calculations for arsenic to the alluvial aquifer from contaminated ground water in the bedrock aquifer;

- The depth of ground water contamination in the alluvial aquifer underlying the EAY is poorly defined since a relatively deep monitor well has not been installed in the study area. Ground water monitoring of the alluvial aquifer underlying the EAY has occurred in the upper 10 feet of the aquifer. As a result, the depth of contamination in the TI evaluation has been estimated to range from 10 feet below the top of the aquifer to 25 feet. The 10-foot depth of aquifer contamination is based primarily on the length of well screens in the two monitor wells (MW-210 and MW-227) located in the EAY area. The 25-foot depth assumes the entire thickness of the alluvial aquifer underlying the EAY is contaminated as a result of recharge to the aquifer by contaminated ground water from the surrounding bedrock system, or from infiltration and deep percolation of precipitation through wastes. This assumption has not been confirmed by sample results.

Uncertainties in TI Evaluations for TI zones in the bedrock aquifers underlying portions of the Smelter Hill, South Opportunity, and Stucky Ridge Subareas were also presented by EPA in ARWW&S OU FS Deliverable No. 3A (EPA 1996a). These uncertainties include the following:

Smelter Hill TI Zone

- The vertical depth of ground water contamination in the TI zone is based on limited information. Additional data should be acquired through installation of paired monitor wells and/or piezometers in strategic locations to better define the bottom of the TI zone in the Smelter Hill Subarea. In addition, all domestic wells currently in use in the area should be inventoried, and sampled where possible;

- Selection of an arsenic level in soil which coincides with ground water contamination in the shallow bedrock aquifer in the area is based on a limited number of data points. The level of arsenic in soil presented in this evaluation is a site-specific value, and should not be used as a standard for identifying potential areas of ground water contamination as a result of elevated levels of arsenic in soil at other sites. As new data are collected at the site, this information will be added to the comparison to re-evaluate the relationship of arsenic levels in soil with arsenic levels in ground water of the Smelter Hill Subarea;

- The identification of widespread ground water contamination in the bedrock aquifer is based exclusively on sample results collected from ground water seep and springs. Although a reasonable conceptual model is presented explaining the relationship of seep and springs with local and regional ground water flow in the bedrock aquifer, confirmation of ground water contamination within the TI zone by installation and subsequent sampling of monitor wells and/or piezometers should be completed;

- The lateral boundary of the TI zone is based on limited data control. Additional sample stations should be added to the data set to better define the lateral extent of ground water contamination in the shallow bedrock aquifer in this area.

Stucky Ridge TI Zone

- The vertical extent of ground water contamination in the TI zone is not defined from data collected in the Stucky Ridge area but is extrapolated from analysis of data collected in the Smelter Hill TI Zone exhibiting a similar range of arsenic levels in soil. Therefore, data should be acquired through the installation of paired monitor wells and/or piezometers in strategic locations to better define the bottom of the TI zone in the bedrock aquifer in the Stucky Ridge area;

- The definition of the west boundary of the TI zone, which coincides with the contact of Colorado Shale and Lowland Creek volcanic is based on analytical results of a single sample collected from one seep/spring location (SS-T-3). Additional ground water quality data should be collected in the vicinity of this boundary to better define the west boundary of the TI zone for the bedrock aquifer underlying Stucky Ridge;

- The identification of widespread ground water contamination in the bedrock aquifer is based almost exclusively on results of ground water samples collected from ground water seeps and springs. Although a reasonable conceptual model is presented for the explanation of ground water discharge at seeps and springs locations with local and regional ground water flow in the bedrock aquifer, confirmation of ground water contamination within the Stucky Ridge TI Zone by installation and subsequent sampling of monitor wells and/or piezometers should be completed in the future.

3.0 SUMMARY OF FIELD ACTIVITIES IN 1997 AT THE ARWW&S OU

A field investigation of the bedrock aquifer in TI zones at the ARWW&S OU was conducted by ARCO in 1997 to address some of the uncertainties identified by EPA in ARWW&S OU FS Deliverable No. 3A (EPA 1996a). A work plan for the investigation was completed by ARCO in April 1997 and was submitted to EPA for its review (ARCO 1997c). The work plan for the 1997 field investigation in TI zones at the ARWW&S OU was approved by EPA on May 1, 1997 (EPA 1997c).

The work plan for the 1997 field investigation included the following data collection activities in TI zones at the ARWW&S OU:

- Installation of two monitor well pairs (4 wells total) in the bedrock aquifer of the Smelter Hill TI Zone. A shallow well installed at the top of the bedrock aquifer and a deep monitor well installed at a depth of approximately 40 to 50 feet below the top of the aquifer were recommended at each location. Analytical results of ground water samples collected from the shallow monitor well would be used to confirm elevated levels of arsenic in the shallow portion of the aquifer in the TI zone. Analytical results of samples collected from the shallow and deep wells would provide information necessary for estimating the vertical extent of contamination in the aquifer;

- Installation of a single monitor well at a shallow depth in the bedrock aquifer of the Smelter Hill TI Zone located near the valley sidewall adjacent to the EAY. Analytical results of a ground water sample collected from the proposed well would confirm elevated levels of arsenic in the aquifer of the Smelter Hill TI Zone, and would be used to confirm the flux of arsenic entering the alluvial aquifer underlying the EAY from the shallow bedrock aquifer;

- Installation of a monitor well pair in the bedrock aquifer underlying Stucky Ridge. A shallow well installed at the top of the bedrock aquifer and a deep monitor well installed at a depth of approximately 40 to 50 feet below the top of the aquifer would be constructed at a site located near the crest of Stucky Ridge. Analytical results of ground water samples collected from each monitor well would be used to confirm the presence of ground water contamination in the aquifer, and would provide information necessary for estimating the vertical extent of contamination in the aquifer;

- An inventory of ground water springs would be generated in the areas surrounding TI zones in the Smelter Hill, South Opportunity, and Old Works/Stucky Ridge Subareas. Ground water samples would be collected from approximately 35 springs to better define the extent of elevated arsenic levels (>18 μg/L) in the bedrock aquifer in the Smelter Hill and Stucky Ridge TI Zone areas;

- In addition, soil samples will be collected near each ground water spring sample location. Soil samples would be collected from a depth of approximately 0 to 2 inches and would be analyzed for total arsenic by x-ray fluorescence (XRF). The results would be used to determine if a correlation is identified between high arsenic in soils and elevated arsenic in ground water of the shallow bedrock aquifer in TI zones at the ARWW&S OU;

- A total of 8 domestic wells were identified by EPA in the Aspen Hills area of the Smelter Hill TI Zone. A letter from EPA requesting permission to sample domestic wells in the Aspen Hill area was sent to the property owners in early May 1997. Ground water samples would be collected from those wells in which permission from the landowner was received by EPA;

- A newly constructed well was also identified by EPA in the Lost Creek area of the Stucky Ridge TI Zone. A letter requesting permission to sample this well was also sent to the owner of this property in May 1997. A ground water sample would be collected if permission was received by EPA;

- A total of three shallow piezometers were installed in the bedrock aquifers in the Smelter Hill and Stucky Ridge areas in 1993 by ARCO. The piezometers were sampled on only one occasion during an investigation of ground water quality at the ARWW OU. In the event that the piezometers are still in service, a ground water sample would be collected for analysis.

Ground water samples collected during the investigation would be analyzed for concentrations of dissolved arsenic, antimony, iron, total dissolved solids, and major ions. Field parameters would include temperature, pH, Eh, dissolved oxygen, and electrical conductance. Water level measurements would be required at the time of sample collection from monitor wells and piezometers. The location of all springs, domestic wells, and monitor wells would be determined using a portable global positioning system unit, or by identifying the position of each station on a 1:24,000 topographic map.

4.0 SUMMARY OF RESULTS OF FIELD INVESTIGATIONS IN 1997

A field investigation of the bedrock aquifer in TI zones at the ARWW&S OU was initiated by ARCO on May 5, 1997 and was completed on July 15, 1997. Results of the investigation are provided by ARCO in the *1997 Field Activities Data Summary Report Anaconda Regional Water, Waste, and Soils Operable Unit Technical Impracticability Zone Boundaries* (ARCO 1997a). Locations of springs and wells in the TI zones are presented on Plate 1, along with a geologic map (MBMG 1998). A summary of the field activities completed during the investigation is presented below.

4.1 INSTALLATION AND SAMPLING OF MONITOR WELLS

All ground water monitor wells were drilled with an air-rotary rig using a 7 $^7/_8$-inch tricone bit. The drilling contractor was O'Keefe Drilling Corporation of Butte, Montana. Ground water monitor wells were installed with 4 inch I.D. PVC pipe and well screen in accordance with Clark Fork Superfund Site Investigations Standard Operating Procedures. A total of five monitor wells were installed in the bedrock aquifer during the 1997 Field Investigation of TI zones at the ARWW&S OU. One of the proposed monitor wells (MW-246) was completed as a dry hole at a depth of 200 feet below ground surface (bgs).

MW-246 was the first well drilled in the investigation at a location in the Smelter Hill TI Zone in the W/2 NE/4 Section 14, T4N, R11W (Plate 1). According to the well log, MW-246 penetrated unsaturated Lowland Creek volcanic rock from a depth of 5 feet bgs to a total depth of 200 feet bgs. Since ground water was not encountered in the bedrock aquifer to its maximum well depth, MW-246 was plugged with grout and abandoned (Attachment A).

Permission to access EPA's proposed location for monitor well pair MW-245 S&D (NE/4 Section 23, T4N, R11W) was not received on a timely basis. As a result, the location for MW-245 S&D was moved by EPA to a location on ARCO property in the SE/4 Section 14, T4N, R11W. MW-245S was drilled to a total depth of 125 feet bgs, and a water bearing zone in the volcanic bedrock aquifer was penetrated at a depth of approximately 113 bgs. MW-245S is constructed with a 20-foot well screen in the bedrock aquifer at a depth of 104 to 124 feet bgs. Following well development, a ground water sample was collected from the bedrock aquifer in MW-245S on June 9, 1997. Analytical results indicate the concentration of dissolved arsenic in the bedrock aquifer at MW-245S is 1,170 μg/L (Table 2). Depth to ground water in MW-245S at the time of sample collection was approximately 98.7 feet below ground surface. A copy of the well log for MW-245S is presented in Attachment A.

At the request of EPA, a second ground water sample was collected from the bedrock aquifer at MW-245S. Analytical results of a ground water sample collected from MW-245S on August 8, 1997 confirm the occurrence of elevated concentrations of dissolved arsenic (1,130 μg/L) in the bedrock aquifer at the MW-245S location.

A deep monitor well was also constructed in the fractured volcanic bedrock aquifer at the MW-245 well pair location. According to the well log, MW-245D was drilled to a total depth of 165 feet bgs and is constructed with a 10-foot well screen at a depth of 154 to 164 feet bgs. However, following well development MW-245D was determined to be a dry hole. A small volume of water (2.2 gallons) was measured in MW-245D during sampling activities on June 9, 1997. After purging approximately 1.8 gallons of water from the well, the well was dry. A check for water in the well on June 10, 1997 confirmed that MW-245D is a dry hole. A copy of the well log for MW-245 D is provided in Attachment A.

A relatively shallow monitor well was constructed in the bedrock aquifer at MW-247 at a depth of approximately 85 feet bgs. According to the well log, MW-247 was drilled through sand, clay, and gravel to a depth of 26 feet bgs before penetrating volcanic rock of the Lowland Creek Formation. A water bearing zone in volcanic rock was penetrated at a depth of 65 feet bgs. MW-247 is constructed in the fractured volcanic bedrock aquifer with a 20-foot well screen at a depth of 65 to 85 feet bgs. Following well development, a ground water sample was collected from MW-247 on June 9, 1997. The concentration of dissolved arsenic in a ground water sample collected from the bedrock aquifer at MW-247 is less than 1.1 μg/L (Table 2). Depth to ground water in MW-247 was approximately 36.5 feet bgs at the time of sampling. A copy of the well log for MW-247 is presented in Attachment A.

Both shallow and deep ground water monitor wells were constructed in the bedrock aquifer on Stucky Ridge at the MW-248 S&D location. MW-248S was drilled to a total depth of 58 feet bgs in Quaternary or Tertiary sediments and weathered volcanic tuff. According to the well log, a water bearing zone was penetrated by MW-248S at a depth of 37 feet bgs in a sandy-clay layer which overlies a zone of weathered Lowland Creek volcanic rock. MW-248S is constructed with a 20-foot well screen in the Quaternary/Tertiary aquifer at a depth of 34 to 54 feet bgs. Following well development, a ground water sample was collected from MW-248S on June 9, 1997. The concentration of dissolved arsenic in a ground water sample collected from the Quaternary/Tertiary aquifer at MW-248S is less than 1.1 μg/L (Table 2). Depth to ground water in MW-248S at the time of sample collection was approximately 18.3 feet bgs. A copy of the well log for MW-248S is presented in Attachment A.

MW-248D was drilled in Quaternary or Tertiary sediments and Lowland Creek volcanic rock to a depth of 113 feet bgs. According to the well log, a water bearing zone was penetrated in the volcanic bedrock at a depth of approximately 100 feet bgs. MW-248D is constructed with a 20-foot well screen from 90 to 110 feet bgs. Following well development, a ground water sample was collected from MW-248D on June 9, 1997. Analytical results indicate the concentration of dissolved arsenic in the bedrock aquifer is 28.9 μg/L (Table 2). The depth to ground water in MW-248D at the time of sample collection was approximately 43.5 feet bgs. A copy of the well log for MW-248D is presented in Attachment A.

A replacement location for monitor wells MW-246 S&D was identified by EPA in the Cabbage Gulch area in the NW/4 Section 25, T4N, R11W. The proposed drill site is located on property owned by the State of Montana. The property is currently included in the Mount Haggin Wildlife Management Area which is regulated by the Montana Department of Fish, Wildlife, and Parks (FWP). While field activities were in progress in 1997, EPA submitted a verbal request to FWP for permission to install a monitor well pair in the bedrock aquifer in the Cabbage Gulch area of the Mount Haggin Wildlife Management Area. EPA's request was denied by FWP pending completion of an environmental assessment (EA) of the proposed action by EPA. However, EPA decided its schedule for completion of field activities in TI zones at the site would not allow EPA adequate time for completion of an EA, therefore, EPA did not follow-up its request to the State for construction of a monitor well pair in the bedrock aquifer of the Cabbage Gulch area with an EA of the potentially impacted area.

4.2 SAMPLING PIEZOMETERS

The two piezometers installed in the bedrock aquifer in the Smelter Hill TI Zone (WGP-2 and NGP-1) are usable for collection of a ground water sample from the shallow bedrock aquifer. As a result, ground water samples were collected from WGP-2 and NGP-1 on May 15, 1997. However, the piezometer installed in the bedrock aquifer at the base of Stucky Ridge (SRP-1) was apparently destroyed as a result of construction activities related to the Old Works Golf Course.

Analytical results from a ground water sample collected from the bedrock aquifer at WGP- 2 indicate the concentration of dissolved arsenic in the bedrock aquifer is 3.2 μg/L (Table 2). Based on a water-level measurements collected during field activities in 1997 and assuming stick-up length of 2-feet, the total depth of the WGP-2 piezometer is approximately 25.7 feet bgs and the depth to ground water in WGP-2 at the time of sample collection was approximately 8.8 feet bgs. According to previous information reported by ARCO, the piezometer at station WGP-2 was constructed with a 5-foot screen of 1 inch I.D. PVC at a depth of approximately 21 to 26 feet bgs (ARCO 1994).

Analytical results of a ground water sample collected from the bedrock aquifer at NGP-1 indicate the concentration of dissolved arsenic in the bedrock aquifer is 176 μg/L (Table 2). Based on a water-level measurement collected by ARCO during field activities in 1997 and assuming a stick-up length of 2-feet, the total depth of NGP-1 is approximately 14.5 feet bgs and the depth to ground water in NGP-1 at the time of sample collection was approximately 4.5 feet bgs. According to previous information reported by ARCO, the piezometer at station NGP-1 was constructed with a 5-foot screen of 1 inch I.D. PVC at a depth of approximately 10 to 15 feet bgs (ARCO 1994).

4.3 SAMPLING GROUND WATER SPRINGS AND SOIL

Ground water samples were collected by ARCO from a total of 40 springs during the period of May 15, 1997 through July 10, 1997. Nine of the sites are located in or near the boundary of the Stucky Ridge TI Zone area with the remainder being located in or adjacent to the Smelter Hill TI Zone (Plate 1). The ground water samples collected during this investigation were analyzed for concentrations of dissolved arsenic, antimony, iron, and major ions. Analytical results indicate that concentrations of dissolved arsenic in spring samples collected in the Stucky Ridge area range from <1.0 to 95.4 μg/L while concentrations of dissolved arsenic in spring samples collected in the Smelter Hill area range from less than 1.1 to 1,990 μg/L. Analytical results for all spring samples collected in 1997 are summarized in Table 2.

Composite soil samples were also collected in the vicinity of each spring sample station during the 1997 field investigation. At each station, a total of 4 to 5 sub-samples which were collected from the shallow soil profile (0- to 2-inch depth) in an area located a short distance upgradient of each spring sample site. The subsamples were mixed thoroughly before a sample was prepared for analytical use. According to ARCO, the area sampled is representative of the recharge area for each spring. All soil samples collected during the investigation were analyzed for concentrations of total arsenic using XRF methods. Analytical results for concentrations of total arsenic in soil are summarized in Table 2.

At EPA's request, ground water samples were also collected in May 1997 from 5 springs located in or near the Smelter Hill TI Zone by the USGS (USGS 1997). Two of the springs are located in Geyser Gulch in the Disturbed Area of Smelter Hill and 3 springs are located in the Nazer Gulch watershed in the Smelter Hill TI Zone. Analytical results of ground water samples collected from Geyser Gulch indicate concentrations of dissolved arsenic in the springs are greater than 700 μg/L. Analytical results indicate concentrations of dissolved arsenic in the springs in Nazer Gulch range from 146 to 324 μg/L (Attachment B).

4.4 SAMPLING DOMESTIC WELLS

During preparation of the 1997 field investigation, EPA identified a total of 8 domestic wells in the Aspen Hills area, and one newly constructed well in the Lost Creek area from a review of well permits and logs at the State of Montana Department of Natural Resources and Conservation field office in Helena, Montana (Attachment C). Prior to the investigation, EPA sent access agreement letters to each property owner for permission to access and sample their respective well. As a result of this effort, EPA received permission to sample 4 domestic wells in or near the Smelter Hill TI Zone in the Aspen Hills area, and 1 domestic well near the Stucky Ridge TI Zone in the Lost Creek area. Therefore, a total of 5 domestic wells were sampled in this portion of the ARWW&S OU during completion of the 1997 Field Investigation.

Analytical results for ground water samples collected from 5 domestic wells completed in the bedrock aquifer are presented in Table 2. Dissolved arsenic concentrations in each of the 5 wells sampled are below the Montana Ground Water Quality Standard (18μg/L). Arsenic was detected in well LCFD at a concentration of 4.5 μg/L, and was below instrument detection limits in the other 4 wells.

5.0 ANALYSIS OF TI EVALUATIONS

Information collected in 1997 in TI zones at the ARWW&S OU are intended by EPA to address some of the data gaps and uncertainties identified during completion of TI evaluations for the bedrock aquifer at the ARWW&S OU (EPA 1996a). Based on results of the 1997 Field Investigation, revisions to TI evaluations for the bedrock aquifers in the Smelter Hill and Stucky Ridge areas, and uncertainties identified in the analysis are presented below .

5.1 SMELTER HILL

5.1.1 INTRODUCTION

The aerial extent of the TI zone for the bedrock aquifer in the Smelter Hill area is defined by the area in which concentrations of arsenic exceed the Montana Ground Water Quality Standard for arsenic of 18 μg/L. Uncertainties in the TI evaluation for the bedrock aquifer in the Smelter Hill area identified by EPA in FS Deliverable No. 3A (EPA 1996a) were primarily concerned with the limited control for defining the geometry of the TI zone, and absence of information to support the conceptual model for fate and transport of arsenic in soils to ground water. Information collected in 1997 in the Smelter Hill area have been used by EPA to address some of these uncertainties; however, uncertainties remain regarding the nature and extent, and transport of arsenic from areas of contaminated soils, and in some instances buried wastes, to ground water of the bedrock aquifer in this portion of the ARWW&S OU.

5.1.2 LATERAL EXTENT OF GROUND WATER CONTAMINATION IN THE BEDROCK AQUIFER

Analytical results from ground water samples collected from 31 previously unsampled springs have been added to the data set for characterizing ground water quality in the shallow bedrock aquifer in the Smelter Hill TI Zone. In addition, two relatively shallow monitor wells were installed in the bedrock aquifer of the Smelter Hill TI Zone and sampled in 1997. The data obtained from these wells, along with sample results from 2 piezometers and 5 domestic wells, have been incorporated into EPA's characterization of the nature and extent of ground water contamination in the Smelter Hill TI Zone (Table 2). Arsenic concentrations in the Smelter Hill TI Zone area presented on Plate 2.

These data incorporated with results from previous ground water investigations at the site in 1992, 1993, 1995, and 1996 show that contamination of arsenic in the shallow bedrock aquifer at levels exceeding the Montana Ground Water Quality Standard for arsenic (18 μg/L) is more widespread than initially postulated by EPA in FS Deliverable No. 3A (EPA 1996a). As a result, the extent of the Smelter Hill TI Zone has greatly expanded to include all spring/seep sample locations exceeding 18 µg/L arsenic (Plate 2). Since the TI Zones are identified for the bedrock aquifer and the Mill Creek valley contains a significant alluvial aquifer, the Smelter Hill TI Zone is divided into two areas separated by the Mill Creek valley. These areas are now identified as: 1) the Smelter Hill TI Zone which encompasses 5,872 acres in the area located north of Mill Creek in T4N, R11W; and 2) the Mount Haggin TI Zone encompassing 17,958 acres in the area located south of Mill Creek in the Cabbage Gulch and upper Willow Creek areas.

Concentrations of dissolved arsenic in shallow ground water in the Smelter Hill TI Zone range from 2.7 to 1,990 µg/L (Plate 2). An area of the bedrock aquifer with elevated levels of dissolved arsenic exceeding 1,000 µg/L in springs and wells is identified extending in a southwest direction from the boundary of the Smelter Hill Disturbed Area into a portion of the Aspen Hills area (Plate 2). The basis for this delineation of highly elevated arsenic in ground water of the shallow bedrock aquifer is analytical results of ground water samples collected from the bedrock aquifer in the Smelter Hill Disturbed Area at monitor wells A1-BR2, A2-BR, B4-BR, and C2-AL during the period of 1991 through 1993; analytical results of ground water samples collected from springs SH-3, SH-4, SS-T-33, SS-T-34, SS-T-07, SP97-09, SP97-11, and SP-97-12 during investigations in 1992, 1995, and 1997; and analytical results of two ground water samples collected from monitor well MW-245S in 1997. Older data from monitoring wells completed in bedrock in the flue and iron ponds area (MW53, MW54, MW96, MW97, and MW98) showed a range of dissolved arsenic from 330 to 6,300 mg/L.

Based on analytical results of ground water samples collected between 1995 and 1997, concentrations of dissolved arsenic in the shallow bedrock aquifer of the Mount Haggin TI Zone range from 17.4 to 414 µg/L (Plate 2). The extent of arsenic contamination in the Mount Haggin TI Zone appears to be consistent with the extent of sampling. This suggests that the extent of arsenic contamination may be widespread in this area or arsenic may be present as background in concentrations near or above the ARAR.

Based on the analytical results for all ground water samples collected from springs in the Smelter Hill and Mount Haggin TI Zones, concentrations of dissolved arsenic are observed to decrease with an increase in elevation (Figure 3). Springs lower in elevation than the top of the stack (approximately 6,360 feet) show a wide range of concentrations. Arsenic concentrations in these springs decrease as distance from the smelter stack increases (Figure 4). These observations lend support to the conclusion that a principal source of arsenic in ground water of the shallow bedrock aquifer in TI zones at the ARWW&S OU below an elevation of 6,360 feet is deposition of metals from smelter emissions on regional soils, and are not a result of background concentrations of arsenic in ground water from naturally occurring sources. Springs higher in elevation show a range of arsenic concentrations less than 50 µg/L (Figure 3) and do not decrease with distance from the stack (Figure 5). This could be due to wide data scatter and few data points, increased dispersion at greater distance from the stack, or background concentrations of arsenic within the range of analytical results.

Major ion chemistry of selected ground water samples from the bedrock aquifer in the Smelter Hill TI Zone is presented on Table 3. Ground water is a mixed type (containing no cation or anion in excess of 60%; Davis and DeWiest, 1966) and ranges from a bicarbonate type water in most of the west and south portions of the Smelter Hill TI Zone to a calcium/sodium-sulfate or mixed sulfate to mixed-mixed type water in most of the east and northeast portion of the Smelter Hill TI zone.

In the northeast corner of the Mount Haggin TI Zone, most of the springs area mixed-sulfate type, while the remaining areas show sodium to mixed-carbonate to mixed type waters. A summary of the major ion chemistry in ground water samples collected in 1997 from the bedrock aquifer in the Smelter Hill and Mount Haggin TI Zones is presented in Table 3.

Major ion data from the 1997 field investigation (Table 3) and data from other monitoring wells and springs on Smelter Hill were categorized by local geologic unit (Plate 2) and averaged (Figure 6). Two springs (SHSN-1 and SHSS-1) emanating from sinter deposits are attributed to a geothermal source (PTI 1996). Generally, the geothermal springs are strongly calcium-sulfate type, the domestic wells (geologic unit not known) and Missoula Group springs are mixed-carbonate, and the granitic springs and wells are calcium-mixed. Average composition of the other units are mixed-mixed. Water types in the Lowland Creek Volcanics vary widely. This may be due to the broad distribution of the unit: near and far from the smelter stack; higher and lower elevations; and a range of slopes and aspects.

There is little correlation between major ion chemistry and arsenic concentrations in springs. For example, Figure 7 shows a comparison of sulfate to arsenic in springs. No trend is observed in this chart. The lack of correlation may be due to a number of factors including a short residence time of ground water, geographic differences including slope, aspect and elevation, and the possibility that some of the springs may be sourced only by colluvium while others may include a deeper bedrock source. Figure 8 shows that a correlation does exist between sulfate and arsenic in bedrock wells. This relations is expected since flue dust contains high concentrations of leachable sulfate and arsenic (SRK 1982).

Concentrations of total dissolved solids (TDS) and sulfate also exhibit their highest levels in ground water of the Smelter Hill TI Zone in the area located closest to the Smelter Hill Disturbed Area (Plates 3 and 4). Based on analytical results of ground water investigations in 1992 through 1997, levels of TDS and sulfate decrease in the bedrock aquifer in the Smelter Hill and Mount Haggin TI Zones with increasing distance from the Smelter Hill Disturbed Area. These results and observations may indicate that impacts to the shallow bedrock aquifer in the Smelter Hill TI Zone are greatest near its common boundary with the Smelter Hill Disturbed Area. The Smelter Hill Disturbed Area has been identified as a proposed WMA by EPA (EPA 1997b). According to recent estimates, the Smelter Hill Disturbed Area contains approximately 900,000 cubic yards of smelter wastes, most of which are located in areas overlying the bedrock aquifer (EPA 1996b). Concentrations of TDS and sulfate in ground water of the bedrock aquifer underlying the Smelter Hill Disturbed Area are elevated and generally exceed 500 mg/L (ARCO 1997b). Ground water in the bedrock aquifer in the Smelter Hill Disturbed Area ranges from a calcium-sulfate to calcium-bicarbonate type water (ARCO 1997b). Elevated concentrations of TDS and sulfate in the bedrock aquifer in this portion of the ARWW&S OU are attributed to ground water contamination from smelter wastes and contaminated soil, and in some instances (SHSN-1, SHSS-1, SH-3, and SH-5), evidence of mixing from thermal springs.

5.1.3 VERTICAL EXTENT OF GROUND WATER CONTAMINATION IN THE BEDROCK AQUIFER

Two monitor well pairs (MW-245S&D and MW-246S&D) were proposed by EPA in the Smelter Hill TI Zone area to provide information regarding the depth of ground water contamination in the bedrock aquifer in this portion of the site (ARCO 1997b). However, one of the wells (MW-246) was completed as a dry hole at a depth of 200 bgs. A replacement location for MW-246 well pair in the Smelter Hill TI Zone has not been determined by EPA. A replacement location for the monitor well pair in the Cabbage Gulch area is being considered by EPA.

Completion in 1997 of a deep monitor well at MW-245S&D also ended with unsuccessful results. Therefore, collection of a ground water sample from a deeply-constructed monitor well in the bedrock aquifer of the Smelter Hill TI Zone at a location where concentrations of dissolved arsenic are known to be significantly elevated in the shallow portion of the aquifer was not accomplished during the 1997 Field Investigation.

Little new data for characterizing the depth of ground water contamination in the bedrock aquifer in the Smelter Hill and Mount Haggin TI Zones were obtained in the 1997 Field Investigation from newly constructed monitor wells. The depth estimates presented by EPA in FS Deliverable No. 3A (EPA 1996a) included 20 feet and 115 feet below the top of the aquifer (EPA 1996a) that are equal to 20 and 250 feet below ground surface.

The low-end value presented in this range is based on a postulated concentration gradient of dissolved arsenic observed in the shallow bedrock aquifer at sample stations SH-3 (spring location) and WGP-2 (piezometer). The concentrations of dissolved arsenic in a ground water sample collected at SH-3 in 1993 was 39.3 μg/L, while the concentrations of dissolved arsenic in ground water samples collected at WGP-2 in 1993 and 1997 have ranged from 3.2 to 4.3 μg/L. According to station coordinates reported for SH-3 and WGP-2 by ARCO (Attachment D), the two stations are located approximately 90 feet apart (Attachment E). The piezometer at WGP-2 was completed in the bedrock aquifer at a depth of approximately 25 feet bgs (ARCO 1994). Assuming ground water in the bedrock aquifer represented by stations SH-3 and WGP-2 is in hydraulic communication, the analytical results of ground water samples collected from these two stations would suggest that relatively low-level contamination of dissolved arsenic in the shallow bedrock aquifer is limited to the upper 10 to 20 feet of the aquifer (Attachment E). However, major ion chemistry (Table 3) suggests that these stations have dissimilar water type and may not be hydraulically connected.

The high-end value for the depth range of arsenic contamination in the bedrock aquifer in the Smelter Hill TI Zone is estimated from a concentration gradient of dissolved arsenic observed from analytical results of ground water samples collected at monitor well pair A1-BR2 and A1-BR3 located adjacent to the boundary of the Smelter Hill TI Zone. The A1-BR well pair is located at the base of the smelter stack for the former Washoe Smelter in the Smelter Hill Disturbed Area. The Smelter Hill Disturbed Area has been identified by EPA as a proposed waste management unit (EPA 1997a). Approximately 900,000 cubic yards of smelter wastes will be contained in the Smelter Hill Disturbed Area. According to station coordinates, the monitor wells at the A1-BR location are separated by a distance of approximately 11 feet (Attachment F). Monitor well A1-BR2 is completed at a relatively shallow depth in the volcanic tuff bedrock aquifer at a depth of 160 to 180 feet bgs. Depth to ground water in A1-BR2 has ranged from 120 to 140 feet bgs.

Based on quarterly ground water monitoring results at A1-BR2 in 1992 and 1993, concentrations of dissolved arsenic in the bedrock aquifer at A1-BR2 have ranged from 4,450 to 8,470 μg/L. In contrast, monitor well A1-BR3 is completed in the bedrock aquifer at a depth of 227 to 247 feet bgs. Depth to ground water in A1-BR3 has ranged from 195 to 205 feet bgs. The difference in the depth to ground water in the bedrock aquifer at the two monitoring wells is attributed to a downward vertical gradient. The vertical gradient (downward) in the bedrock aquifer at the A1-BR location is approximately 0.9 to 1.2 ft/ft (ARCO 1997b). This implies that this portion of the Smelter Hill area behaves as a recharge area for the underlying regional bedrock aquifer. Based on quarterly ground water monitoring results at A1-BR3 in 1992 and 1993, concentrations of dissolved arsenic range from less than 15.6 to 33.4 μg/L (Attachment F). Since the average concentration of dissolved arsenic in the bedrock aquifer at A1-BR3 (20.3 μg/L) is very close to the Montana Ground Water Quality Standard for arsenic (18 μg/L), the portion of the bedrock aquifer exposed in the well screen in A1-BR3 may represent the maximum vertical depth of ground water contamination in the Smelter Hill TI Zone since the A1-BR well pair is located in the most highly contaminated portion of the ARWW&S OU in a potential recharge area to the bedrock aquifer. Furthermore, since concentrations of dissolved arsenic in the shallow bedrock aquifer at the A1-BR well pair location are among the highest levels observed at the ARWW&S OU, this analysis for estimating the maximum depth of contamination in the bedrock aquifer is considered a worst-case scenario. Assuming the water bearing zones in the bedrock aquifer at the A1-BR location are hydraulically connected and based on ground water monitoring results collected in July 1993 when concentrations of dissolved arsenic in A1-BR3 were at their highest levels (32.4 μg/L), monitoring results at the A2-BR well pair location suggest that elevated levels of dissolved arsenic above the Montana Ground Water Quality Standard for arsenic extend to a maximum depth in the bedrock aquifer of approximately 115 feet bgs (Attachment F). Assuming that the top of the bedrock aquifer at this location is equal to the static water level in A1-BR2, the bottom of the elevated arsenic is 115 feet below the top of the aquifer and 250 feet below ground surface.

The high-end value is also substantiated based on ground water monitoring results in the bedrock aquifer in and near the Disturbed Area of Smelter Hill. A plot of arsenic concentrations in ground water versus depth to water-bearing zone is presented for the bedrock aquifer on Figure 9. A fit of regression lines through the data plotted on Figure 9 suggests that and arsenic concentration of 18 μg/L in ground water may occur at a depth of around 200 to 225 feet below ground surface. A worst case line drawn between the bottom of the water-bearing zones on wells A1-BR2 and A1-BR3 suggests contamination could be as deep as 260 feet. Overall, the trend lines shown on Figure 9 suggest a maximum depth of contamination of approximately 250 feet. Given the sporadic occurrence of water-bearing zones within the bedrock aquifer, it would be difficult to obtain ground water data from this exact depth, however, the trend suggest that wells completed deeper than 250 feet may contain arsenic concentrations less than 18 μg/L.

Although a deep monitoring well was not successfully constructed in the bedrock aquifer of the Smelter Hill TI Zone during the 1997 Field Investigation, analytical results of samples collected from 4 domestic wells located in the Aspen Hills area of the Smelter Hill TI Zone provide additional information which may verify the range of the vertical depth of ground water contamination in the bedrock aquifer of the Smelter Hill TI Zone discussed above. The domestic wells sampled in 1997 range in depth from 60 feet to 360 feet bgs. Concentrations of dissolved arsenic in ground water samples collected from the bedrock aquifer in domestic wells in the Smelter Hill TI Zone range from less than 1.1 μg/L to 2.1 μg/L (Table 2). The Prete well, which was constructed at a total depth of 150 feet bgs exhibits the highest level of dissolved arsenic in all domestic wells sampled in this area. According to the well log, the Prete well is perforated in rock from 90 to 150 feet bgs, and the static water level of the aquifer is approximately 65 feet bgs (Attachment C).

In addition, analytical results from ground water samples collected at the Kinney, Dishman, and Martin domestic wells located in Section 27, T4N, R11W provide additional vertical control pertaining to undetected levels of dissolved arsenic at depth in the bedrock aquifer in the Smelter Hill TI Zone. According to 1997 results, concentrations of dissolved arsenic in the bedrock aquifer in these three wells are below detection limits (<1.4 μg/L). The total depth of the Martin well is approximately 184 feet bgs (ARCO 1997a). The well log for the Martin domestic well indicates the well is perforated from 140 to 180 feet bgs. At the time of sample collection, depth to ground water in the Martin well was approximately 20 bgs (ARCO 1997a). The sample results from the Martin well would indicate that concentrations of arsenic in the bedrock aquifer are below detection limits at a depth of 140 to 160 feet bgs.

Well information for the Dishman and Kinney wells suggest these wells are completed at a total depth of 60 and 360 feet bgs, respectively. The Dishman and Kinney wells are perforated from 47 to 53 feet bgs and 320 to 360 feet bgs, respectively. A static water level measurement of 20 bgs was reported on the well log for the Dishman well. The sample results from the Dishman well suggest concentrations of dissolved arsenic in the bedrock aquifer in this portion of the Smelter Hill TI Zone are below detection limits at a depth of 47 to 53 feet bgs. Although a static water level measurement is not available for the Kinney well, sample results indicate concentrations of dissolved arsenic in the bedrock aquifer are below detection limits at depth of approximately 320 feet bgs at the Kinney residence. Well log reports for the domestic wells sampled during the 1997 Field Investigation at the ARWW&S OU are presented in Attachment C.

Data are not available to determine the vertical extent of ground water contamination in the Mount Haggin TI Zone. Since a relationship between arsenic levels in the shallow bedrock aquifer versus distance from the smelter stack is observed from results of the 1997 Field Investigation, and because arsenic levels in soil in the Mount Haggin area are generally less than those in the Smelter Hill TI Zone, the vertical extent of ground water contamination in the bedrock aquifer in the Mount Haggin TI Zone is postulated to be less than that in the Smelter Hill TI Zone (less than 115 feet below the top of the water table and less than 250 feet bgs).

5.1.4 UNCERTAINTIES AND CONCLUSIONS

Numerous uncertainties are recognized in EPA's characterization of ground water contamination in the bedrock aquifer of the Smelter Hill TI Zone. These uncertainties are identified and briefly discussed below. Portions of the boundary of the Smelter Hill and Mount Haggin TI Zones are not well defined by existing sample control (Plate 2). This is especially true in the southern and eastern portions of the Mount Haggin TI Zone where sufficient spring sample control is not available to define the boundary for concentrations of dissolved arsenic below 18 μg/L in the bedrock aquifer.

In addition to ground water samples collected from spring sample station locations, near-surface composite soil samples were also collected at spring sample locations during the 1997 field investigation. The soil samples were analyzed for concentrations of total arsenic by XRF methods. The results have been used to characterize concentrations of arsenic in contaminated soils in potential source areas for ground water contamination in the bedrock aquifer at spring sample locations. A statistical comparison of estimated concentrations of arsenic in regional surface soils at the ARWW&S OU with concentration of dissolved arsenic in ground water of spring sample stations was presented by EPA in FS Deliverable No. 3A (EPA 1996a). This comparison indicates a fair correlation is observed between arsenic levels in surface soil and arsenic levels in ground water of the shallow bedrock aquifer. The correlation was used as evidence by EPA that widespread areas of contaminated soils are a source of ground water contamination to the bedrock aquifer in TI zones at the ARWW&S OU. However, a comparison of the soil and ground water data collected during the 1997 Field Investigation suggest there is a very poor correlation between arsenic levels in soil with concentrations of arsenic in ground water at spring sample locations in TI zones at the ARWW&S OU (Figure 10). When other factors are considered, including elevation (Figure 11) and distance from the stack (Figure 12), the correlation does not improve. The poor correlation of arsenic levels in soil and arsenic in ground water of the bedrock aquifer may be evidence that the soil sampling techniques (i.e., sample depth) used in 1997 were inconsistent with techniques used during previous soil investigations at the site; the relationship of the flow path from contaminated soil to ground water is more complicated than initially thought; other factors are involved in the loading rate of arsenic to ground water in the shallow bedrock aquifer.

A review of the analytical results of arsenic levels in soil samples collected by the State of Montana Natural Resources Damage Program (NRDP) in segments of the Smelter Hill and Stucky Ridge TI Zones, indicates concentrations of arsenic in soil decrease by approximately 25 to 30 percent in the 0- to 6-inch sample depth interval versus those levels measured in samples collected at the same station in the 0- to 2-inch sample interval (Table 4). Analytical results of soil samples collected by NRDP are reported in the *Terrestrial Resources Injury Assessment Report Upper Clark Fork River NPL Site* (NRDP 1995). The sample technique used to collect soil samples in TI zones during the 1997 Field Investigation involved a composite of 4 or 5 subsamples collected at each station in the 0- to 2-inch interval with a small shovel or spade. Since the sample depth was estimated by sight and not measured during sample collection, the arsenic levels observed in the results may indicate that the sample interval may have exceeded a 2-inch depth.

The conclusions from a comparison of concentrations of arsenic in surface soil with arsenic levels in ground water at seep/spring locations sampled in 1997 may reflect uncertainties associated with the sampling method (e.g., sample depth; frequency and spacing of sub-samples used in the composite sample), and/or uncertainties in the identification of the potential loading area (source area) for arsenic to ground water at each spring sample location. The analytical results for concentrations of total arsenic in soil at spring sample stations are relatively low when compared to estimated levels of arsenic in regional surface soil, and the 90 percent confidence interval of arsenic in regional surface soils, derived from a geostatistical analysis of regional undisturbed soil sample results collected at the ARWW&S OU (Table 5). Observations from this comparison indicate analytical results from 34 out of 40 samples are below the respective estimate for arsenic in regional surface soils determined by ARCO in a kriging analysis of existing soils data at the ARWW&S OU (Table 5) (ARCO 1996). The comparison also indicates that almost half (results from 19 spring soil samples) of the sample results are below the lower confidence interval estimated by ARCO in the kriging analysis for concentrations of arsenic in regional surface soil. In contrast, a comparison of estimated levels of arsenic in regional surface soils determined from the kriging analysis with results of arsenic in the shallow bedrock aquifer indicates a fair correlation is observed between estimated arsenic in soil and arsenic in ground water (Figure 13). Results of this comparison suggest elevated concentrations of dissolved arsenic in ground water of the shallow bedrock aquifer may occur in areas underlying concentrations of arsenic in regional surface soils of 200 mg/kg, or greater (Figure 13).

A comparison of the analytical results of soil samples collected in the Stucky Ridge, Smelter Hill, and Mount Haggin TI Zones with analytical results of soil samples collected in the 0- to 2-inch sample interval in the same areas by NRDP in 1992 indicates analytical results of soil samples collected in 1997 are low. A summary of the analytical results from NRDP investigation is provided on Table 6. A summary of analytical results of soil samples collected in 1997 sorted by TI zone is presented on Table 7. A comparison of the range and mean from both data sets indicates soil sample results from the 1997 Field Investigation are low compared to results collected by NRDP in TI zones at the ARWW&S OU in 1992. The difference in the results from the 2 investigations may be explained by differences in sample collection methods, differences in analytical technique (XRF versus Contract Laboratory Program methods), and differences in soil conditions due to a relatively dry year in 1992 and a wet year in 1997.

During the 1997 Field Investigation, two monitor wells (MW-245S and MW-247) were installed in the bedrock aquifer in the Smelter Hill TI Zone to confirm the occurrence of elevated concentrations of arsenic in the Smelter Hill TI Zone. In addition, two piezometers installed by ARCO in the bedrock aquifer in Walker Gulch (WGP-2) and Nazer Gulch (NGP-1) in 1993 were also sampled during the 1997 investigation. Analytical results from ground water samples collected from the wells and piezometers exhibit mixed results. Analytical results of a ground water sample collected at MW-245S confirm the occurrence of highly elevated levels of dissolved arsenic (1,170 μg/L) in the upper portion of the bedrock aquifer in this portion of the Smelter Hill TI Zone. An attempt by ARCO to construct a deep monitor well at MW-245 S&D was unsuccessful, therefore, the downward vertical extent of ground water contamination in this portion of the bedrock aquifer is not defined.

Analytical results of a ground water sample collected from the bedrock aquifer at MW-247 indicate concentrations of dissolved arsenic in this portion of the aquifer adjacent to the EAY are below detection limits (<1.0 μg/L). This result is contrary to analytical results from ground water samples collected from the bedrock aquifer at monitor well A2-BR, and piezometer NGP-1. Monitor well A2-BR is constructed in the shallow volcanic tuff bedrock aquifer immediately adjacent to the valley sidewall near the south boundary of the EAY (Plate 1). A2-BR penetrated the top of the Tertiary volcanic tuff at a depth of 52 feet bgs and is constructed with a well screen at approximately 60 to 80 feet bgs. Concentrations of dissolved arsenic in ground water samples collected at A2-BR range from 843 to 2,410 μg/L. Highly elevated concentration of dissolved arsenic in this portion of the bedrock aquifer are attributed to loading of arsenic from buried wastes and contaminated soils located in the Disturbed Area on Smelter Hill. However, A2-BR is also located downgradient of buried wastes in the EAY at the former crushing plant (Plate 1). These wastes may also contribute elevated levels of dissolved arsenic to the shallow bedrock aquifer at A2-BR.

A review of the well log for MW-247 indicates the well was constructed with a well screen from 65 to 84 feet bgs. MW-247 penetrated the top of a volcanic tuff at a depth of 26 feet bgs. A water level measurement from MW-247 during sample collection in June 1997 indicates static water level is approximately 36.5 feet bgs. As a result, the bedrock interval sampled in MW-247 may be 30 to 50 feet below the top of the bedrock aquifer. Elevated levels of dissolved arsenic may occur in the shallow portion of the bedrock aquifer located behind casing at the MW-247 well. However, the analytical results of a ground water sample collected from MW-247 suggest concentrations of dissolved arsenic in the bedrock aquifer are low at depth, and decrease significantly from the highly elevated levels observed in the bedrock aquifer in the area located near the downgradient boundary of the Smelter Hill Disturbed Area at A2-BR. Although concentrations of dissolved arsenic in the bedrock aquifer at MW-247 are low (less than 1.1μg/L), levels of TDS (1,060 mg/L) and sulfate (352 mg/L) are elevated (Table 2). Elevated levels of TDS and sulfate at depth (approximately 65 to 84 feet bgs) in the bedrock aquifer at MW-247 may indicate that impacts to the aquifer are apparent and may be more severe at a relatively shallow depth in the bedrock aquifer at MW-247. However, a comparison analytical results of ground water sample collected from each monitor well, suggest concentrations of dissolved arsenic in the shallow bedrock aquifer may decrease significantly in an east-west direction along the sidewall valley of the EAY.

Analytical results of a ground water sample collected from the bedrock aquifer at MW-247 may imply that the loading rate of dissolved arsenic to the alluvial aquifer from the bedrock aquifer along the valley sidewall of the EAY may be less than previously estimated by EPA in its TI evaluation for the alluvial aquifer underlying the EAY area presented in ARWW&S OU FS Deliverable No. 3A (EPA 1996a). The loading estimate for arsenic entering the alluvial aquifer in the EAY area from contaminated ground water in the bedrock aquifer assumed the concentration of dissolved arsenic in the bedrock aquifer adjacent to the sidewall valley is approximately 930 μg/L (EPA 1996a). This value was strongly influenced by analytical results of ground water samples collected at A2-BR and piezometer NPG-1. However, the analytical results of a ground water sample collected at MW-247 indicate concentrations of dissolved arsenic in the bedrock aquifer along the entire length of the valley sidewall with the EAY may be significantly lower than 930 μg/L. Based on EPA's isoconcentration map for arsenic in the bedrock aquifer of the Smelter Hill TI Zone, arsenic levels along the sidewall valley of the EAY may range from 10 to greater than 1,000 μg/L, and may average approximately 300 μg/L (Plate 2). In EPA's Sidewall Valley Model presented in Section 3.1.6.4 of ARWW&S OU FS Deliverable No. 3A, flux estimates for arsenic to the alluvial aquifer of the EAY were determined from an approximate balance of the flux of arsenic entering the alluvial aquifer as a result of recharge to the aquifer from valley through-flow, sidewall valley recharge from the bedrock aquifer, and infiltration of precipitation and surface water runoff. Using data from MW-247 and assuming no other changes to the assumptions of EPA's model, the contribution of arsenic from sidewall valley recharge to the alluvial aquifer from the bedrock aquifer ranges from 1.6 to 38.8 percent, the contribution from recharge of the aquifer due to infiltration of precipitation and surface water runoff through wastes and contaminated soil ranges from 52.6 to 91.3 percent, and the contribution of arsenic from recharge of the aquifer from valley through-flow ranges from 5.4 to 8.6 percent of the total arsenic exiting the aquifer at the downgradient boundary of the EAY (Table 8). In each case, the concentration of arsenic in pore water underlying buried wastes and contaminated soil in the EAY area is estimated to be 6,500 μg/L.

The conclusions of EPA's Sidewall Valley Flux Model for estimating loading rates of arsenic to the alluvial aquifer in the EAY emphasize the significance in the uncertainty in the concentration of dissolved arsenic in pore water underlying areas of buried wastes in the EAY. The analytical results of a ground water sample collected from the bedrock aquifer at MW-247 does suggest that the contribution of arsenic to the alluvial aquifer as a result of sidewall valley recharge from contaminated ground water in the bedrock aquifer is less than previously determined by EPA in ARWW&S OU FS Deliverable No. 3A.

Piezometer NGP-1 is constructed in the bedrock aquifer in the Smelter Hill TI Zone in the Nazer Gulch area. Concentrations of dissolved arsenic in ground water samples collected at NGP-1 have ranged from 167 μg/L in 1993 to 176 μg/L in May 1997 (Table 2). A ground water sample collected by the USGS from a spring (SS-T-30) located in Nazer Gulch at a location approximately 150 feet upgradient of NGP-1 also exhibited elevated concentrations of dissolved arsenic (245 μg/L) (USGS 1997). Analytical results of ground water samples collected by the USGS in 1997 from two additional spring locations (SS-T-31 and SS-T-32) in the upper segment of the Nazer Gulch watershed also exhibit elevated concentrations of dissolved arsenic (146 to 324 μg/L) in ground water of the shallow bedrock aquifer. Based on analytical results of ground water samples collected from the bedrock aquifer in the Nazer Gulch area, contaminated soil resulting from deposition of smelter emissions is a potential loading source of arsenic to the shallow bedrock aquifer in this portion of the ARWW&S OU. However, wastes allegedly transported from the Acid Plant formerly located in the EAY, and deposited in Nazer Gulch at a location upgradient of SS-T-30 are a potential source of ground water contamination to the shallow bedrock aquifer at NGP-1 and SS-T-30 (Attachment G).

Since the combined area of the Smelter Hill and Mount Haggin TI Zones is very large (23,828 acres) and the primary source of arsenic to ground water is infiltration of precipitation through widespread areas of contaminated soil, EPA considers it to be technically impracticable to restore ground water quality in the bedrock aquifer in the two areas to levels below the Montana Ground Water Quality Standard for arsenic (18 μg/L). Since uncertainties are recognized by EPA in its interpretation of the geometry of the TI zone for the bedrock aquifer in the Smelter Hill and Mount Haggin areas, the following tasks are recommended:

- Residential development is currently in progress in a portion of the Aspen Hills and Clear Creek areas in a portion of the Smelter Hill TI Zone. Elevated concentrations of dissolved arsenic are identified in the shallow bedrock aquifer in this area. Since the depth of ground water contamination in this portion of the bedrock aquifer is not well defined, EPA recommends construction of a deep monitor well at the MW-245 location or in the Aspen Hills Subdivision to determine the vertical extent of elevated concentrations of dissolved arsenic in this portion of the Smelter Hill TI Zone;

- EPA will complete a thorough inventory of domestic wells in the Smelter Hill TI Zone area which will include information pertaining to the depth and construction design of all domestic wells in the Smelter Hill TI Zone area. EPA will make an effort to collect a ground water sample from all domestic wells in the Smelter Hill TI Zone area to characterize ground water quality in the bedrock aquifer in areas where ground water is being used as a domestic water supply;

- EPA will discuss conclusions of its TI evaluation for the bedrock aquifer with State and County officials. A detailed process utilizing to regulate and monitor ground water use within the boundaries of TI zones at the ARWW&S OU (including the Smelter Hill TI Zone) will be formulated by EPA and ARCO. The plan must also be approved by State and County officials;

- Additional sources for domestic water supply and use will also be identified by EPA during its inventory of domestic wells in the Smelter Hill TI Zone. This effort may require site visits by EPA to determine sources of domestic water supply currently in use in TI zones at the ARWW&S OU. Since elevated levels of arsenic in surface water are also observed in the area of the Smelter Hill and Mount Haggin TI Zones, methods for restricting the use of surface water as a domestic water supply will also be formulated by EPA and ARCO, and must be approved by the State of Montana, EPA, and Anaconda-Deer Lodge County (ADLC);

- Determine property ownership in the Mount Haggin TI Zone and determine if there is current use of ground water as a domestic supply of water. Based on land ownership, an evaluation of the potential future use of ground water as a domestic water supply will be completed and monitored;

- Determine the boundary of the southern and eastern extent of the Mount Haggin TI Zone, principally in the upper portion of the Willow Creek drainage through collection of additional springs and seep data;

- Complete discussions with Mount Haggin Wildlife Management officials regarding the expanded boundary of the Mount Haggin TI Zone; and

- A long-term monitoring plan will be designed and implemented by EPA to evaluate changes in ground water quality of the Smelter Hill and Mount Haggin TI Zones as source control measures and ICs are implemented during remedial design/remedial action at the ARWW&S OU. EPA will implement these recommendations through the Record of Decision (ROD) for the ARWW&S OU, and as described in Section 9.5.4 of the ROD. The ROD calls for additional site characterization and expansion of the domestic well inventory with pre-design data collection begun in the summer of 1998; and implementation of water use restrictions for protection of public health through expansion of the current ADLC Development Permit System (DPS) and petitions for Controlled Groundwater Use Areas through the State of Montana Department of Natural Resources Conservation.

5.2 STUCKY RIDGE

5.2.1 INTRODUCTION

Uncertainties in the TI evaluation for the bedrock aquifer in the Stucky Ridge area presented by EPA in ARWW&S OU FS Deliverable No. 3A (EPA 1996a) included the geometry of the TI zone and representativeness of the conceptual model for explaining fate and transport of arsenic in soils and waste to ground water. The information collected in 1997 in the Stucky Ridge area are used by EPA to address some of the uncertainties; however, numerous questions remain regarding the nature and extent, and transport of arsenic from areas of contaminated soils, and in some instances buried wastes, to ground water of the bedrock aquifer in this portion of the ARWW&S OU.

5.2.2 LATERAL EXTENT OF GROUND WATER CONTAMINATION IN THE BEDROCK AQUIFER

Data collected from 9 previously unsampled springs have been added to the data set for characterizing ground water quality in the shallow bedrock aquifer in the Stucky Ridge TI Zone. In addition, two monitor wells were installed in the bedrock aquifer in the Stucky Ridge TI Zone, and the monitor wells were recently sampled.

These data considered with sample results from previous field investigations in 1993, 1995, and 1996 suggest that the extent of dissolved arsenic concentrations above the Montana Ground Water Quality Standard is more widespread than initially postulated by EPA in ARWW&S OU FS Deliverable No. 3A (Plate 2). Based on all data collected from spring sample sites, monitor wells, and piezometer located in the Stucky Ridge TI Zone since 1993, elevated concentrations of dissolved arsenic in ground water encompass an area of approximately 4,771 acres (Plate 2). This area is larger than EPA's earlier estimate of 3,622 acres for the TI zone on Stucky Ridge presented in ARWW&S OU FS Deliverable No. 3A (EPA 1996a).

Based on results of all field investigations in the Stucky Ridge area, concentrations of dissolved arsenic in the shallow bedrock aquifer exhibit their highest levels (>100 μg/L) in the area common to the corner of Sections 26, 27, 34, 35, T5N, R11W (Plate 3). The basis for a delineation of significantly elevated levels of arsenic in the bedrock aquifer of the Stucky Ridge TI Zone is analytical results of ground water samples collected at spring sites SS-T-14 and SP97-20.

Concentrations of TDS in the bedrock aquifer of the Stucky Ridge TI Zone range from 48 to 982 mg/L. Concentrations of TDS are highest in the bedrock aquifer in the vicinity of the Upper and Lower Works structural areas (Plate 3).

Concentrations of sulfate in the Stucky Ridge TI Zone range from 30 to 472 mg/L. Concentrations of sulfate are highest in the bedrock aquifer underlying the Upper and Lower Works structural areas, and in portions of the aquifer located on the north slope of Stucky Ridge (Plate 4).

In the Stucky Ridge TI Zone, calcium-sulfate water is predominant in springs located at the west end of the zone while rest of the area has a range of calcium-mixed to mixed-mixed water type. A summary of the major ion chemistry in ground water samples collected in 1997 from the bedrock aquifer in the Smelter Hill and Mount Haggin TI Zones is presented in Table 3.

5.2.3 VERTICAL EXTENT OF GROUND WATER CONTAMINATION IN THE BEDROCK AQUIFER

A monitor well pair at MW-248 S&D was completed in the bedrock aquifer during the 1997 Field Investigation at the ARWW&S OU. The monitor well pair is located approximately 160 to 220 feet upgradient of spring sample site (SP97-20) which exhibits relatively high concentrations of dissolved arsenic (95.4 μg/L).

MW-248S is constructed in the bedrock aquifer with a 20-foot well screen from 34 to 54 feet bgs. MW-248S penetrated the top of weathered Lowland Creek volcanics at a depth of approximately 40 feet bgs. The water-bearing zone is a sandy clay at a depth of 37 to 40 feet. Depth to ground water in MW-248S is approximately 18.3 feet bgs. Based on analytical results of a ground water sample collected in June 1997, the concentration of dissolved arsenic in the bedrock aquifer at MW-248S, at a depth of 37 to 40 feet bgs, is less than 1.1 μg/L. A comparison of the analytical results of ground water samples collected at MW-248S and SP97-20 suggest that concentrations of dissolved arsenic in the bedrock aquifer greater than the Montana Ground Water Quality Standard for arsenic is limited to the upper 15 to 25 feet of the aquifer at this location (Attachment H). Elevated levels of sulfate are observed in the analytical results of a ground water samples collected at MW-248S (127 mg/L) and SP97-20 (177 mg/L). A review of major ions in ground water at SP97-20 and MW-248S indicates ground water in this portion of the shallow bedrock aquifer is a calcium/magnesium-bicarbonate/sulfate type water.

MW-248D, which is located approximately 115 feet from MW-248S, was drilled to a total depth of 113 feet bgs. MW-248D is constructed in the bedrock aquifer with a 20-foot length of 4 inch I.D. PVC screen from 90 to 110 feet bgs. MW-248D penetrated the top of weathered Lowland Creek volcanics at a depth of 24 feet bgs. A water-bearing zone was encountered at a depth of 100 feet bgs. The static water level in MW-248D is approximately 43.5 feet bgs. Based on analytical results of a ground water sample collected at MW-248D, the concentration of dissolved arsenic in the bedrock aquifer is approximately 28.9 μg/L. However, levels of sulfate (22 mg/L) and TDS (299 mg/L) are low in ground water of the bedrock aquifer at MW-248D relative to levels observed in the shallow segment of the aquifer at SP97-20 and MW-248S.

A comparison of ground water elevations in the bedrock aquifer indicates the elevation of the water table in the bedrock aquifer in MW-248S is approximately 23.5 feet higher than the water table in the bedrock aquifer in MW-248D. This difference may be indicative of a downward vertical gradient in the bedrock aquifer, or may be representative of the elevation of the water table in two separate bedrock aquifers underlying the Stucky Ridge TI Zone.

A comparison of the occurrence of major ions in water samples collected from MW-248 S&D suggests two distinct water types are represented from the analytical results of samples collected from each well. Ground water in the bedrock aquifer at MW-248S and SP97-20 is a calcium/magnesium-bicarbonate/sulfate-type water while ground water in the bedrock aquifer at MW-248D is a sodium-bicarbonate type water exhibiting very little sulfate (Table 3).

Based on the difference in the ground water elevation of the bedrock aquifer at MW-248 S&D, and significant differences in major ion chemistry of ground water samples collected from each well, two bedrock aquifers are hypothesized underlying the Stucky Ridge TI Zone in the vicinity of monitor well pair MW-248 S&D and spring SP97-20 (Attachment H). Concentrations of dissolved arsenic and sulfate in the shallow portion of the aquifer are elevated but appear to decrease significantly with depth of the aquifer.

Based on analytical results of a sample collected at MW-248S, dissolved arsenic in the shallow bedrock aquifer may decrease to levels below the Montana Ground Water Quality Standard for arsenic in ground water (18 μg/L) in the upper 15 to 25 feet of the aquifer. In contrast, based on analytical results of a ground water sample collected at MW-248D, concentrations of dissolved arsenic in a deeper portion of the aquifer are elevated (28.9 μg/L) at levels above the State of Montana Ground Water Standard for arsenic to a depth of at least 100 feet bgs.

5.2.4 UNCERTAINTIES AND CONCLUSIONS

Numerous uncertainties are observed in a characterization of the aquifer geometry for the bedrock aquifer of the Stucky Ridge TI Zone. These uncertainties are identified and briefly discussed below.

Although the boundary of the Stucky Ridge TI Zone is fairly well defined from existing sample control, the data for characterizing ground water quality in the aquifer are dominated by analytical results of ground water samples collected from springs (Plate 2). Confirmation of the extent of ground water contamination using piezometers or shallow monitor wells would address uncertainties in the nature and extent of ground water contamination in the bedrock aquifer in the Stucky Ridge area, and better define the hydraulics of the bedrock aquifer(s).

The vertical extent of ground water contamination in the Stucky Ridge area is not well defined from existing data. Results of ground water samples collected from a newly installed monitor well pair located near the crest of Stucky Ridge are somewhat inconsistent with the conceptual model that loading of arsenic occurs from metals contamination in regional surface soils on Stucky Ridge. Analytical results of ground water samples collected at monitor well pair MW-248 indicate two distinct water types are observed at depth in the bedrock aquifer in this portion of the Stucky Ridge TI Zone. In addition, arsenic levels are higher at depth in the bedrock aquifer (MW-248D) than those levels observed at a relatively shallow interval in the aquifer at MW-248S. Water level measurements from the wells indicate either a downward vertical gradient is present in this portion of the bedrock aquifer, or that two distinct bedrock aquifers are identified. A comparison of arsenic levels in the bedrock aquifer at SP97-20 and MW-248S indicate elevated levels of dissolved arsenic above the State of Montana standard for arsenic in ground water may be limited to the upper 15 feet of the aquifer. However, the arsenic level in the bedrock aquifer at MW-248D is above arsenic above the State of Montana standard. MW-248D encountered a water-bearing zone at a depth of approximately 100 feet below ground surface. The results of ground water monitoring at well pair MW-248S&D and SP97-20 present a level of uncertainty in the conceptual model for the fate and transport of elevated levels of arsenic in contaminated soils and wastes to the shallow bedrock aquifer in the Stucky Ridge TI Zone area.

Several springs (SS-T-03 and SS-T-14) located in the Stucky Ridge TI Zone area exhibit arsenic levels below the Montana Ground Water Quality Standard. Analytical results of ground water samples collected at these stations are an indication that natural variability in arsenic levels may exist, seasonal fluctuations of arsenic levels in ground water are possible, and complexities may exist in the path and rates of unsaturated and saturated flow underlying areas of contaminated soil in the Stucky Ridge TI Zone.

Since deposition of smelter emissions are likely to have impacted surface soils in the area located north of Lost Creek, it is also possible that elevated levels of dissolved arsenic occur in ground water of the shallow bedrock aquifer in portions of the area located north of the Lost Creek Valley. Therefore, an uncertainty exists that ground water contamination in the shallow bedrock aquifer is limited to the Stucky Ridge TI Zone, and does not extend to at least a portion of the shallow bedrock aquifer in the area located north of the Lost Creek Valley.

Based on the uncertainties identified in the TI evaluation of the bedrock aquifer in the Stucky Ridge area, the following actions are recommended by EPA.

- An inventory of spring will be developed in the area located immediately north of Lost Creek. Spring locations identified will be sampled to characterize ground water quality in the shallow bedrock aquifer in this portion of the ARWW&S OU;

- EPA will discuss areas of concern regarding potential human health risks from exposure of contaminated ground water in the bedrock aquifer in the Stucky Ridge TI Zone area with the ADLC Planning Office. A clear and concise description of ICs required by EPA for regulating use of ground water in areas of concern at the ARWW&S OU (including the Smelter Hill TI Zone) will be discussed in detail with officials of the ADLC Planning Office. At least a portion of the Stucky Ridge TI Zone area located in portions of

Sections 26 and 36, T5N, R11W are being contemplated by current landowners for future residential use; and

- A long-term monitoring plan will be designed and implemented by EPA to record changes in ground water quality of the Stucky Ridge TI Zone as source control measures and ICs are implemented during remedial design/remedial action at the ARWW&S OU. The information will be evaluated prior to EPA's 5-year review to ensure that variations in the nature and extent, fate and transport, and changes in land-use have not significantly changed EPA's assessment of the exposure of ground water contamination in the Stucky Ridge TI Zone area to human health and/or the environment.

5.3 SUMMARY OF CONCLUSIONS

Based on the conclusions of a TI evaluation for the bedrock aquifer in the ARWW&S OU (EPA 1996a) including the additional information and analysis presented herein, the areas exceeding the ARAR for arsenic in ground water (18µg/L) are currently delineated to include 4771 acres in the Stucky Ridge TI Zone, 5872 acres in the Smelter Hill TI Zone, and 17956 acres in the Mount Haggin TI Zone. The depth of elevated arsenic has been estimated to range from 115 feet to 20 feet below the top of the aquifer. The aquifer material is fractured rock and characterization is difficult leading to uncertainties in identifying the upper and lower boundaries of the aquifer. This, in turn, leads to difficulty in practical identification of the bottom of the TI Zone based on a measurement below the top of the aquifer.

The maximum depth of contamination has been identified as 250 below ground surface in the vicinity of the Disturbed Area on Smelter Hill. The maximum depth of contamination on the flanks of Smelter Hill include less than 65 feet bgs at MW247 and less than 71 feet at F2-BR. However, the maximum depth of contamination has not been well defined by data from monitor wells elsewhere including all of the Stucky Ridge and Mount Haggin TI Zones. Domestic wells in the area do not show elevated levels of arsenic, but the well log data are insufficient to draw conclusions regarding the source of the water entering the wells, thus the depth at which the aquifer is not contaminated is uncertain.

Due to these uncertainties, the maximum depth of contamination is identified as 250 feet below ground surface across all three bedrock aquifer TI Zones recognizing that many areas will not be contaminated to this depth. The Agencies will use 250 feet below ground surface as the maximum depth of contamination for administration purposes across the TI Zones, but will evaluate an appropriate management scheme to modify this depth in areas where development is occurring.

6.0 EVIDENCE OF SOIL CONTAMINATION AS A SOURCE OF GROUND WATER CONTAMINATION IN TI ZONES AT THE ARWW&S OU

Soil samples were also collected in the vicinity of each spring sample station to determine arsenic levels in source areas at each site. The data collected in this investigation are used to determine whether a good correlation exists between arsenic levels in ground water of the shallow bedrock aquifer and concentrations of arsenic in nearby regional surface soils. Results of a previous comparison of estimated levels of arsenic in soils based on results of a geostatistical analysis (kriging) for regional surface soils at the ARWW&S OU (ARCO 1996) with concentrations of arsenic in ground water of the bedrock aquifer, were presented by EPA in ARWW&S OU FS Deliverable No. 3A (EPA 1996a). The conclusions of this comparison indicate potential levels of dissolved arsenic above 18 μg/L occur in shallow bedrock aquifers at the ARWW&S OU in areas in which arsenic levels in surface soil exceed 550 mg/kg (EPA 1996a).

A comparison of arsenic levels in soil samples collected at spring sample locations in 1997 with arsenic levels in ground water of the shallow bedrock aquifer determined from analytical results of ground water samples collected at 1997 spring sample sites indicates no meaningful relationship (Figure 10). The poor relationship observed in the 1997 sample results may be evidence that the soil sampling techniques (i.e., sample depth) used in 1997 were inconsistent from sample station to sample station and with sample techniques used during previous soil investigations at the site; the flow path and flow rate of unsaturated flow from areas of contaminated soil to ground water are more complicated and less predictable than initially hypothesized in EPA's conceptual model; and other factors such as soil type and texture, and vegetation cover and type may be involved in the loading rate of arsenic in soil to ground water of the shallow bedrock aquifer. The analytical results of soil samples collected at spring locations in 1997 indicate concentrations of arsenic in surface soil near spring sample sites range from 8.1 mg/kg (SP97-40) to 861 mg/kg (SP97-25). The average concentration of arsenic in surface soil at 1997 spring sample sites located within or near TI zones boundaries at the ARWW&S OU is approximately 116 mg/kg. A comparison of the analytical results of soil samples collected in TI zones at the ARWW&S OU in 1997 with estimated levels of arsenic in regional surface soils based on results of a geostatistical analysis of concentrations of metals in regional surface soils at the site indicates sample results for arsenic in surface soil collected in TI zones in 1997 are low when compared to previous estimates (Table 5). Based on the results of a geostatistical analysis of arsenic levels in regional surface soils at the site, concentrations of arsenic in surface soil at 1997 spring sample locations are estimated to range from 88 to 886. The average concentration of estimated arsenic in soil at 1997 spring sample stations is estimated from the kriging analysis of regional soils to be approximately 342 mg/kg (Table 5). A comparison of analytical results of arsenic in surface soils samples collected near 1997 spring locations with estimated levels of arsenic in regional surface soil based on kriging results indicates results from samples collected in 1997 are low. A detailed comparison of the 1997 sample results with results of the kriging analysis indicates that sample results are lower than the estimated levels of arsenic in regional surface soil at all but six stations, and that the 1997 sample results do not fall within the upper and lower 90 percent confidence interval estimated from the kriging analysis for 19 out of at total of 40 stations sampled (Table 5). The results of this comparison suggest that the estimates for arsenic in regional surface soil are not representative of actual concentrations of arsenic in surface soil (0- to 2-inch depth) in and near TI zones at the ARWW&S OU, or that the analytical results of soil samples collected in the 1997 Field Investigation are not representative of actual arsenic levels in source areas of 1997 spring sample locations.

A comparison of estimated levels of arsenic in regional surface soils, based on results of a kriging analysis of regional surface soils at the ARWW&S OU, with the concentration of arsenic in ground water of the bedrock aquifer based on analytical results of ground water samples collected from 1997 spring locations indicates a relationship between arsenic levels in surface soil and ground water of the shallow bedrock aquifer may exist. The results of this comparison indicate that potential levels of dissolved arsenic above 18 μg/L may occur in shallow bedrock aquifers at the ARWW&S OU in areas underlying area of soil contamination with arsenic concentrations in surface soil greater than 150 to 200 mg/kg (Figure 13).

7.0 LAND OWNERSHIP, POSTULATED AREAS FOR FUTURE DOMESTIC GROUNDWATER USE, AND INSTITUTIONAL CONTROLS

A land ownership map for TI zones at the ARWW&S OU is presented on Plate 5. Most land in TI zones at the operable unit is owned by either ARCO, ADLC, the State of Montana, and the U.S. Department of Agriculture. In most instances, lands owned by these government entities will not be used for future residential development. An exception is identified for the State-owned property (480 acres) in Section 36, T5N, R11W in the Stucky Ridge TI Zone area. According to sources at the State of Montana Department of Natural Resources and Conservation, the State is considering residential use as the most appropriate land-use for a portion of this acreage.

The areas of TI zones postulated for current of future residential land-use includes privately-owned property in TI zones at the ARWW&S OU. These areas are identified below.

Smelter Hill TI Zone

- The Aspen Hills/Clear Creek Area encompassing all or part of Sections 21, 22, 23, 24, 27, and 28, T4N, R11W; and
- Ten acres located in the NWSW Section 10, T4N, R11W are privately owned.

Mount Haggin TI Zone

- Property in all or portions of Sections 31, 32, and 33, T4N, R11W; and Sections 4, 5, 6, 7, and 8, T3N, R11W in which the current ownership is unknown but is thought to be in private ownership; and
- Property in all or portions of Sections 19, 20, 28, 29, 30, and 32, T4N, R10W are privately owned.

Stucky Ridge TI Zone

- State-owned land in Section 36, T5N, R11W; and
- Privately-owned land in all or portions of Section 26, 27, 28, 33, and 34, T5N, R11W.

A map of the Mount Haggin Wildlife Management Area is presented in Attachment I. A more detailed and accurate determination of land ownership in TI zones at the ARWW&S OU should be conducted by EPA during future investigations at the site.

EPA will continue coordination and discussion with local land use planning officials in the ADLC to assess on-going changes in land use. To date, EPA has incorporated information from the county's 1992 Master Plan on land use to determine domestic ground water use areas. The Master Plan will be updated and adopted by local officials in 1998, and EPA will continue to incorporate new information into Superfund institutional controls (ICs) planning. The associated ADLC's DPS will be revised to reflect changes in the Master Plan, and EPA will work with the local officials to expand the well drilling and water use restrictions, as appropriate.

Sections 9.7 and 9.8 of the ARWW&S OU ROD describes implementation and use of a site-wide ICs planning tool to track compliance with the ground water use restrictions on the site. Changes in land use, developments in the ADLC's Master Plan or DPS, and an assessment of the protectiveness of the ICs will be presented in site-wide five-year reviews.

The ROD also calls for implementation of a TI Zones ground water monitoring plan and, in case of plume expansion, contingencies to provide for additional waiver of the ground water standard and provisions for an alternative water supply. In the event that domestic water users are discovered using contaminated ground water, springs, and/or surface water with arsenic above the State of Montana standards, an alternative water supply for those home owners will be instituted. If the spatial extent of the TI Zone changes from the current estimate based on new findings during the monitoring program, the ADLC planning commission and county commissioners will be notified and the Superfund Site Record will be updated with the revised TI Zone.

8.0 REFERENCES

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TABLES

TABLE 1

Summary of Restoration Alternative Costs

Smelter Hill	**Estimated Costs**
Source Removal	$82 million
Source Containment	$623 million
Ground Water Extraction/Treatment	$9.3 million
In situ Treatment	$72-83 million
Stucky Ridge	**Estimated Costs**
Source Removal	$36 million
Source Containment	$251 million
Ground Water Extraction/Treatment	$7.9 million
In situ Treatment	$42 million

Table 2 Summary of Analytical Results for Spring/Seep and Domestic Well Samples

Station	Elevation (feet)	East (feet)	North (feet)	Date	Basis	Arsenic (ug/L)	Q	Arsenic (mg/kg)	Calcium (ug/L)	Q	Iron (ug/L)	Q	Magnesium (ug/L)	Q	Manganese (ug/L)	Q	Potassium (ug/L)	Q	Sodium (ug/L)	Q	Bicarbonate (mg/L)	Q	Chloride (mg/L)	Q	Sulfate (mg/L)	Q	TDS (mg/L)	Q
SP97-1	6020	1119951	804512.5	16-May-97	DIS	40.7		95.3	54000		8 6	U	7130		3	U	979		7600		81 6		6		68		253	
SP97-2	6000	1118091	805505 3	16-May-97	DIS	42.9		82 1	24400		188		5190		13 1		1640		6770		39		5	U	50		151	
SP97-3	6020	1118267	806611 5	16-May-97	DIS	13.4		163	94200		9 4		22400		11 2		2030		29200		191		23		151		478	
SP97-4	6360	1118576	811974.1	19-May-97	DIS	17.3		122	8030		78.2		1430		3 7		991		1780		16 6		5	U	14		57	
SP97-5	6080	1121927	810912.6	19-May-97	DIS	18.2	B	179	7810		40.6		898		3	U	1500		1830		19 8		5	U	8		48	
SP97-6	6340	1116399	813788.4	19-May-97	DIS	2.5	B	11 6	14700		8.6	U	2480		3	U	1020		4610		21.8		5	U	29		118	
SP97-7	6000	1115185	808672.8	20-May-97	DIS	8.7	B	31.7	368000		147		9200		25.3		1200		14700		81.6		5	U	79		226	
SP97-8	5940	1116621	809015.4	20-May-97	DIS	19.6		168	101000		27.6		16000		107		3620		21600		144		5	U	186		463	
SP97-9	5900	1132312	783905.7	21-May-97	DIS	1990		88.2	45700		18.4		11100		3	U	2270		55800		150		5	U	135		395	
SP97-10	5780	1127942	782062.9	21-May-97	DIS	277		80.9	64800		8.6	U	32700		3	U	4650		15600		261		5	U	79		392	
SP97-11	5670	1128600	781428.9	21-May-97	DIS	608		169	53500		6.6	U	21200		3	U	2220		28400		228		5	U	71		356	
SP97-12	5620	1129467	781490 6	21-May-97	DIS	482		34.1	62200		8.6	U	23300		3	U	1660		34500		261		5	U	88		402	
SP97-13	5800	1126253	778792.4	22-May-97	DIS	37.4		66.4	74500		8.6	U	19200		3	U	1940		14300		189		5	U	117		379	
SP97-14	6880	1117745	782908.3	22-May-97	DIS	3.6	B	28.4	9170		101		1850		3	U	900		4940		27.4		5	U	17		100	
SP97-15	6650	1116328	784189.6	22-May-97	DIS	5.7	B	178	4670		30.7		1240		6.3		873		2950		16.2		5	U	11		56	
SP97-16	6760	1117614	783422.2	22-May-97	DIS	1.1	U	75.8	6330		227		1280		3	U	810		3440		24		5	U	10		104	
SP97-17	6250	1116185	769796.2	23-May-97	DIS	112		185	7310		852		911		7.2		1220		3860		23.8		5	U	15		186	
SP97-18	6260	1115727	769210.4	23-May-97	DIS	87.4		104	5350		371		942		3	U	883		2820		23		5	U	10		119	
SP97-19	5360	1127716	791603	23-May-97	DIS	2.7		315	78600		12.2		41200		3	U	2760		20500		212		12		189		498	
SP97-19 D	5360	1127718	791603	23-May-97	DIS	2.2		362	78200		8.6		41200		3	U	2790		20700		214		12		185		490	
SP97-20	5690	1127662	802149.5	09-Jun-97	DIS	95.4		78.2	99800		8.6	U	21000		80.8		5480		3930		92.4		85		177		611	
SP97-21	6200	1120843	778211.3	10-Jun-97	DIS	147		201	9960		187		2670		3	U	1320		3600		28.2		5	U	30		101	
SP97-22	5640	1136302	775015.8	10-Jun-97	DIS	223		170	42800		266		17900		572		2720		21400		87.4		5	U	147		313	
SP97-23	5660	1136863	774485.1	10-Jun-97	DIS	42.3		155	42800		39.6		9010		3	U	1510		16600		79.4		5	U	98		235	
SP97-24	5560	1129413	778452.2	24-Jun-97	DIS	269		116	73100		26		32900		18		3370		10600		248		5	U	63		391	
SP97-25	5550	1129562	778953.9	24-Jun-97	DIS	710		861	59200		37.6		18200		4.3		2210		54300		240		5	U	93		394	
SP97-26	5400	1137381	770510	26-Jun-97	DIS	60.4		94	45400		75.1		15800		8.6		3540		51100		203		5	U	84		340	
SP97-27	5470	1135885	766416.7	26-Jun-97	DIS	34.8		31.7	40100		31.8		5720		4.3		1490		6180		135		5	U	23		195	
SP97-28	5500	1135460	763595.9	26-Jun-97	DIS	50.9		100	8000		884		748		7.7		2090		19500		44.8		5	U	38		191	
SP97-29	5720	1138591	765491.6	26-Jun-97	DIS	260		37.8	25400		182		477		10.3		1240		74400		107		5		123		341	
SP97-30	5720	1140930	769140.5	26-Jun-97	DIS	33.8		53.1	22700		139		4540		183		3520		4700		10	U	5	U	49		355	
SP97-31	5320	1138906	771153.1	26-Jun-97	DIS	74.8		98.1	38200		49.1		17100		5.1		2250		14500		59		5	U	49		175	
SP97-32	5920	1125033	770530.1	08-Jul-97	DIS	73.1		145	31200		38.7		8620		4.4		1100		12100		101		5	U	46		174	
SP97-33	6160	1124738	768411.1	09-Jul-97	DIS	189		57.8	17600		74.5		2730		30.1		872		25900		64.2		5	U	48		185	
SP97-34	7120	1122471	758271.3	09-Jul-97	DIS	42.9		31.3	1590		107		198		3	U	998		3460		18.4		5	U	8		62	
SP97-35	6840	1124930	762826.7	09-Jul-97	DIS	29.3		53.7	10400		26.8		875		3.5		447		4590		31.4		5	U	17		92	
SP97-36	6520	1122548	761815.5	09-Jul-97	DIS	32.3		20.7	1690		71.5		229		3.5		588		5740		14.4		5	U	8		49	
SP97-37	6600	1120618	763012.7	09-Jul-97	DIS	17.4		77.1	8470		71.5		451		8		686		8610		25.8		5	U	31		77	
SP97-38	6560	1119965	762635.8	09-Jul-97	DIS	42.7		67.5	5440		25.8		260		6.2		544		3450		17.4		5	U	13		53	
SP97-39	6180	1115307	765980.4	10-Jul-97	DIS	45.9		16.9	3400		173		875		31.8		593		14000		46.6		5	U	8		114	
SP97-40	6390	1118103	761906.1	10-Jul-97	DIS	20.1		8.1	7840		155		508		4.4		337		10500		35.2		5	U	14		58	
SS-T-30	5390			29-May-97	DIS	245																			NA			
SS-T-31	5480			29-May-97	DIS	324																			NA			
SS-T-32	5760			29-May-97	DIS	146																			NA			
SS-T-33	5780			29-May-97	DIS	708																			NA			
SS-T-34	5760			29-May-97	DIS	777																			NA			
MW-245S	5700	1130055	782176.9	09-Jun-97	DIS	1170			5400		834		1580		5.8		954		81100		108		5	U	82		302	
MW-245S	5700	1130055	782176.9	08-Aug-97	DIS	1130			5050		434		1400		5.3		759		82100		108		5	U	82		281	
MW-247	5235	1130479	792094.3	09-Jun-97	DIS	1.1	U		5400		199		472		5		1060		374000		456		15		352		1060	
MW-248S	5725	1127541	802257.8	09-Jun-97	DIS	1.1	U		102000		8.6		20400		8.4		2650		40700		165		21		127		523	
MW-248D	5725	1127595	802357.1	09-Jun-97	DIS	28.9			6080		60.4		793		3	U	1420		110000		184		25		22		299	
WGP-2		1133688	788510	15-May-97	DIS	3.3			170000		2370		32100		142		10800		45800		217		5		432		832	
WGP-2 DUP		1133688	788510	15-May-97	DIS	3.4			163000		2290		30900		135		10500		45000		216		6		425		837	
NGP-1		1129466	790874	15-May-97	DIS	176			68200		18.7		11800		84.3		4150		60100		204		6		128		454	
Dishman				09-May-97	DIS	1.1	U		42300		28.1		10100		3	U	1150		6460		90.4		5	U	59		217	
Prete	6300	1119660	778467.2	15-Jul-97	DIS	2.1	B		31000		8.6		19700		3	U	1900		7990		154		5	U	29		191	
Martin	5660	1123519	773129.3	15-Jul-97	DIS	1.4	U		27400		137		6920		19.4		640		16800		110		5	U	25		160	
LCFD				15-Jul-97	DIS	1.9	B		43300		28.6		10500		3	U	1310		3540		138		5	U	18		170	
Kinney				24-Sep-97	DIS	1.4	U		37000		24.2	U	9580		8.9		416		33800		154		5	U	58		212	

U - Not detected B - Below instrument detection limit

Table 3
Calculation of Percent meq/L Common Ions

	Ca	Mg	Na+K	SO4	CO3+HCO3	Cl	Water Type		Geologic	TI
Station	% meq/L	% meq/L	% meq/L	% meq/L	% meq/L	% meq/L	Cations	Anions	Unit	Zone
SP97-1	74	16	10	48	46	6	Ca	SO4+HCO3	KJs	Stucky Ridge
SP97-2	61	22	17	62	38	0	Ca	SO4	Tlc	Stucky Ridge
SP97-3	60	23	17	45	45	9	Ca	SO4+HCO3	Tlc	Stucky Ridge
SP97-4	65	19	17	52	48	0	Ca	SO4+HCO3	Ts	Stucky Ridge
SP97-5	67	13	20	34	66	0	Ca	HCO3	KJs	Stucky Ridge
SP97-6	63	18	19	63	37	0	Ca	SO4	Tlc	Stucky Ridge
SP97-7	56	23	21	55	45	0	Ca+Mg+Na	SO4+HCO3	Tlc	Stucky Ridge
SP97-8	68	18	14	62	38	0	Ca	SO4	Tlc	Stucky Ridge
SP97-9	40	16	44	53	47	0	Ca+Na	SO4+HCO3	Tlc	Smelter Hill
SP97-10	48	40	12	28	72	0	Ca+Mg	HCO3	Tlc	Smelter Hill
SP97-11	47	31	23	28	72	0	Ca+Mg+Na	HCO3	Tlc	Smelter Hill
SP97-12	47	29	24	30	70	0	Ca+Mg+Na	HCO3	Tlc	Smelter Hill
SP97-13	62	26	11	44	56	0	Ca	HCO3+SO4	Kg	Smelter Hill
SP97-14	54	18	28	44	56	0	Ca+Na	HCO3+SO4	Tlc	Smelter Hill
SP97-15	48	21	31	46	54	0	Ca+Mg+Na	HCO3+SO4	Qs	Smelter Hill
SP97-16	53	18	29	35	65	0	Ca+Na	HCO3	Tlc	Smelter Hill
SP97-17	57	12	31	44	56	0	Ca+Na	HCO3+SO4	Tlc	Mount Haggin
SP97-18	55	16	30	36	64	0	Ca+Na	HCO3	Tlc	Mount Haggin
SP97-19	47	41	12	50	45	4	Ca+Mg	SO4+HCO3	Tlc	Smelter Hill
SP97-20	71	25	4	49	20	32	Ca	SO4+Cl+HCO3	Tlc	Stucky Ridge
SP97-21	55	24	21	57	43	0	Ca+Mg+Na	SO4+HCO3	Qs	Smelter Hill
SP97-22	55	27	18	68	32	0	Ca+Mg	SO4	Tlc	Mount Haggin
SP97-23	59	20	21	61	39	0	Ca+Mg+Na	SO4	Tlc	Mount Haggin
SP97-24	53	39	8	24	76	0	Ca+Mg	HCO3	Qs	Smelter Hill
SP97-25	43	22	35	33	67	0	Ca+Mg+Na	HCO3	Kg	Smelter Hill
SP97-26	39	22	39	34	66	0	Ca+Mg+Na	HCO3	Tlc	Mount Haggin
SP97-27	72	17	11	18	82	0	Ca	HCO3	Tlc	Mount Haggin
SP97-28	29	5	66	52	48	0	Na	SO4+HCO3	Tlc	Mount Haggin
SP97-29	28	1	71	57	39	3	Na	SO4+HCO3	Tlc	Mount Haggin
SP97-30	63	21	16	86	14	0	Ca	SO4	Tlc	Mount Haggin
SP97-31	48	35	17	51	49	0	Ca+Mg	SO4+HCO3	Tlc	Mount Haggin
SP97-32	55	25	20	37	63	0	Ca+Mg+Na	HCO3	Tlc	Mount Haggin
SP97-33	39	10	51	49	51	0	Na+Ca	HCO3+SO4	Tlc	Mount Haggin
SP97-34	29	6	65	36	64	0	Na	HCO3	Tlc	Mount Haggin
SP97-35	65	9	26	41	59	0	Ca	HCO3+SO4	Tlc	Mount Haggin
SP97-36	23	5	72	41	59	0	Na	HCO3+SO4	Tlc	Mount Haggin
SP97-37	50	4	46	60	40	0	Ca+Mg	SO4	Tlc	Mount Haggin
SP97-38	59	5	36	49	51	0	Ca+Na	HCO3+SO4	Tlc	Mount Haggin
SP97-39	20	8	72	18	82	0	Na	HCO3	Tlc	Mount Haggin
SP97-40	44	5	52	34	66	0	Na+Ca	HCO3	Tlc	Mount Haggin
MW-245S	7	3	90	49	51	0	Na	HC03+SO4	Tlc	Smelter Hill
MW-245S	6	3	91	50	50	0	Na	HC03+SO4	Tlc	Smelter Hill
MW-247	2	0	98	48	49	3	Na	HC03+SO4	Tlc	Smelter Hill
MW-248S	59	19	21	45	46	10	Ca+Na	HC03+SO4	Tlc	Stucky Ridge
MW-248D	6	1	93	11	73	16	Na	HCO3	Tlc	Stucky Ridge
WGP-2	63	20	17	71	28	1	Ca	SO4	Tlc	Smelter Hill
NGP-1	48	14	38	43	54	3	Ca+Na	HC03+SO4	Tlc	Smelter Hill
Dishman	65	26	10	45	55	0	Ca	HC03+SO4		Mill Creek
Prete	43	45	11	19	81	0	Mg+Ca	HC03		Smelter Hill
Martin	51	21	28	22	78	0	Ca+Na+Mg	HCO3		Mill Creek
LCFD	67	27	6	14	86	0	Ca	HCO3		Lost Creek
Kinney	45	19	36	32	68	0	Ca+Na	HCO3		Smelter Hill
OWS-1	58	12	30	48	27	25	Ca+Na	SO4+HCO3+Cl	Tlc	Stucky Ridge
OWS-2	47	14	38	48	39	13	Ca+Na	SO4+HCO3	Ts	Stucky Ridge
OWS-4	18	23	59	48	50	3	Na+Mg	HCO3+SO4	Ts	Stucky Ridge
SH-1	44	16	40	43	54	3	Ca+Na	HCO3+SO4	Tlc	Smelter Hill
SH-2	41	17	42	37	58	5	Na+Ca	HCO3+SO4	Tlc	Smelter Hill
SH-3	15	41	43	82	17	1	Na+Mg	SO4	Tlc	Smelter Hill
SH-4	38	14	48	54	40	6	Na+Mg	SO4+HCO3	Tlc	Smelter Hill
SH-5	66	16	18	79	20	1	Ca	SO4	Tlc	Smelter Hill
SHSN-1	66	15	19	83	17	1	Ca	SO4	Geothermal	Smelter Hill
SHSS-1	66	15	19	83	16	1	Ca	SO4	Geothermal	Smelter Hill
SP-1	55	13	33	58	22	19	Ca+Na	SO4+HCO3	Tlc	Stucky Ridge
SP-2	45	16	39	57	21	21	Ca+Na	SO4+HCO3+Cl	Tlc	Stucky Ridge
SP-3	48	13	39	49	38	13	Ca+Na	SO4+HCO3	Ts	Stucky Ridge
F2-BR	75	17	8	50	46	4	Ca	HCO3+SO4	Kg	Smelter Hill
A1-BR2	46	44	10	78	14	8	Ca+Mg	SO4	Tlc	Smelter Hill
A1-BR3	34	45	20	31	58	11	Ca+Mg+Na	HCO3+SO4	Tlc	Smelter Hill
C2-BR	68	16	16	84	15	1	Ca	SO4	Tlc	Smelter Hill
A2-BR	60	17	23	69	28	3	Ca	SO4	Tlc	Smelter Hill
B4-BR	29	3	68	82	14	4	Na	SO4	Tlc	Smelter Hill
C2-AL	70	19	11	91	7	2	Ca	SO4	Tlc	Smelter Hill

Table 4

A Comparison of Analytical Results of Soil Samples Collected from 0-2 and 0-6 Inches at Stations Located in TI Zones at the ARWWS OU

Station	Depth inches	Arsenic ppm	pH	Depth inches	Arsenic ppm	pH
			Stucky Ridge TI Zone*			
A3	0-2	381.4	8.1	0-6	188.9	8.4
A6	0-2	285.5	5.5	0-6	184.9	5.6
A10	0-2	429.6	5.1	0-6	385.6	5.0
	Mean	365.5			253.1	
			Smelter Hill TI Zone*			
B3	0-2	243.8	7.1	0-6	114.0	7.5
B5	0-2	183.3	6.9	0-6	134.2	6.9
B11	0-2	658.0	5.4	0-6	518.2	5.4
B13	0-2	660.6	6.1	0-6	559.0	6.1
B16	0-2	972.9	7.1	0-6	642.5	7.3
	Mean	543.7			393.6	
			Mount Haggin TI Zone*			
C1	0-2	133.6	4.8	0-6	93.5	5.3
C7	0-2	107.6	5.5	0-6	133.1	5.5
C9	0-2	630.0	4.9	0-6	378.0	5.1
C14	0-2	247.4	5.1	0-6	172.5	5.7
	Mean	279.7			194.3	

* Samples were collected by the State of Montana Natural Resource Damage Program. Results are reported in the Terrestrial Resources Injury Assessment Report, January 1995.

Table 5

Summary of Arsenic Levels in Soil at Spring Sample Locations and Estimated Levels of Arsenic in Regional Surface Soils Predicted by ARCO (ARCO 1996)

Station	East	North	Date	Basis	Arsenic (ug/L)	Q	Arsenic (mg/kg)	Est. Arsenic (mg/kg)	UCL Arsenic (mg/kg)	LCL Arsenic (mg/kg)	Sulfate (mg/L)	Distance to Smelter Stack (ft)
SP97-1	1119951	804512.5	16-May-97	DIS	40.7		95.3	209	342	77	68	22639
SP97-2	1118091	805505.3	16-May-97	DIS	42.9		82.1	157	253	62	50	24621
SP97-3	1118267	806611.5	16-May-97	DIS	13.4		163	131	231	33	151	25329
SP97-4	1118576	811974.1	19-May-97	DIS	17.3		122	108	212	5	14	29424
SP97-5	1121927	810912.6	19-May-97	DIS	18.2		179	125	225	25	8	26780
SP97-6	1116399	813788.4	19-May-97	DIS	2.5		11.6	106	208	4	29	32149
SP97-7	1115185	808672.8	20-May-97	DIS	8.7		31.7	88	163	14	79	28920
SP97-8	1116621	809015.4	20-May-97	DIS	19.6		168	89	169	9	186	28225
SP97-9	1132312	783905.7	21-May-97	DIS	1990		88.2	886	1166	606	135	4337
SP97-10	1127942	782062.9	21-May-97	DIS	277		80.9	424	587	261	79	8734
SP97-11	1128600	781428.9	21-May-97	DIS	608		169	553	769	338	71	8654
SP97-12	1129467	781490.6	21-May-97	DIS	482		34.1	553	769	338	88	8007
SP97-13	1126253	778792.4	22-May-97	DIS	37.4		66.4	354	505	203	117	12177
SP97-14	1117745	782908.3	22-May-97	DIS	3.6		28.4	478	787	169	17	17669
SP97-15	1116328	784189.6	22-May-97	DIS	5.7		178	416	685	148	11	18778
SP97-16	1117614	783422.2	22-May-97	DIS	1.1	U	75.8	475	796	155	10	17671
SP97-17	1116185	769796.2	23-May-97	DIS	112		185	164	250	78	15	25668
SP97-18	1115727	769210.4	23-May-97	DIS	87.4		104	162	255	68	10	26404
SP97-19	1127716	791603	23-May-97	DIS	2.5		339	489	670	309	189	8233
SP97-20	1127662	802149.5	09-Jun-97	DIS	95.4		78.2	363	500	226	177	16358
SP97-21	1120843	778211.3	10-Jun-97	DIS	147		201	417	671	164	30	16753
SP97-22	1136302	775015.8	10-Jun-97	DIS	223		170	803	1349	258	147	12518
SP97-23	1136863	774485.1	10-Jun-97	DIS	42.3		155	740	1406	75	98	13121
SP97-24	1129413	778452.2	24-Jun-97	DIS	269		116	533	755	312	63	10494
SP97-25	1129562	778953.9	24-Jun-97	DIS	710		861	533	755	312	93	9988
SP97-26	1137381	770510	26-Jun-97	DIS	60.4		94	600	1223	-22	84	17129
SP97-27	1135885	766416.7	26-Jun-97	DIS	34.8		31.7	262	536	-13	23	21057
SP97-28	1135460	763595.9	26-Jun-97	DIS	50.9		100	260	562	-41	38	23860
SP97-29	1138591	765491.6	26-Jun-97	DIS	260		37.8	183	368	-1	123	22276
SP97-30	1140930	769140.5	26-Jun-97	DIS	3.8		53.1	250	513	-12	49	19299
SP97-31	1138906	771153.1	26-Jun-97	DIS	74.8		98.1	420	762	79	49	16798
SP97-32	1125033	770530.1	08-Jul-97	DIS	73.1		145	345	513	177	46	19544
SP97-33	1124738	768411.1	09-Jul-97	DIS	189		57.8	328	480	177	48	21541
SP97-34	1122471	758271.3	09-Jul-97	DIS	42.9		31.3	244	402	86	8	31683
SP97-35	1124930	762826.7	09-Jul-97	DIS	29.3		53.7	300	465	135	17	26533
SP97-36	1122548	761815.5	09-Jul-97	DIS	32.3		20.7	270	404	136	8	28418
SP97-37	1120618	763012.7	09-Jul-97	DIS	17.4		77.1	224	325	123	31	28262
SP97-38	1119965	762635.8	09-Jul-97	DIS	42.7		67.5	224	325	123	13	28919
SP97-39	1115307	765980.4	10-Jul-97	DIS	45.9		16.9	194	317	71	8	29011
SP97-40	1118103	761906.1	10-Jul-97	DIS	20.1		8.1	213	306	121	14	30527

Max	861	886
Min	8.1	88
Mean	116.9	341.8

Table 6

Summary of Analytical Results of Surface Soil Samples Collected by NRDP

Stucky Ridge TI Zone Area		
Sample Station	Depth (in)	Arsenic (ppm)
A3	0-2	381.4
A4	0-2	386.8
A5	0-2	624.3
A6	0-2	285.5
A7	0-2	142.7
A8	0-2	143.5
A9	0-2	178.5
A10	0-2	429.6
	Max:	**624.3**
	Min:	**142.7**
	Mean:	**321.5**
Smelter Hill TI Zone Area		
B1	0-2	310.5
B2	0-2	278.5
B3	0-2	243.8
B4	0-2	335.1
B5	0-2	183.3
B6	0-2	386.1
B7	0-2	778.4
B9	0-2	708.7
B10	0-2	615.5
B11	0-2	658.0
B12	0-2	496.0
B13	0-2	660.6
B14	0-2	1846.7
B16	0-2	972.9
	Max:	**1846.7**
	Min:	**183.3**
	Mean:	**605.3**
Mount Haggin TI Zone Area		
C1	0-2	133.6
C2	0-2	317.9
C3	0-2	224.2
C4	0-2	238.5
C5	0-2	178.2
C6	0-2	299.6
C7	0-2	107.6
C8	0-2	237.1
C9	0-2	630.0
C10	0-2	181.6
C11	0-2	215.6
C12	0-2	336.9
C13	0-2	471.9
C14	0-2	247.4
C15	0-2	576.3
	Max:	**630.0**
	Min:	**107.6**
	Mean:	**293.1**

Table 7

Summary of Analytical Results of Surface Soil Samples, Ground Water Samples, and Estimated Values for Arsenic in Regional Soil at 1997 Spring Locations

Stucky Ridge TI Zone Area

Station	East	North	Date	Basis	Arsenic (ug/L)	Q	Arsenic (mg/kg)	Est. Arsenic (mg/kg)	UCL Arsenic (mg/kg)	LCL Arsenic (mg/kg)	Sulfate (mg/L)	Distance to Smelter Stack (ft)
SP97-1	1119951	804512.5	16-May-97	DIS	40.7		95.3	209	342	77	68	22639
SP97-2	1118091	805505.3	16-May-97	DIS	42.9		82.1	157	253	62	50	24621
SP97-3	1118267	806611.5	16-May-97	DIS	13.4		163	131	231	33	151	25329
SP97-4	1118576	811974.1	19-May-97	DIS	17.3		122	108	212	5	14	29424
SP97-5	1121927	810912.6	19-May-97	DIS	18.2		179	125	225	25	8	26780
SP97-6	1116399	813788.4	19-May-97	DIS	2.5		11.6	106	208	4	29	32149
SP97-7	1115185	808672.8	20-May-97	DIS	8.7		31.7	88	163	14	79	28920
SP97-8	1116621	809015.4	20-May-97	DIS	19.6		168	89	169	9	186	28225
SP97-20	1127662	802149.5	09-Jun-97	DIS	95.4		78.2	363	500	226	177	16358
				Count	9		9	9	9	9	9	
				Max	95.4		179.0	363.0	500.0	226.0	186.0	
				Min	2.5		11.6	88.0	163.0	4.0	8.0	
				Mean	28.7		103.4	152.9	255.9	50.6	84.7	

Smelter Hill TI Zone Area

Station	East	North	Date	Basis	Arsenic (ug/L)	Q	Arsenic (mg/kg)	Est. Arsenic (mg/kg)	UCL Arsenic (mg/kg)	LCL Arsenic (mg/kg)	Sulfate (mg/L)	Distance to Smelter Stack (ft)
SP97-9	1132312	783905.7	21-May-97	DIS	1990		88.2	886	1166	606	135	4337
SP97-10	1127942	782062.9	21-May-97	DIS	277		80.9	424	587	261	79	8734
SP97-11	1128600	781428.9	21-May-97	DIS	608		169	553	769	338	71	8654
SP97-12	1129467	781490.6	21-May-97	DIS	482		34.1	553	769	338	88	8007
SP97-13	1126253	778792.4	22-May-97	DIS	37.4		66.4	354	505	203	117	12177
SP97-14	1117745	782908.3	22-May-97	DIS	3.6		28.4	478	787	169	17	17669
SP97-15	1116328	784189.6	22-May-97	DIS	5.7		178	416	685	148	11	18778
SP97-16	1117614	783422.2	22-May-97	DIS	1.1	U	75.8	475	796	155	10	17671
SP97-19	1127716	791603	23-May-97	DIS	2.5		339	489	670	309	189	8233
SP97-21	1120843	778211.3	10-Jun-97	DIS	147		201	417	671	164	30	16753
SP97-24	1129413	778452.2	24-Jun-97	DIS	269		116	533	755	312	63	10494
SP97-25	1129562	778953.9	24-Jun-97	DIS	710		861	533	755	312	93	9988
				Count	12		12	12	12	12	12	
				Max	1990.0		861.0	886.0	1166.0	606.0	189.0	
				Min	1.1	U	28.4	354.0	505.0	148.0	10.0	
				Mean	377.8		186.5	509.3	742.9	276.3	75.3	

Mount Haggin TI Zone Area

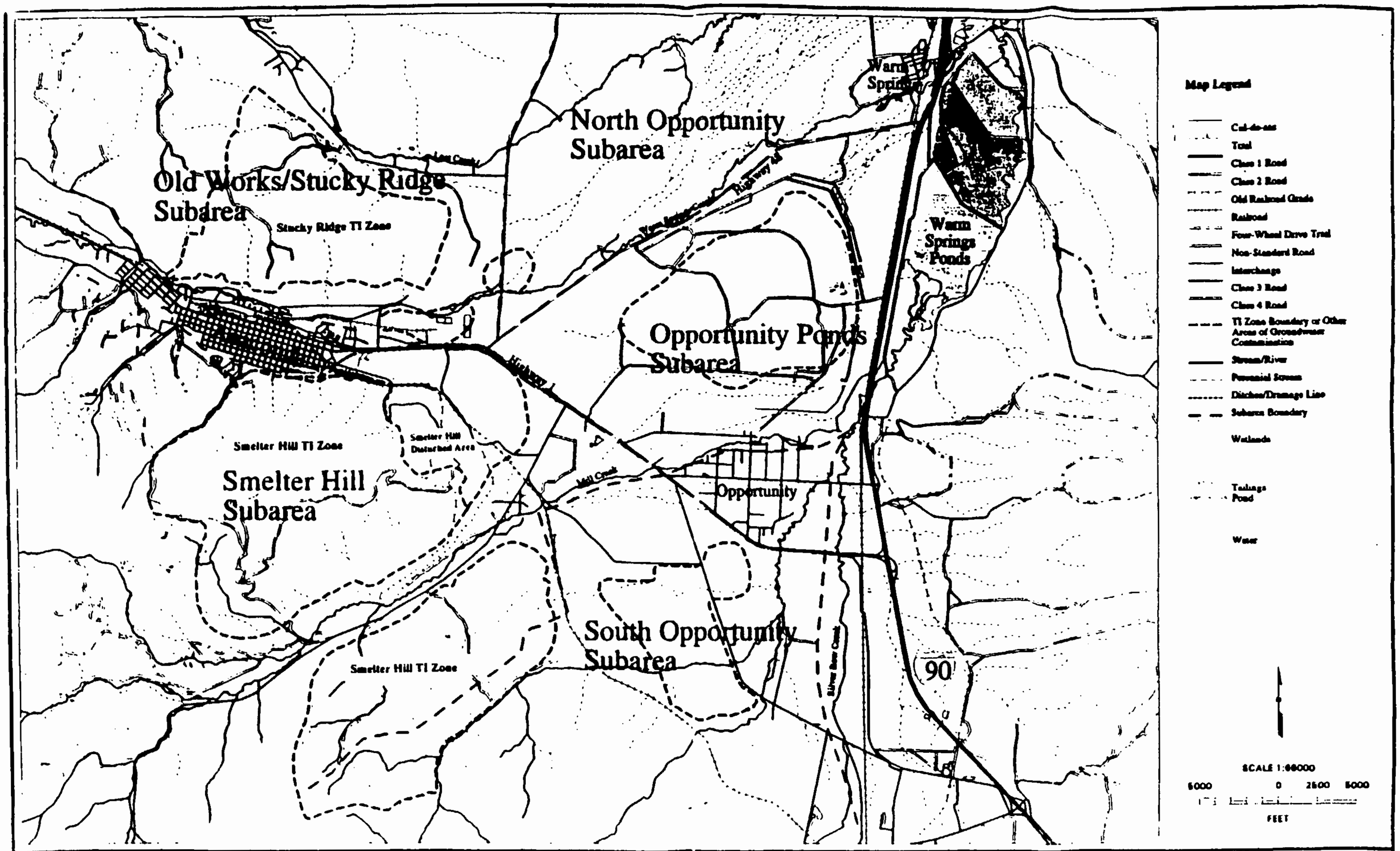
Station	East	North	Date	Basis	Arsenic (ug/L)	Q	Arsenic (mg/kg)	Est. Arsenic (mg/kg)	UCL Arsenic (mg/kg)	LCL Arsenic (mg/kg)	Sulfate (mg/L)	Distance to Smelter Stack (ft)
SP97-17	1116185	769796.2	23-May-97	DIS	112		185	164	250	78	15	25668
SP97-18	1115727	769210.4	23-May-97	DIS	87.4		104	162	255	68	10	26404
SP97-22	1136302	775015.8	10-Jun-97	DIS	223		170	803	1349	258	147	12518
SP97-23	1136863	774485.1	10-Jun-97	DIS	42.3		155	740	1406	75	98	13121
SP97-26	1137381	770510	26-Jun-97	DIS	60.4		94	600	1223	-22	84	17129
SP97-27	1135885	766416.7	26-Jun-97	DIS	34.8		31.7	262	536	-13	23	21057
SP97-28	1135460	763595.9	26-Jun-97	DIS	50.9		100	260	562	-41	38	23860
SP97-29	1138591	765491.6	26-Jun-97	DIS	260		37.8	183	368	-1	123	22276
SP97-30	1140930	769140.5	26-Jun-97	DIS	33.8		53.1	250	513	-12	49	19299
SP97-31	1138906	771153.1	26-Jun-97	DIS	74.8		98.1	420	762	79	49	16798
SP97-32	1125033	770530.1	08-Jul-97	DIS	73.1		145	345	513	177	46	19544
SP97-33	1124738	768411.1	09-Jul-97	DIS	189		57.8	328	480	177	48	21541
SP97-34	1122471	758271.3	09-Jul-97	DIS	42.9		31.3	244	402	86	8	31683
SP97-35	1124930	762826.7	09-Jul-97	DIS	29.3		53.7	300	465	135	17	26533
SP97-36	1122548	761815.5	09-Jul-97	DIS	32.3		20.7	270	404	136	8	28418
SP97-37	1120618	763012.7	09-Jul-97	DIS	17.4		77.1	224	325	123	31	28262
SP97-38	1119965	762635.8	09-Jul-97	DIS	42.7		67.5	224	325	123	13	28919
SP97-39	1115307	765980.4	10-Jul-97	DIS	45.9		16.9	194	317	71	8	29011
SP97-40	1118103	761906.1	10-Jul-97	DIS	20.1		8.1	213	306	121	14	30527
				Count	19		19	19	19	19	19	
				Max	260.0		185.0	803.0	1406.0	258.0	147.0	
				Min	17.4		8.1	162.0	250.0	-41.0	8.0	
				Mean	77.5		79.3	325.6	566.4	85.2	43.6	

Table 8

EPA's Revised Estimate of the Flux of Arsenic Migrating through the Alluvial Aquifer Underlying the East Anaconda Yard

	Valley Through - Flow			Sidewall Recharge			Surface Infiltration						Outflow							
	Q in (cfs)	Arsenic (ug/L)	Flux (lb/yr)	Q in (cfs)	Arsenic (ug/L)	Flux (lb/yr)	Area (acres)	Infiltratio (in/yr)	Q in (cfs)	Arsenic (ug/L)	Flux (lb/yr)	Total Flux In (lb/yr)	Q out (cfs)	Arsenic (ug/L)	Total Flux Out (lb/yr)	Difference (%) (fluxin-fluxout)/fluxo	Loss to Atten. (lb/yr)	Contribution Valley Flow	Contribution Sidewall	Contribution Infiltration
Case 1	1.91	7	26.3	0.01	300	5.9	64	0.5	0.004	6.5	0.05	32.3	1.93	79.5	302.1	89.3%	-269.8	81.6%	18.3%	0.1%
	1.91	7	26.3	0.01	300	5.9	64	0.5	0.004	65.0	0.47	32.7	1.93	79.5	302.1	89.2%	-269.4	80.5%	18.1%	1.4%
	1.91	7	26.3	0.01	300	5.9	64	0.5	0.004	650.0	4.71	36.9	1.93	79.5	302.1	87.8%	-265.1	71.3%	16.0%	12.8%
	1.91	7	26.3	0.01	300	5.9	64	0.5	0.004	6,500.0	47.14	79.4	1.93	79.5	302.1	73.7%	-222.7	33.2%	7.4%	59.4%
Case 2	1 91	7	26.3	0.01	300	5.9	64	1.7	0.013	6.5	0.16	32.4	1.96	79.5	306.8	89.4%	-274.4	81.3%	18.2%	0 5%
	1.91	7	26.3	0.01	300	5.9	64	1.7	0.013	65.0	1.60	33.8	1.96	79.5	306.8	89.0%	-272.9	77.8%	17.5%	4.7%
	1.91	7	26.3	0.01	300	5.9	64	1.7	0.013	650.0	16.03	48.3	1.96	79.5	306.8	84.3%	-258.5	54.5%	12.2%	33.2%
	1.91	7	26.3	0.01	300	5.9	64	1.7	0.013	6,500.0	160.26	192.5	1.96	79.5	306.8	37.3%	-114.3	13.7%	3.1%	83.3%
Case 3	1.91	7	26.3	0.01	300	5.9	64	3.6	0.027	6.5	0.34	32.6	2.00	79.5	313.0	89.6%	-280.5	80.8%	18.1%	1.0%
	1 91	7	26.3	0.01	300	5.9	64	3.6	0.027	65.0	3.39	35.6	2.00	79.5	313.0	88.6%	-277.4	73.9%	16.6%	9.5%
	1.91	7	26.3	0.01	300	5.9	64	3.6	0.027	650.0	33.94	66.2	2.00	79.5	313.0	78.9%	-246.9	39.8%	8.9%	51.3%
	1.91	7	26.3	0.01	300	5.9	64	3.6	0.027	6,500.0	339.38	371.6	2.00	79.5	313.0	15.8%	58.6	7.1%	1.6%	91.3%
Case 4	1.91	7	26.3	0.08	300	47.2	64	0.5	0.004	6.5	0.05	73.6	2.00	79.5	313.0	76.5%	-239.4	35.8%	64.2%	0.1%
	1 91	7	26.3	0.08	300	47.2	64	0.5	0.004	65.0	0.47	74.0	2.00	79.5	313.0	76.3%	-239.0	35.5%	63.8%	0.6%
	1.91	7	26.3	0.08	300	47.2	64	0.5	0.004	650.0	4.71	78.3	2.00	79.5	313.0	75.0%	-234.7	33.6%	60.4%	6.0%
	1.91	7	26.3	0.08	300	47.2	64	0.5	0.004	6,500.0	47.14	120.7	2.00	79.5	313.0	61.4%	-192.3	21.8%	39.1%	39.0%
Case 5	1 91	7	26.3	0.08	300	47.2	64	1.7	0.013	6.5	0.16	73.7	2.02	79.5	316.2	76.7%	-242.4	35.7%	64.1%	0.2%
	1 91	7	26.3	0.08	300	47.2	64	1.7	0.013	65.0	1.60	75.2	2.02	79.5	316.2	76.2%	-241.0	35.0%	62.9%	2.1%
	1.91	7	26.3	0.08	300	47.2	64	1.7	0.013	650.0	16.03	89.6	2.02	79.5	316.2	71.7%	-226.6	29.4%	52.7%	17.9%
	1 91	7	26.3	0.08	300	47.2	64	1.7	0.013	6,500.0	160.26	233.8	2.02	79.5	316.2	-35.2%	-82.3	11.3%	20.2%	68.5%
Case 6	1.91	7	26.3	0.08	300	47.2	64	3.6	0.027	6.5	0.34	73.9	2.06	79.5	322.4	77.1%	-248.5	35.6%	63.9%	0.5%
	1.91	7	26.3	0.08	300	47.2	64	3.6	0.027	65.0	3.39	77.0	2.06	79.5	322.4	76.1%	-245.5	34.2%	61.4%	4.4%
	1.91	7	26.3	0.08	300	47.2	64	3.6	0.027	650.0	33.94	107.5	2.06	79.5	322.4	66.7%	-214.9	24.5%	43.9%	31.6%
	1.91	7	26.3	0.08	300	47.2	64	3.6	0.027	6,500.0	339.38	413.0	2.06	79.5	322.4	21.9%	90.5	6.4%	11.4%	82.2%
Case 7	1.91	7	26.3	0.20	300	118.1	64	0.5	0.004	6.5	0.05	144.5	2.12	79.5	331.8	-129.6%	-187.3	18.2%	81.8%	0.0%
	1 91	7	26.3	0.20	300	118.1	64	0.5	0.004	65.0	0.47	144.9	2.12	79.5	331.8	-129.0%	-186.9	18.2%	81.5%	0.3%
	1.91	7	26.3	0.20	300	118.1	64	0.5	0.004	650.0	4.71	149.2	2.12	79.5	331.8	-122.5%	-182.7	17.6%	79.2%	3.2%
	1 91	7	26.3	0.20	300	118.1	64	0.5	0.004	6,500.0	47.14	191.6	2.12	79.5	331.8	-73.2%	-140.2	13.7%	61.7%	24.6%
Case 8	1.91	7	26.3	0.20	300	118.1	64	1.7	0.013	6.5	0.16	144.6	2.15	79.5	336.5	-132.7%	-191.9	18.2%	81.7%	0.1%
	1.91	7	26.3	0.20	300	118.1	64	1.7	0.013	65.0	1.60	146.0	2.15	79.5	336.5	-130.4%	-190.5	18.0%	80.9%	1.1%
	1.91	7	26.3	0.20	300	118.1	64	1.7	0.013	650.0	16.03	160.5	2.15	79.5	336.5	-109.7%	-176.0	16.4%	73.6%	10.0%
	1.91	7	26.3	0.20	300	118.1	64	1.7	0.013	6,500.0	160.26	304.7	2.15	79.5	336.5	-10.4%	-31.8	8.6%	38.8%	52.6%
Case 9	1 91	7	26.3	0.20	300	118.1	64	3.6	0.027	6.5	0.34	144.8	2.19	79.5	342.8	-136.7%	-198.0	18 2%	81.6%	0.2%
	1 91	7	26.3	0.20	300	118.1	64	3.6	0.027	65 0	3.39	147 8	2 19	79.5	342.8	-131.8%	-194.9	17.8%	79.9%	2.3%
	1 91	7	26.3	0.20	300	118.1	64	3.6	0.027	650.0	33.94	176.4	2.19	79 5	342.8	-92.2%	-164.4	14.8%	66.2%	19.0%
	1 91	7	26.3	0 20	300	118.1	64	3 6	0.027	6.500.0	339.38	483.8	2.19	79.5	342.8	29.2%	141.1	5 4%	24.4%	70.1%

FIGURES



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SUBAREAS OF THE
ANACONDA SMELTER NPL SITE

Figure 1. Map of TI Zone Boundaries Identified at the ARWWS OU in 1996 by EPA

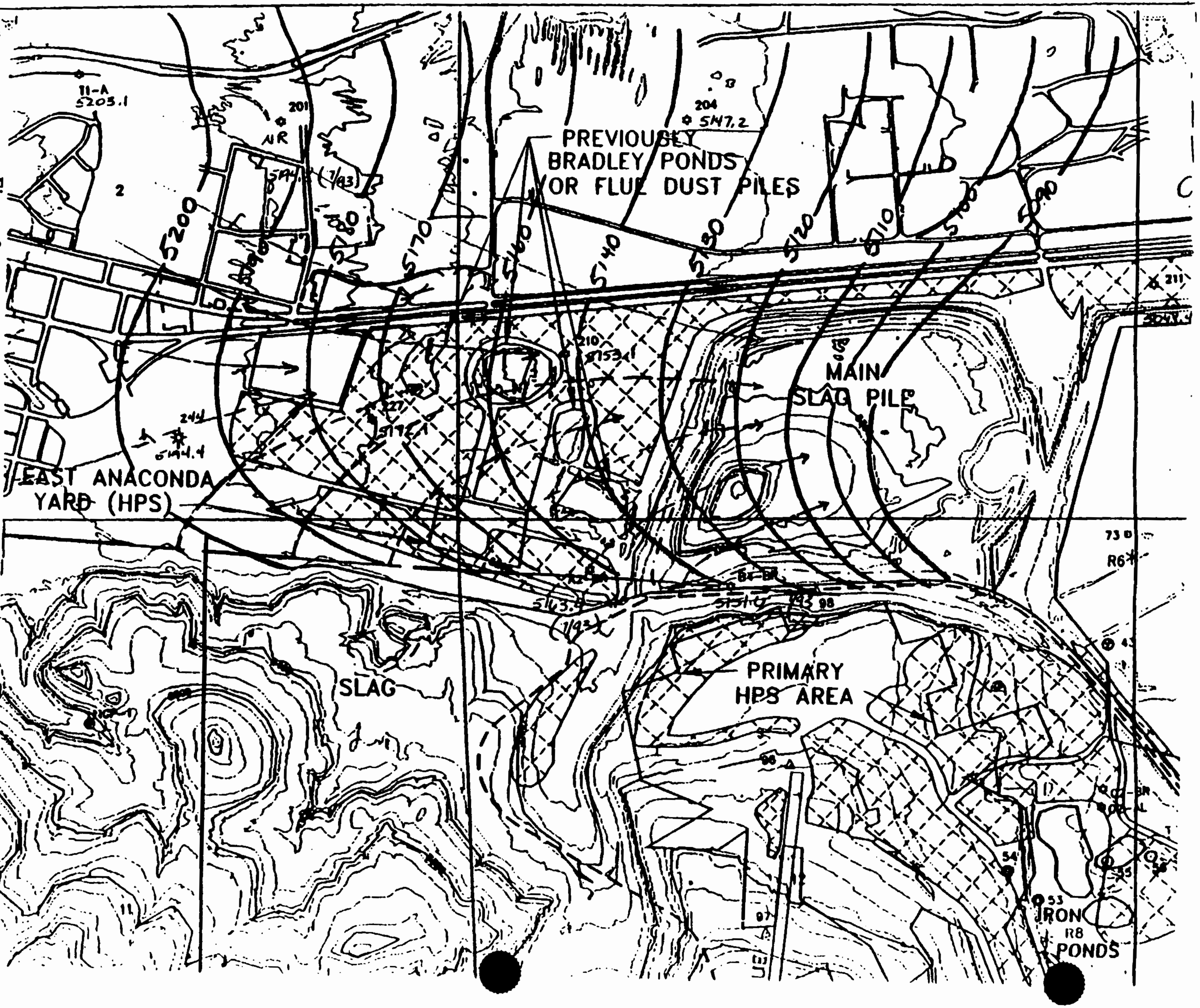


Figure 2. Water Table Map (August 1996) for the Alluvial Aquifer in the East AnacondaYard Area

Scale 1:12,000

Contour Interval = 10 feet
→ = Direction of Ground Water Flow
--- = Boundary of the Alluvial Aquifer

Figure 3
Arsenic v. Elevation for Spring/Seep Samples

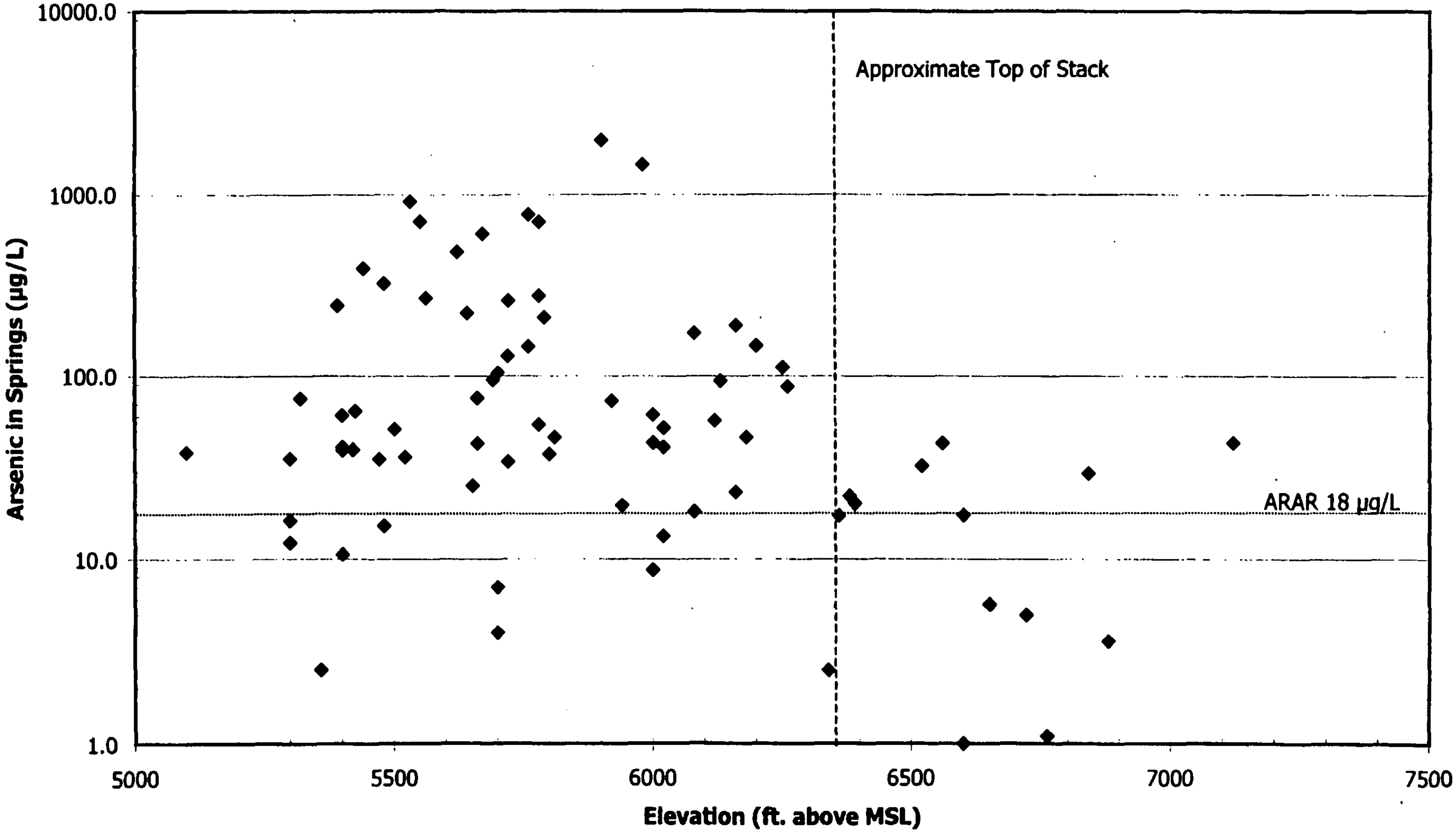


Figure 4

Arsenic Concentration v. Distance from Smelter Stack for Spring Locations at Elevations below the Top of the Stack (6360 ft.)

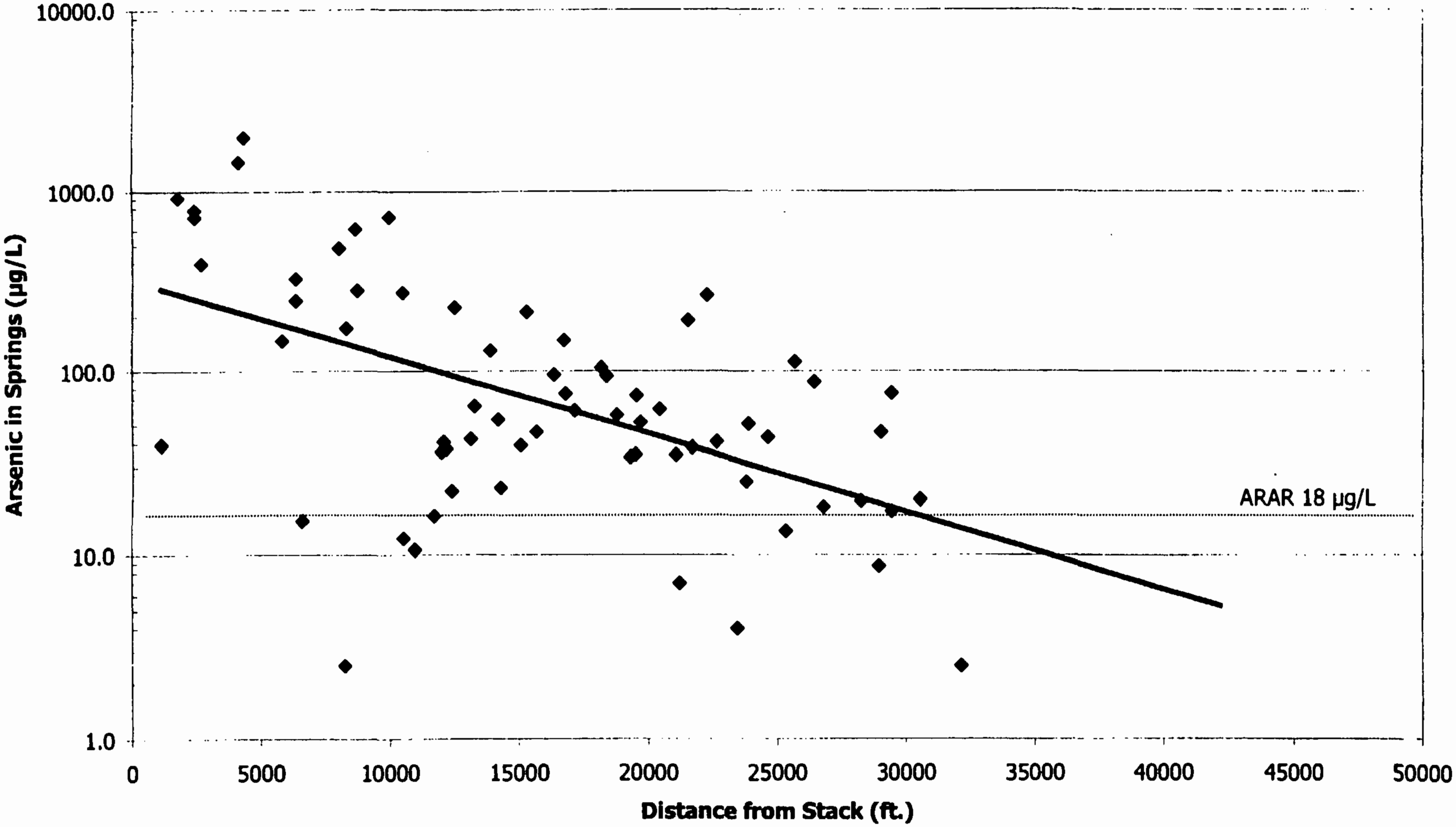


Figure 5

Arsenic Concentration v. Distance from Smelter Stack for Spring Locations at Elevations above the Top of the Stack (6360 ft.)

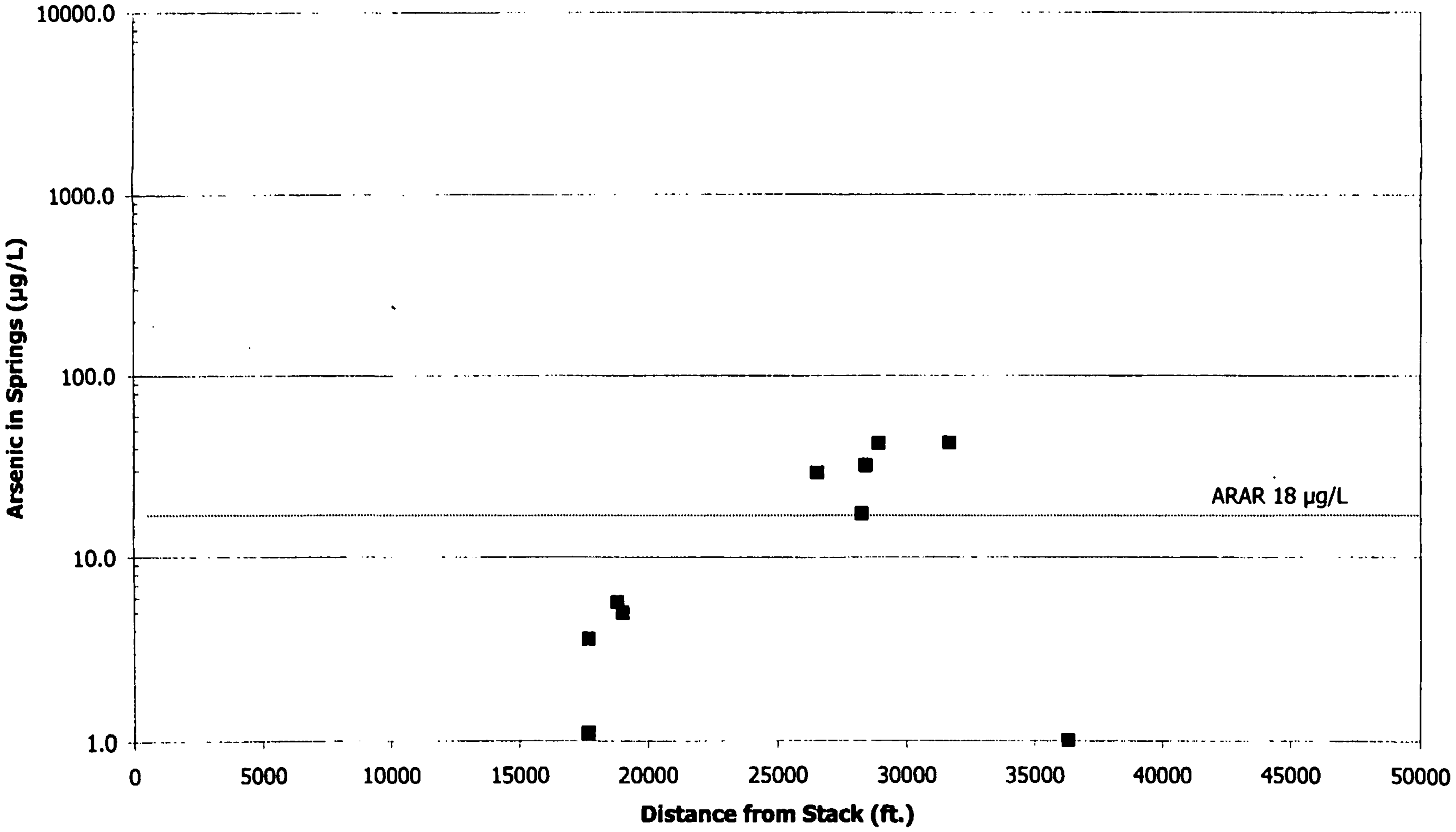


Figure 6

Average Major Ion Chemistry of Waters in Local Geologic Units of the Bedrock Aquifer

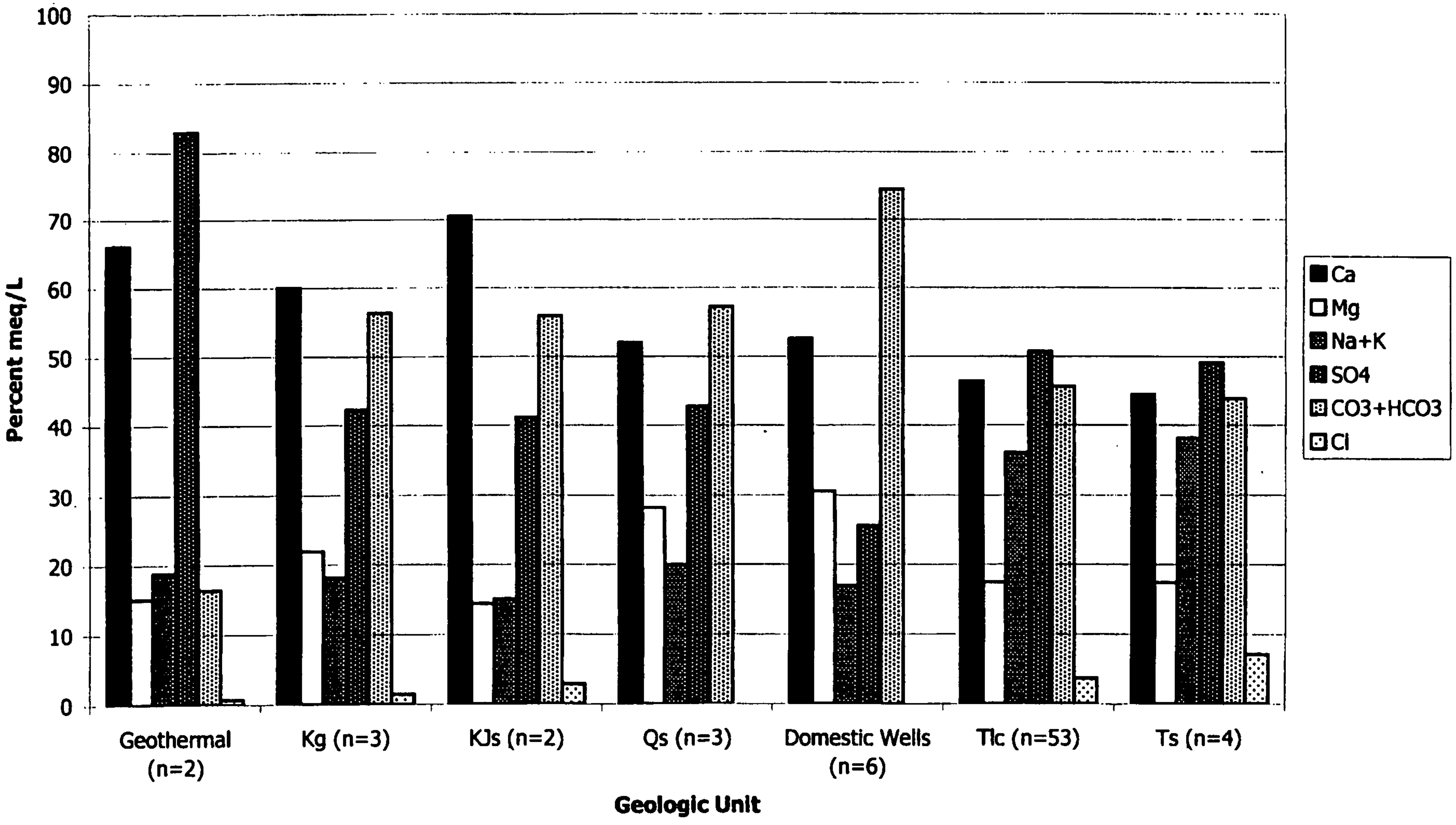


Figure 7
Arsenic v. Sulfate in Springs - All Locations

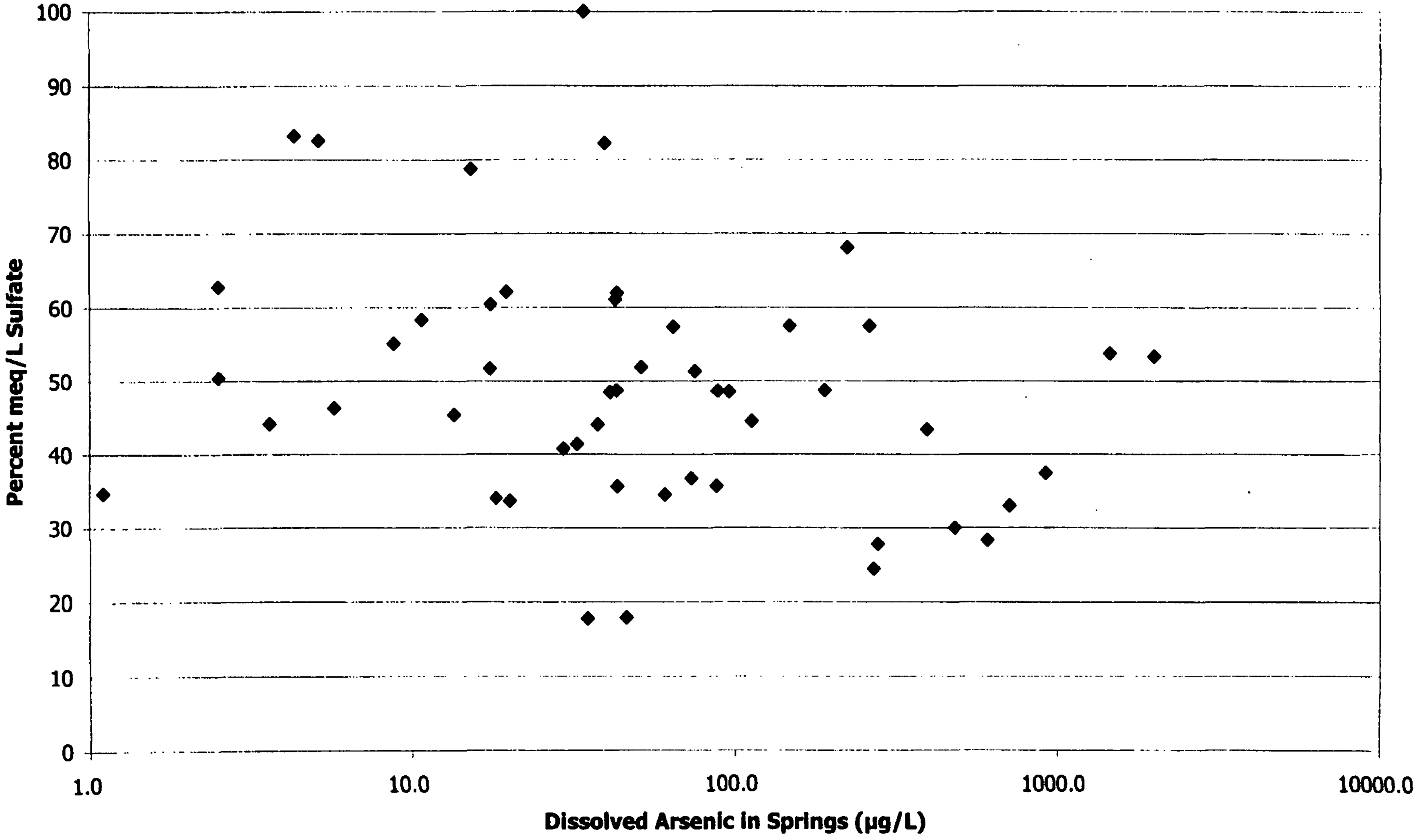


Figure 8
Arsenic v. Sulfate in Bedrock Wells

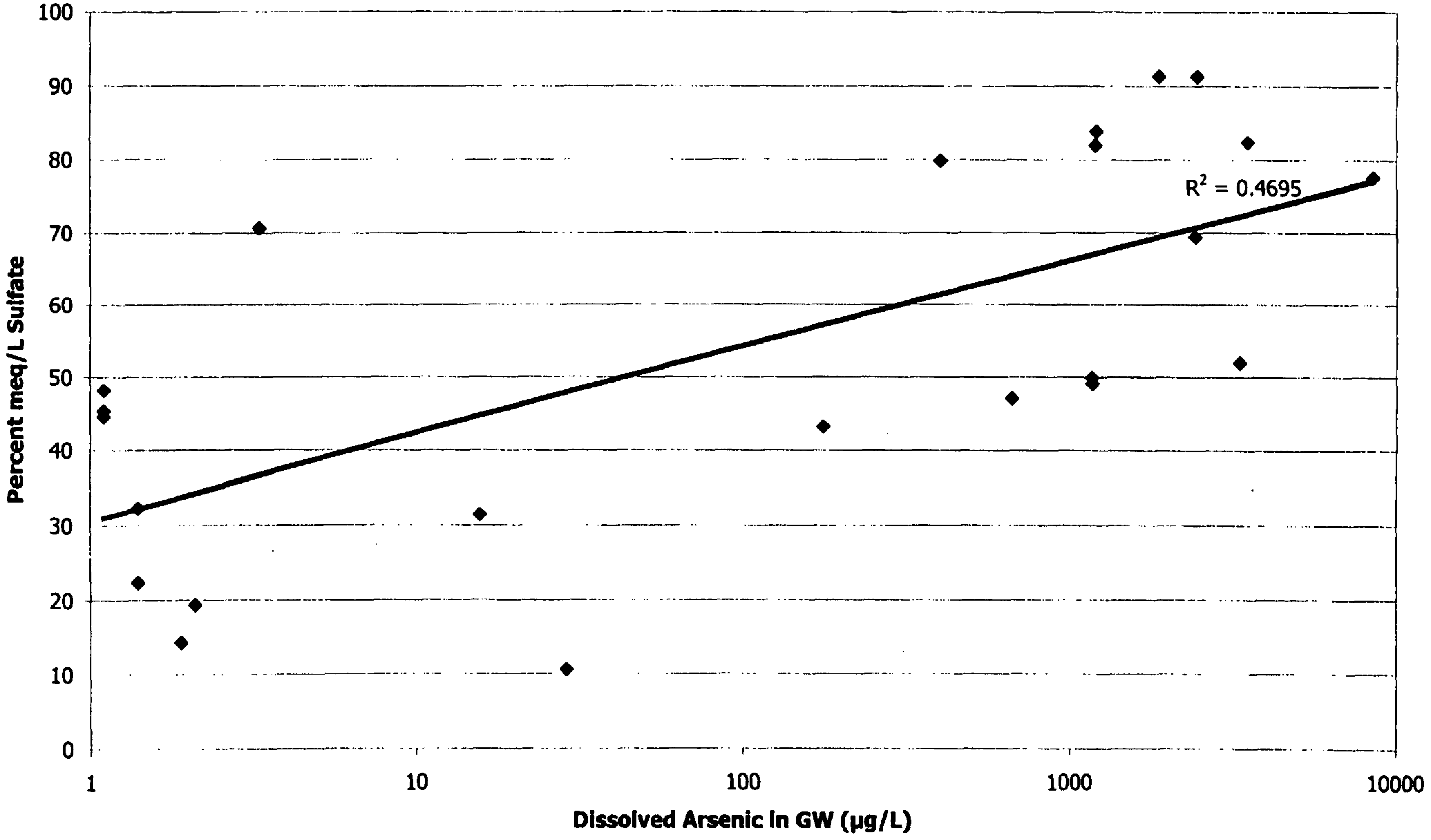


Figure 9
Arsenic v. Depth to Water-Bearing Zone in Bedrock Monitoring Wells on Smelter Hill

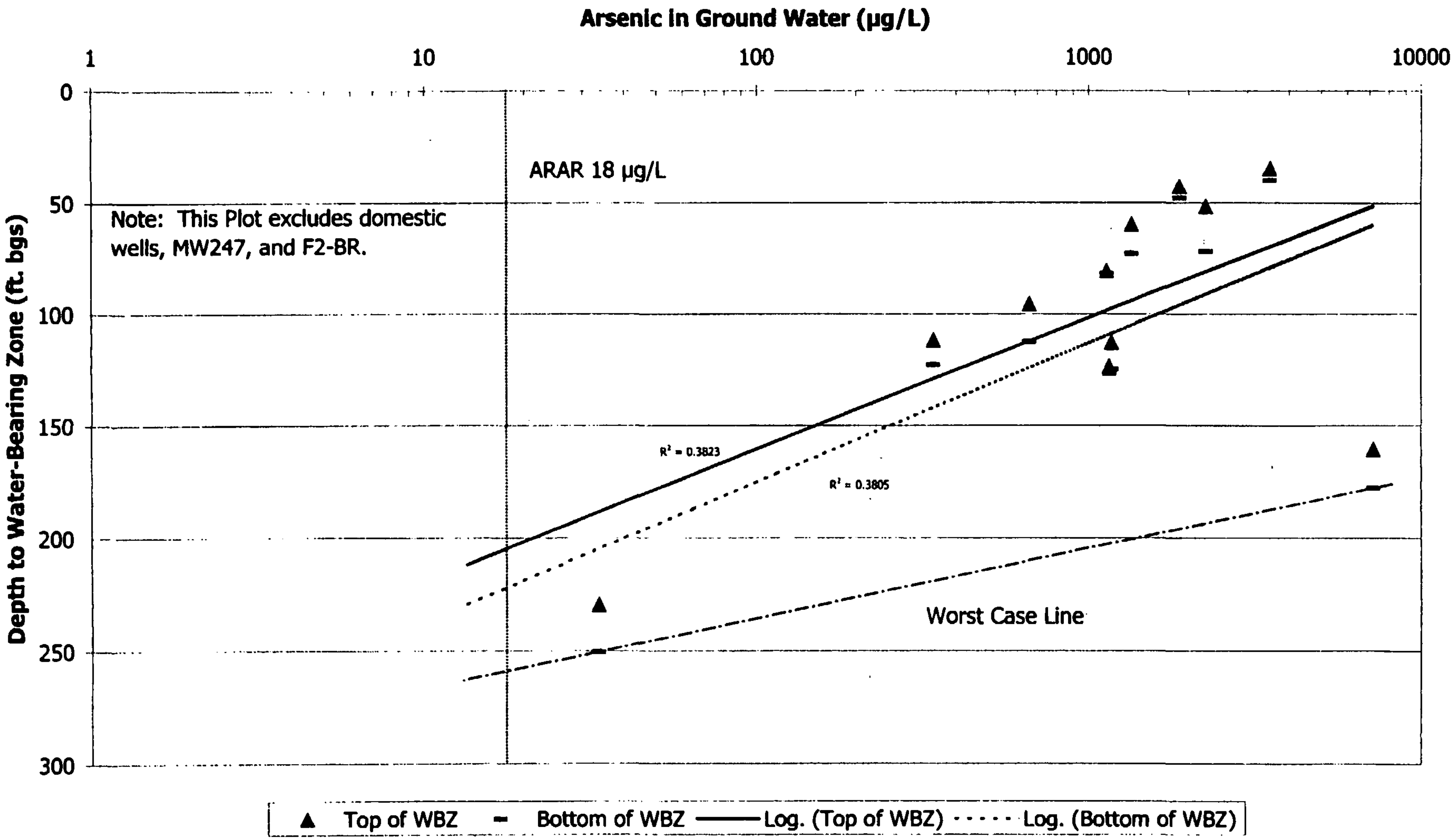


Figure 10
Arsenic in Soil v. Arsenic in Springs

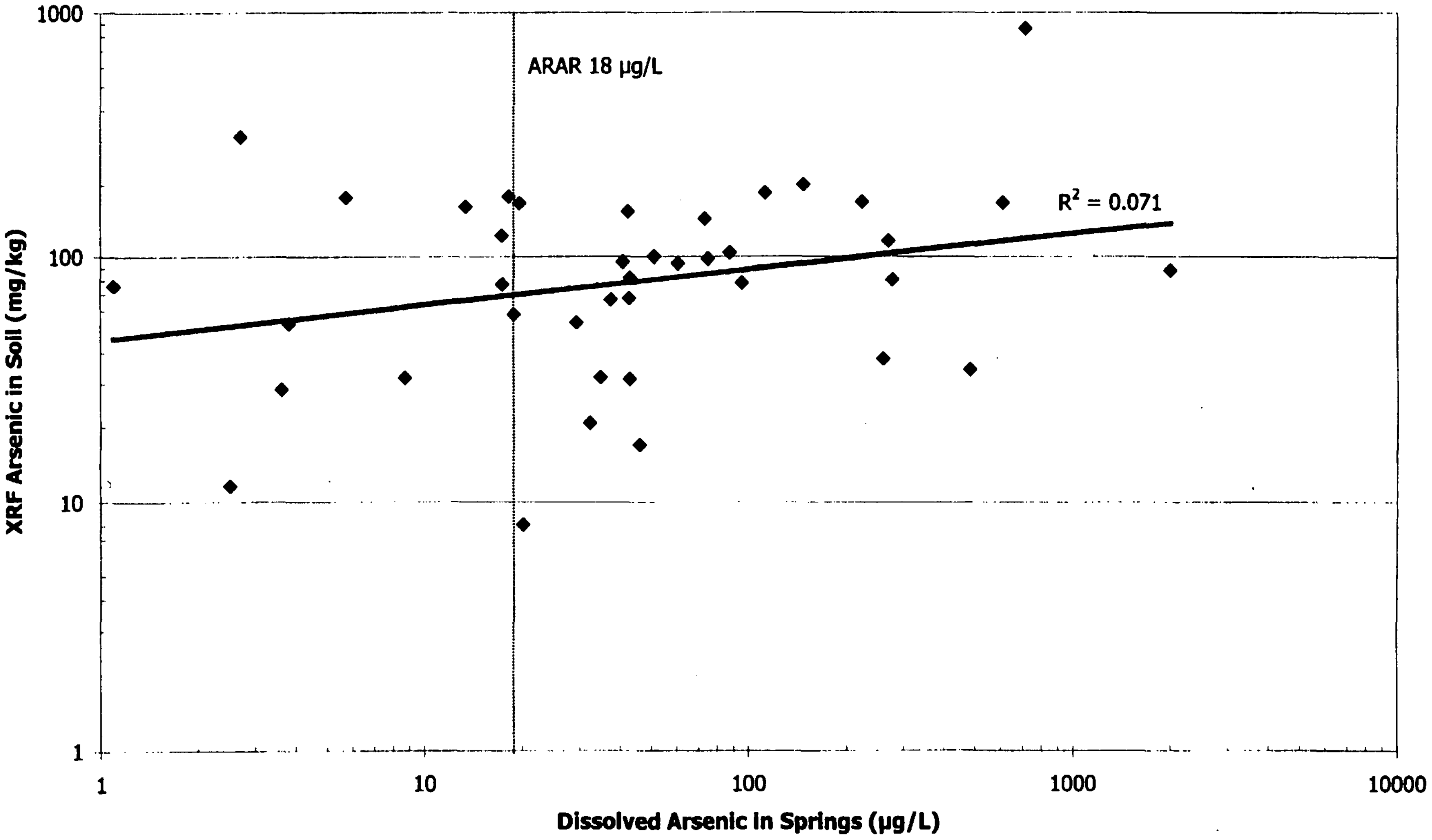


Figure 11

Arsenic in Springs v. Arsenic in Soil - Sorted by Elevation

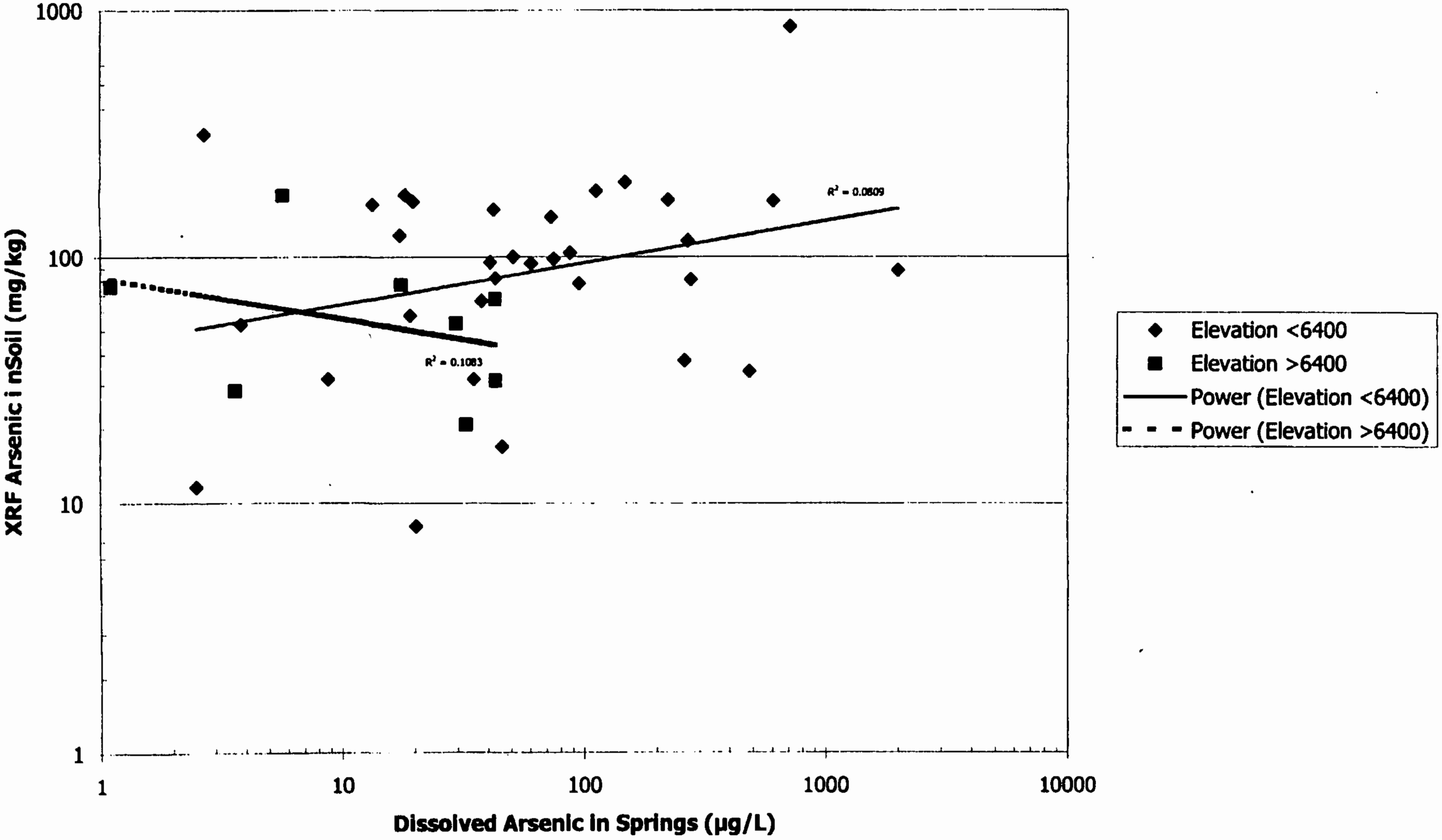


Figure 12

Arsenic in Springs v. Arsenic in Soil - Sorted by Distance from Stack

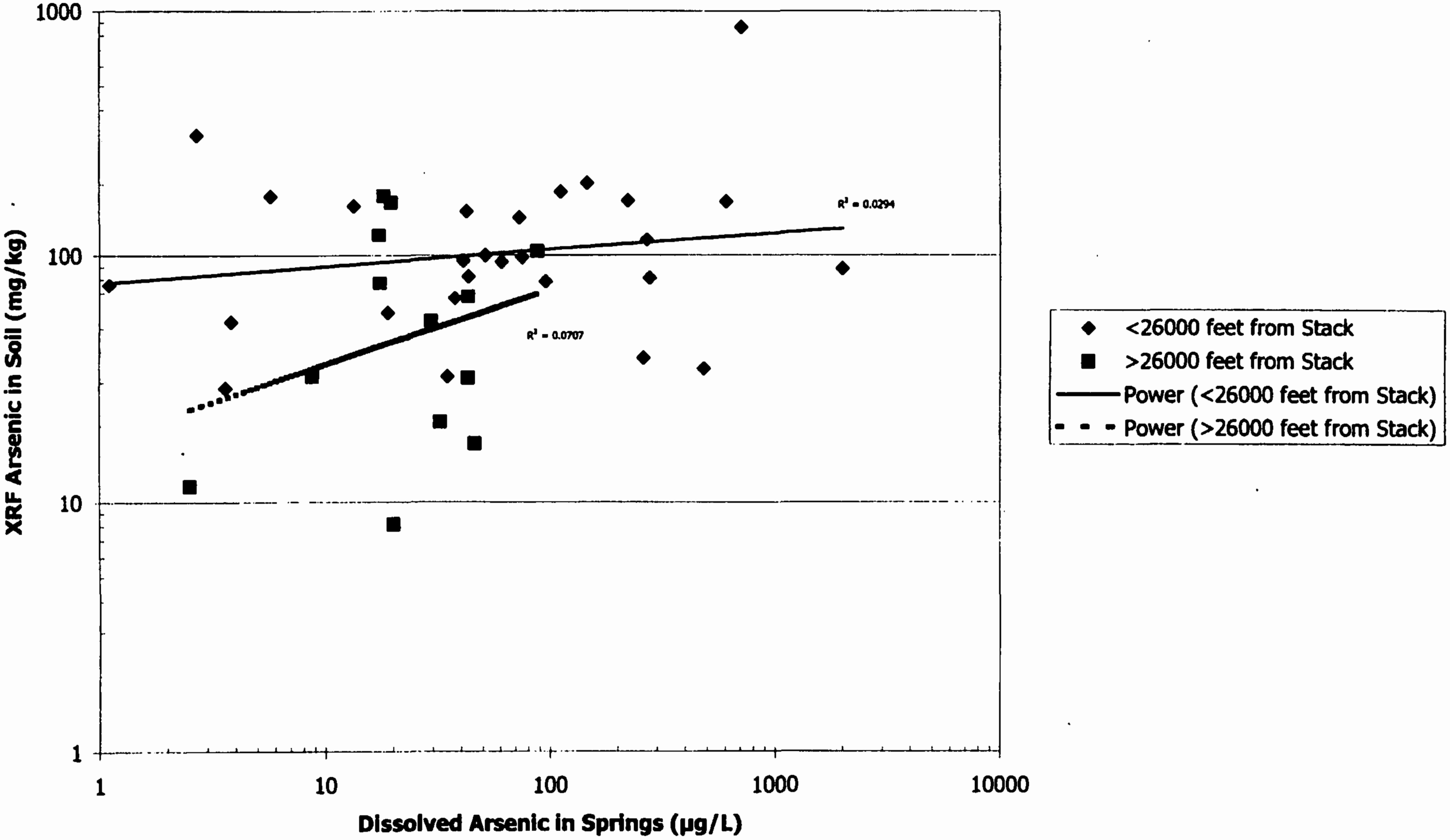
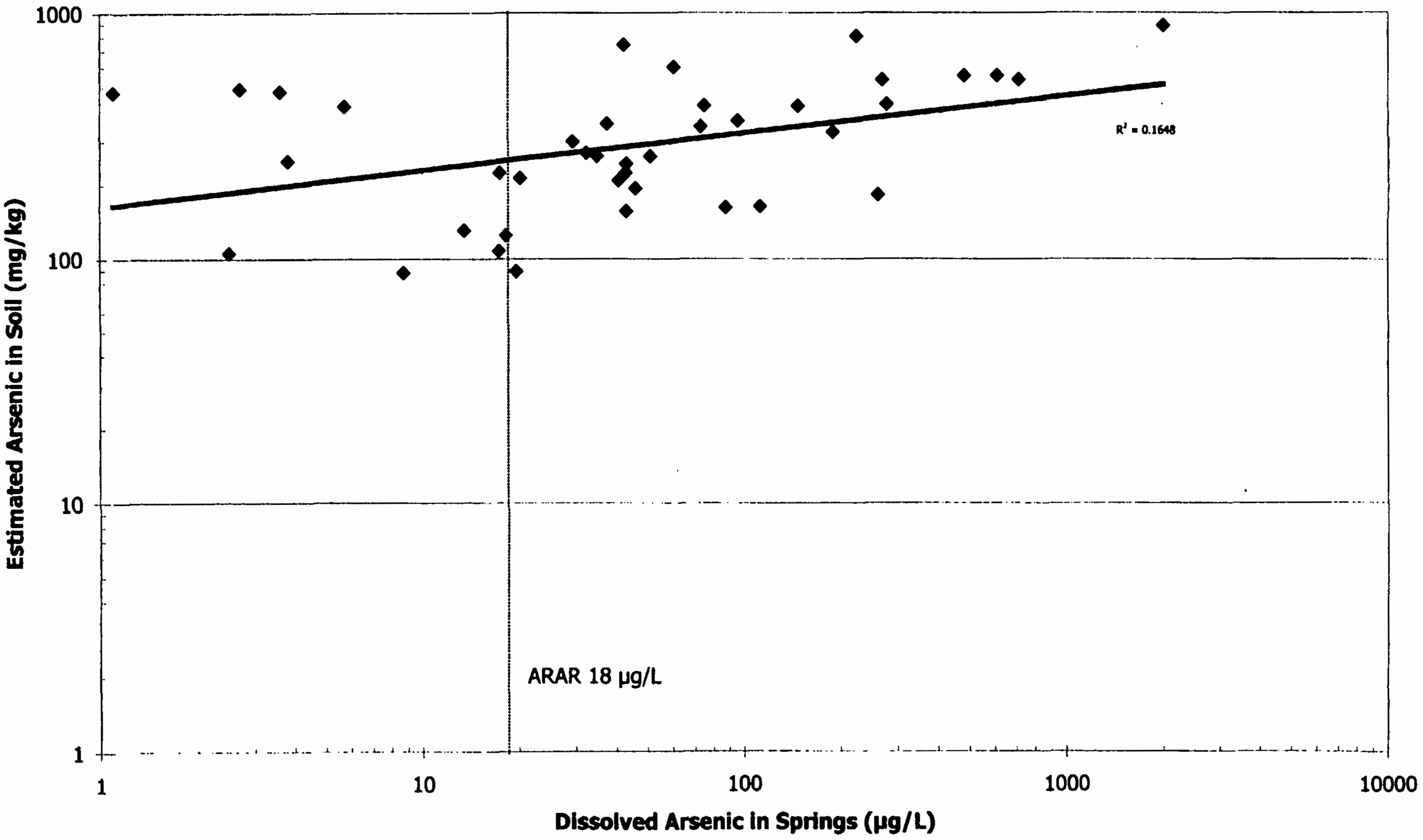
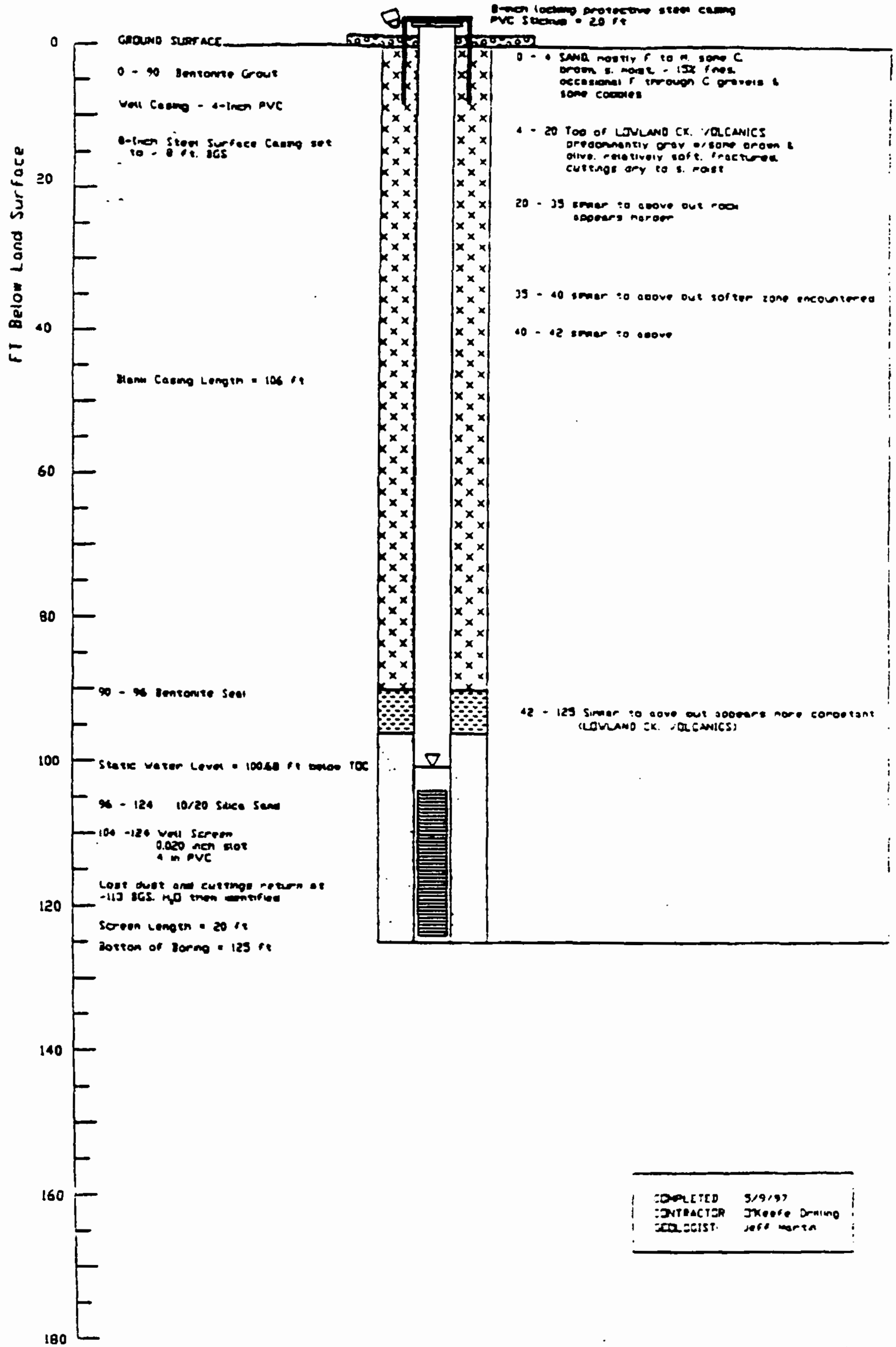


Figure 13
Arsenic in Springs v. Estimated Arsenic in Soil



PLATES



COMPLETED 5/9/97
CONTRACTOR O'Keefe Drilling
GEOLOGIST Jeff Martin

WELL MW - 245s

QST ENVIRONMENTAL

FIELD SAMPLE DATA SHEET

Page 6 of

PROJECT NAME: ARWW-II
PROJECT NUMBER: 829-7031-0100-8200

WELL/STATION MW245S DATE 6-9-97 ARRIVAL TIME 1430
SAMPLING PERSONNEL JP - JM WEATHER CONDITIONS Sunny, warm, lt. breeze
SKETCH ON BACK: Yes___ No ✓ PHOTOGRAPHS: Yes___ No ✓ ROLL#_____ EXPOSURE#_____

PURGE DATA:

PURGE METHOD Grunfos Redi Flo II
START PURGING 1441
PURGE RATE 1.8 [✓ GPM] LPM
RATE CHANGE 1)Time 1511 Rate <2 gpm
2)Time_____ Rate_____
SAMPLE TIME 1512

WELL DEPTH 127.0 Feet
DEPTH TO WATER 100.68 Feet
COLUMN HEAD 26.32 Feet
CASING DIAMETER 4 Inch
3 WELL VOLUMES 51.56 Gal
TOTAL PURGE VOLUME 54.0 Gal

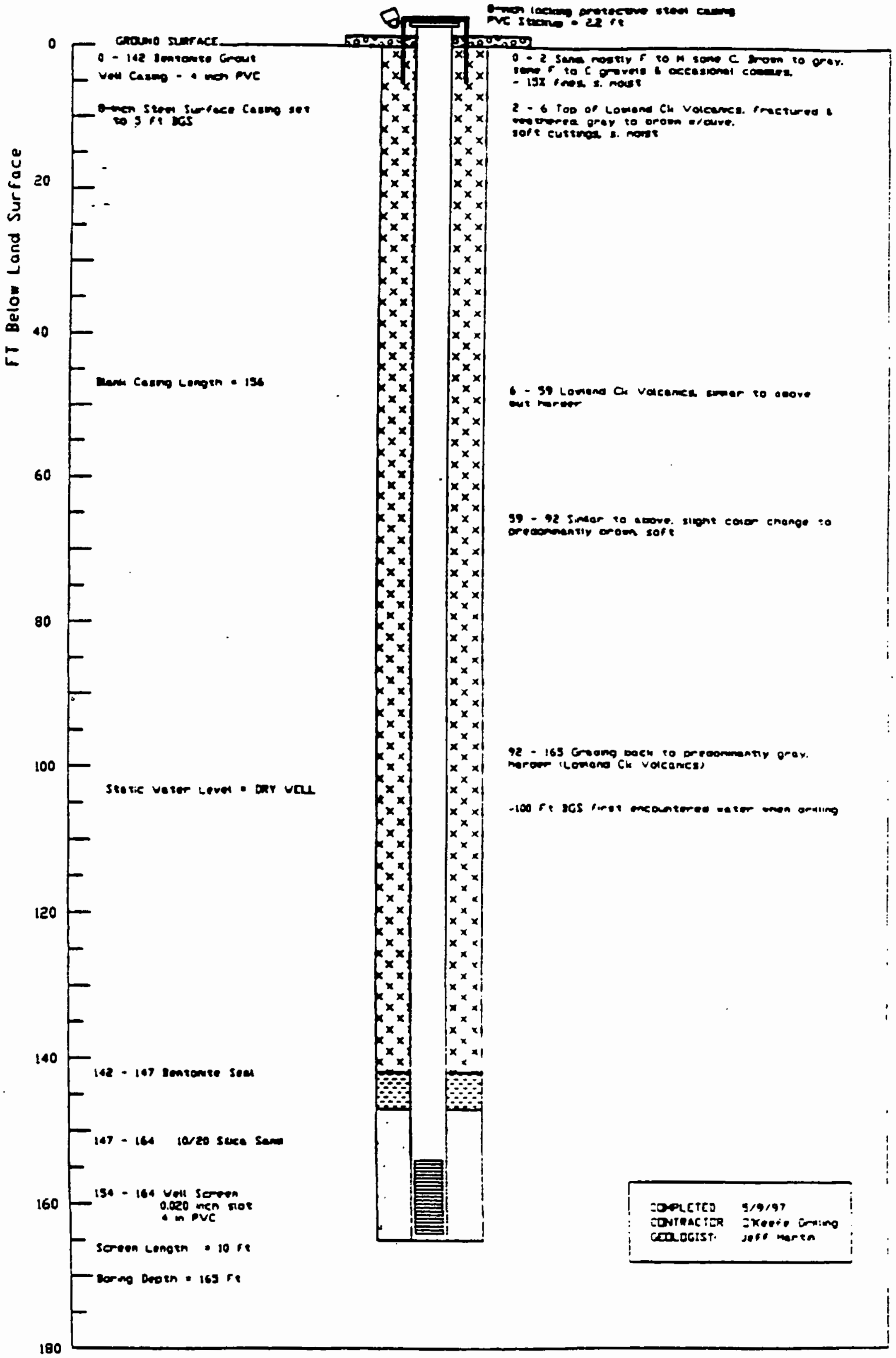
SAMPLE DATA:

SAMPLE ID	SAMPLE #	TAG #	VOLUME	CHECK IF FILTERED	PRES.	ANALYSIS REQUESTED
MW245S-01	GW0030	00060	500 mL	✓	HNO_3	Diss. As. Ca. Fe. K. Mg. Mn. Na. Sb
MW245S-02	"	00061	500 mL		NONE	HCO_3. Cl. SO_4. TDS

TIME	TEMP (°C)	pH	SC (mmhos/cm @ 25°C)		EH (MV)	DO (mg/L)
1447	10.81	8.04	0.381	TURBIDITY 21.2 NTU	91	10.16
1453	11.15	7.93	0.378	16.4 NTU	102	9.98
1459	11.61	7.74	0.380	13.6 NTU	114	9.93
1505	11.76	7.66	0.381	12.2 NTU	123	10.14
1511	11.72	7.63	0.381	11.6 NTU	129	10.13
****************** FINAL FIELD PARAMETERS PRIOR TO SAMPLING ******************						
1511	11.72	7.63	0.381	11.6 NTU	-129	10.13

FIELD EQUIPMENT Q/A AND CALIBRATION: Recorded in field logbook

FIELD REMARKS: Pump set @ 115'



COMPLETED 5/9/97
CONTRACTOR O'Keefe Drilling
GEOLOGIST Jeff Martin

WELL MW - 245-d

QST ENVIRONMENTAL

FIELD SAMPLE DATA SHEET

Page 5 of ____

PROJECT NAME: ARWW-II

PROJECT NUMBER: 829-7031-0100-8200

WELL/STATION MW 245 d DATE 6-9-97 ARRIVAL TIME 1330

SAMPLING PERSONNEL dP/JM WEATHER CONDITIONS Sunny, Warm

SKETCH ON BACK: Yes___No ✓ PHOTOGRAPHS: Yes___No ✓ ROLL#____ EXPOSURE#____

PURGE DATA:

PURGE METHOD Bailer

START ~~PURGING~~ 1338

PURGE RATE NA GPM LPM

RATE CHANGE 1)Time____Rate____

2)Time____Rate____

SAMPLE TIME ____

WELL DEPTH 167.30 Feet

DEPTH TO WATER 163.94 Feet

COLUMN HEAD 3.36 Feet

CASING DIAMETER 4 Inch

3 WELL VOLUMES 6.58 Gal.

TOTAL PURGE VOLUME ____ Gal.

SAMPLE DATA:

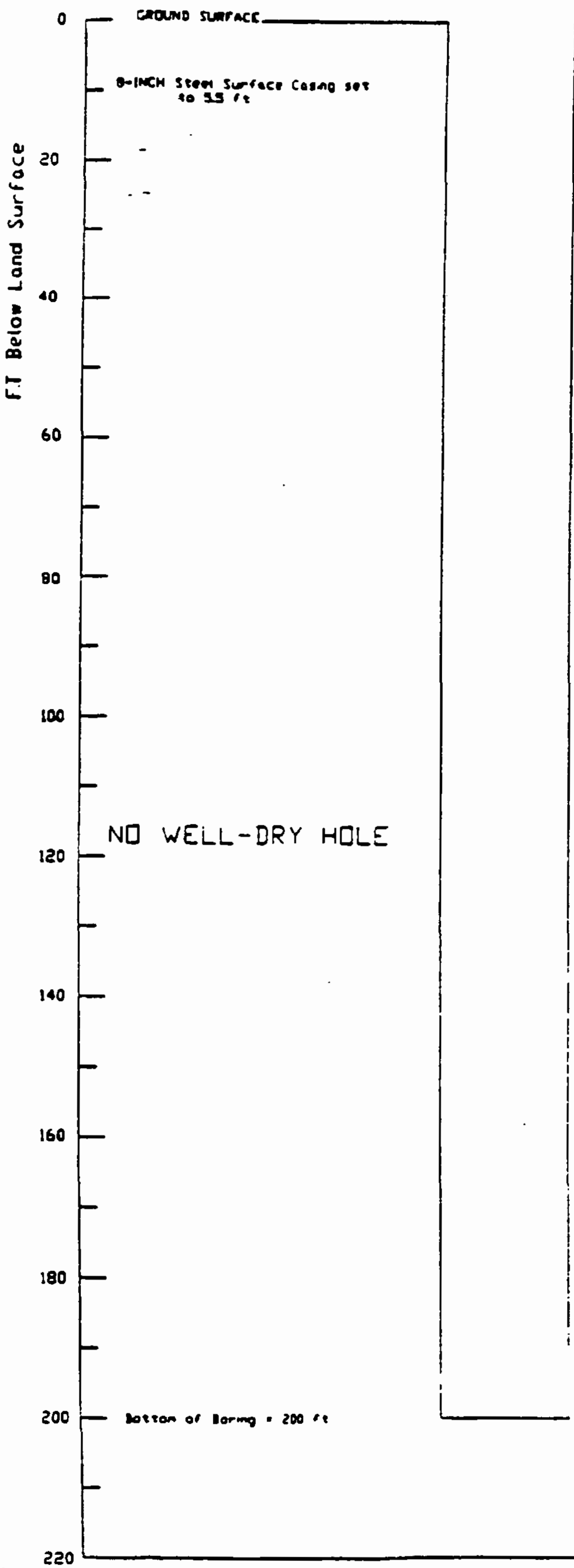
SAMPLE ID	SAMPLE #	TAG #	VOLUME	CHECK IF FILTERED	PRES.	ANALYSIS REQUESTED
			500 mL	✓	HNO₃	Diss. As, Ca, Fe, K, Mg, Mn, Na, Sb
			500 mL		NONE	HCO₃, Cl, SO₄, TDS
		Dry		Dry		

TIME	TEMP (°C)	pH	SC (mmhos/cm @ 25°C)	EH (MV)	DO (mg/L)
1403	12.45	9.67	0.677	126	5.96
1423	10.40	9.93	0.718	72	6.00

****************** FINAL FIELD PARAMETERS PRIOR TO SAMPLING ******************

FIELD EQUIPMENT Q/A AND CALIBRATION: Recorded in field logbook

FIELD REMARKS: Very little water in well – Bailed dry, will check next day – Stop @ 1424 – after removing 18 gal H2O' DTW: 167.03'



0 - 3 Top Soil, dk brown, s. moist, organic material present numerous Lowena Ck volcanic cobbles & boulders scattered about

3 - 5 Sandy clay, sands mostly F to M, some C grey to brown, s. moist, soft

5 - 23 Top of 'competent' Lowena Ck Volcanics Formation, grey to brown with some olive & red, soft to mod hard, fractured, dry

23 - 33.5 Lowena Ck Volcanic Bedrock, rock has become harder at this level. Otherwise, similar to above

33.5 - 34 Clay seam or fractured zone (50 ft spot)

34 - 38 Lowena Ck volcanics

35 - 40 Soft zone possibly weathered, S. moist

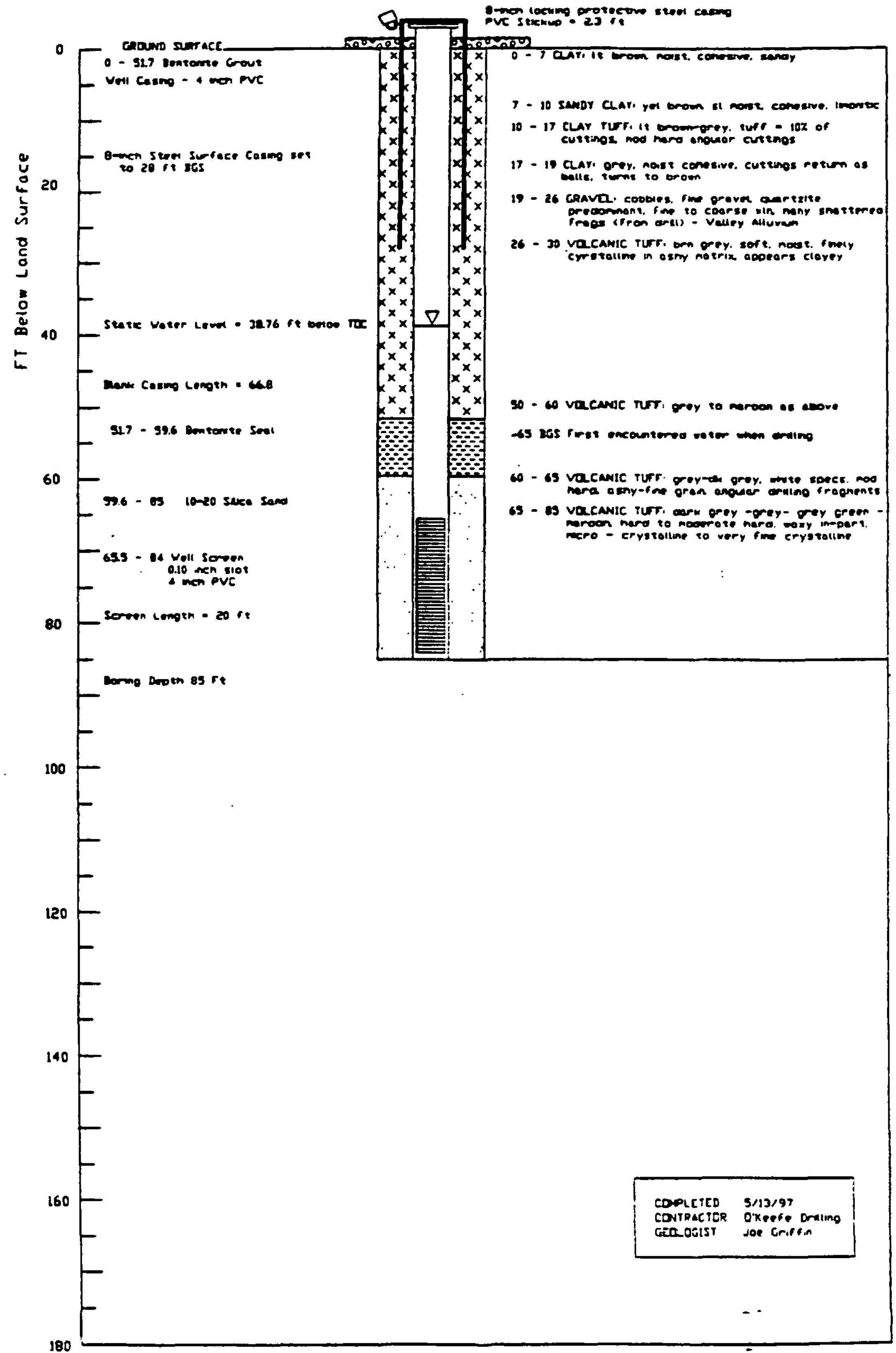
40 - 181 Lowena Ck Volcanics, mod hard, grey to brown w/olive & red, cuttings dry to s. moist, rock generally competent

180 - 200 Similar to above w/slight color change to brown

COMPLETED 5/7/97
CONTRACTOR O'Keefe Drilling
GEOLOGIST Jeff Martin

BORING 246

QST ENVIRONMENTAL



0 - 7 CLAY: lt brown, moist, cohesive, sandy

7 - 10 SANDY CLAY: yel brown, sl moist, cohesive, limonitic

10 - 17 CLAY TUFF: lt brown-grey, tuff = 10% of cuttings, mod hard angular cuttings

17 - 19 CLAY: grey, moist cohesive, cuttings return as balls, turns to brown

19 - 26 GRAVEL: cobbles, fine gravel, quartzite predominant, fine to coarse sln, many shattered frags (from drill) - Valley Alluvium

26 - 30 VOLCANIC TUFF: brn grey, soft, moist, finely cyrstalline in ashy matrix, appears clayey

50 - 60 VOLCANIC TUFF: grey to maroon as above

~65 BGS First encountered water when drilling

60 - 65 VOLCANIC TUFF: grey-dk grey, white specs, mod hard, ashy-fine grain, angular drilling fragments

65 - 85 VOLCANIC TUFF: dark grey -grey- grey green - maroon, hard to moderate hard, waxy in-part, micro - crystalline to very fine crystalline

COMPLETED 5/13/97
CONTRACTOR O'Keefe Drilling
GEOLOGIST Joe Griffin

WELL MW - 247

QST ENVIRONMENTAL

FIELD SAMPLE DATA SHEET

Page 2 of ____

PROJECT NAME: ARWW-TI

PROJECT NUMBER: 829-7031-0100-8200

WELL/STATION MW 247 DATE 6-9-97 ARRIVAL TIME 1558

SAMPLING PERSONNEL AP/JM WEATHER CONDITIONS Sunny, Warm

SKETCH ON BACK: Yes___ No ✓ PHOTOGRAPHS: Yes___ No ✓ ROLL#____ EXPOSURE#____

PURGE DATA:

PURGE METHOD Grunfos Redi Flo II

START PURGING 1609

PURGE RATE 1.8 [✓ GPM] LPM

RATE CHANGE 1)Time 1304 Rate <2gpm

2)Time____ Rate____

SAMPLE TIME 1705

WELL DEPTH 87.30 Feet

DEPTH TO WATER 38.76 Feet

COLUMN HEAD 48.54 Feet

CASING DIAMETER 4 Inch

3 WELL VOLUMES 95.09 Gal

TOTAL PURGE VOLUME ~100? Gal

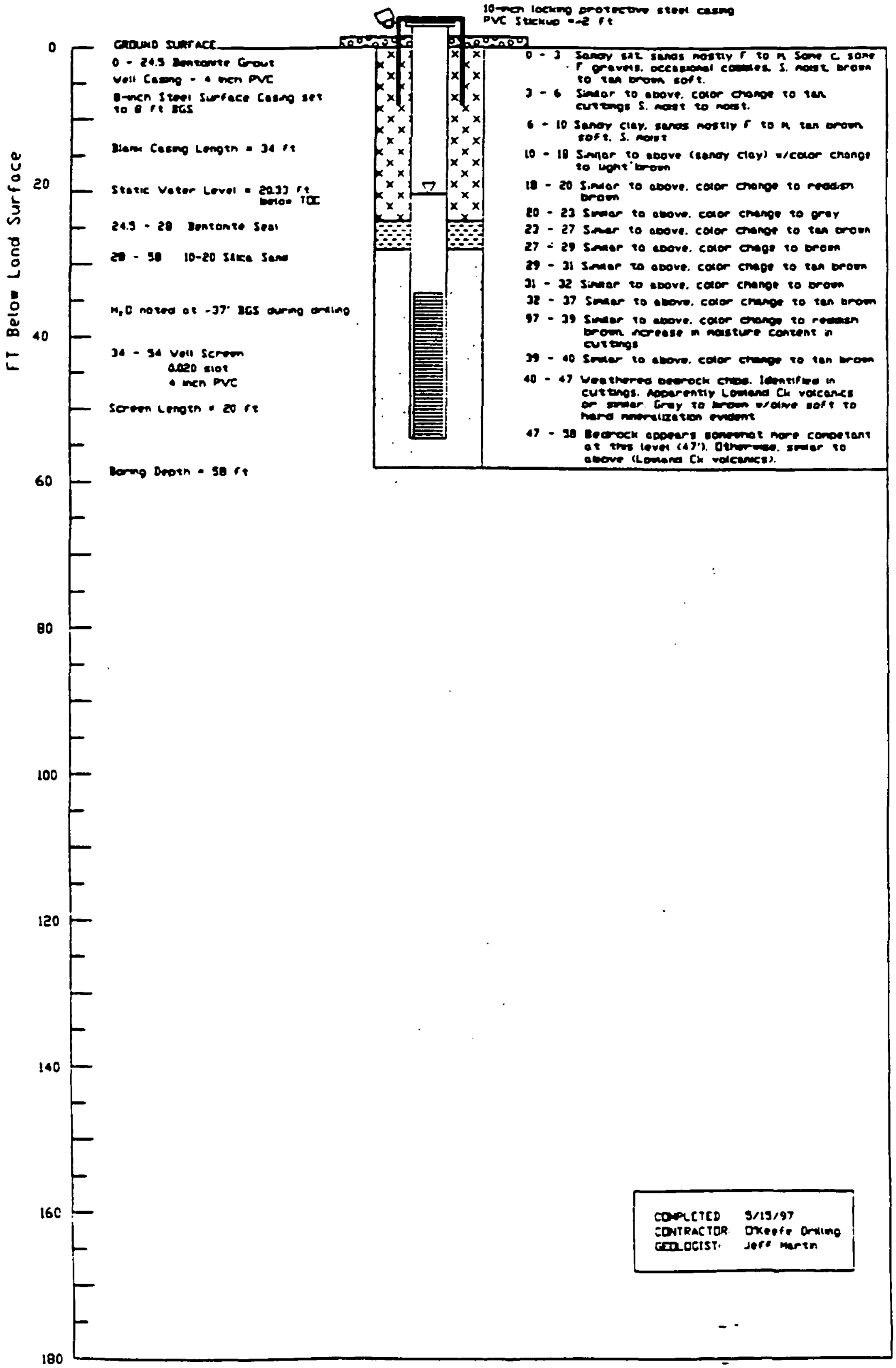
SAMPLE DATA:

SAMPLE ID	SAMPLE #	TAG #	VOLUME	CHECK IF FILTERED	PRES.	ANALYSIS REQUESTED
MW247-01	GW0031	00062	500 mL	✓	HNO$_3$	Diss. As. Ca. Fe. K. Mg. Mn. Na. Sb
MW247-02	"	00063	500 mL		NONE	HCO$_3$, Cl. SO$_4$, TDS

TIME	TEMP (°C)	pH	SC (mmhos/cm @ 25°C)		EH (MV)	DO (mg/L)
1620	10.64	8.91	1.59	Turbidity 63 NTU	175	5.72
1631	10.69	8.85	1.60	38.4 NTU	172	5.81
1642	11.09	8.80	1.60	26.4 NTU	166	5.39
1653	11.48	8.78	1.60	23.4 NTU	154	4.95
1704	10.72	8.75	1.59	10.1 NTU	134	4.75
****************** FINAL FIELD PARAMETERS PRIOR TO SAMPLING ******************						
1704	10.72	8.75	1.59	10.1 NTU	125	4.75

FIELD EQUIPMENT Q/A AND CALIBRATION: Recorded in field logbook

FIELD REMARKS: Pump set @ 96'



10-inch locking protective steel casing
PVC Stickup =~2 ft

GROUND SURFACE

0 - 24.5 Bentonite Grout

Well Casing - 4 inch PVC

8-inch Steel Surface Casing set
to 8 ft BGS

Blank Casing Length = 34 ft

Static Water Level = 20.33 ft
below TOC

24.5 - 28 Bentonite Seal

28 - 58 10-20 Silica Sand

H_2O noted at ~37' BGS during drilling

34 - 54 Well Screen
0.020 slot
4 inch PVC

Screen Length = 20 ft

Boring Depth = 58 ft

0 - 3	Sandy silt. sands mostly F to M. Some C. some F gravels. occasional cobbles. S. moist. brown to tan brown soft.
3 - 6	Similar to above. color change to tan. cuttings S. moist to moist.
6 - 10	Sandy clay. sands mostly F to M. tan brown. soft. S. moist
10 - 18	Similar to above (sandy clay) w/color change to light brown
18 - 20	Similar to above. color change to reddish brown
20 - 23	Similar to above. color change to grey
23 - 27	Similar to above. color change to tan brown
27 - 29	Similar to above. color chage to brown
29 - 31	Similar to above. color chage to tan brown
31 - 32	Similar to above. color change to brown
32 - 37	Similar to above. color change to tan brown
97 - 39	Similar to above. color change to reddish brown. increase in moisture content in cuttings
39 - 40	Similar to above. color change to tan brown
40 - 47	Weathered bedrock chips. Identified in cuttings. Apparently Lowland Ck volcanics or similar. Grey to brown w/olive soft to hard mineralization evident
47 - 58	Bedrock appears somewhat more competent at this level (47'). Otherwise, similar to above (Lowland Ck volcanics).

COMPLETED 5/15/97
CONTRACTOR O'Keefe Drilling
GEOLOGIST Jeff Martin

WELL MW - 248s

QST ENVIRONMENTAL

FIELD SAMPLE DATA SHEET

Page 4 of ____

PROJECT NAME: ARWW-II

PROJECT NUMBER: 829-7031-0100-8200

WELL/STATION MW 248 S DATE 6-9-97 ARRIVAL TIME 1133

SAMPLING PERSONNEL SP | JM WEATHER CONDITIONS Sunny, warm

SKETCH ON BACK: Yes___ No ✓ PHOTOGRAPHS: Yes___ No ✓ ROLL#_____ EXPOSURE#_____

PURGE DATA:

PURGE METHOD Grunfos Redi Flo II

START PURGING 1145

PURGE RATE 2.2 [✓ GPM] LPM

RATE CHANGE 1)Time 1215 Rate <2gpm

2)Time_____ Rate_____

SAMPLE TIME 1216

WELL DEPTH 54.0 Feet

DEPTH TO WATER 20.33 Feet

COLUMN HEAD 3367 Feet

CASING DIAMETER 4 Inch

3 WELL VOLUMES 66 Gal.

TOTAL PURGE VOLUME ______ Gal.

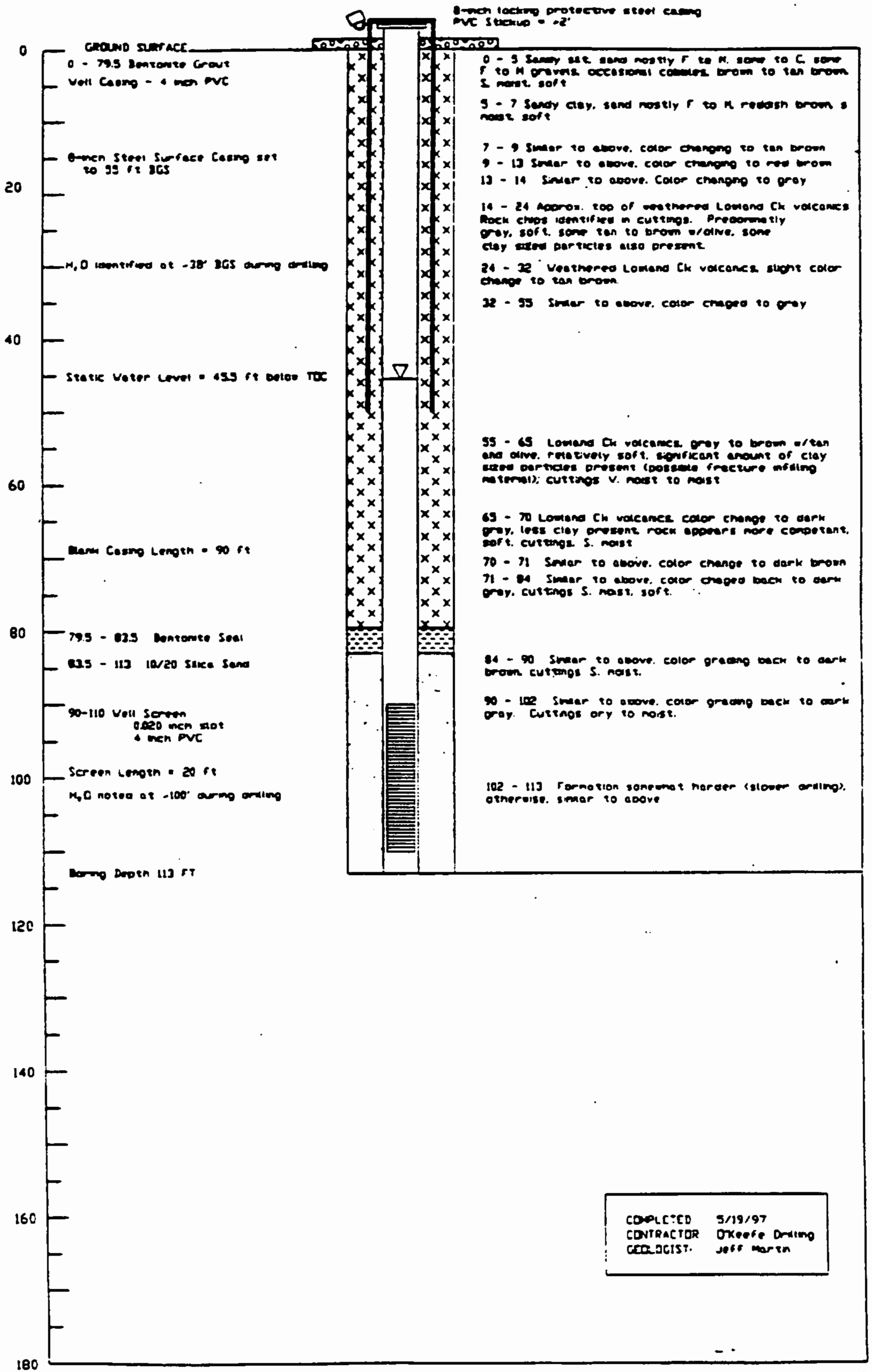
SAMPLE DATA:

SAMPLE ID	SAMPLE #	TAG #	VOLUME	CHECK IF FILTERED	PRES.	ANALYSIS REQUESTED
MW248S-01	GW0028	00056	500 mL	✓	HNO_3	Diss. As. Ca. Fe. K. Mg. Mn. Na. Sb
MW248S-02	"	00057	500 mL		NONE	HCO_3. Cl. SO_4. TDS

TIME	TEMP (°C)	pH	SC (mmhos/cm @ 25°C)		EH (MV)	DO (mg/L)
1151	9.76	7.53	0.793	Turbidity 5.54NTU	210	12.80
1157	10.25	7.39	0.745	5.09 NTU	211	12.22
1203	10.75	7.34	0.689	5.07NTU	211	11.52
1209	11.39	7.30	0.686	5.06NTU	210	11.40
1215	11.43	7.30	0.689	5.06NTU	210	11.33
****************** FINAL FIELD PARAMETERS PRIOR TO SAMPLING ******************						
1215	11.43	7.30	0.689	5.06 NTU	210	11.33

FIELD EQUIPMENT Q/A AND CALIBRATION: Recorded in field logbook

FIELD REMARKS: Pump set @ 50'



0 - 5 Sandy silt, sand mostly F to M, some to C, some F to M gravels, occasional cobbles, brown to tan brown, S. moist, soft

5 - 7 Sandy clay, sand mostly F to M, reddish brown, s moist, soft

7 - 9 Similar to above, color changing to tan brown

9 - 13 Similar to above, color changing to red brown

13 - 14 Similar to above. Color changing to grey

14 - 24 Approx. top of weathered Lowland Ck volcanics Rock chips identified in cuttings. Predominantly grey, soft, some tan to brown w/olive, some clay sized particles also present.

24 - 32 Weathered Lowland Ck volcanics, slight color change to tan brown

32 - 55 Similar to above, color chaged to grey

55 - 65 Lowland Ck volcanics, grey to brown w/tan and olive, relatively soft, significant amount of clay sized particles present (possible fracture infilling material); cuttings V. moist to moist

65 - 70 Lowland Ck volcanics, color change to dark grey, less clay present, rock appears more competent, soft, cuttings S. moist

70 - 71 Similar to above, color change to dark brown

71 - 84 Similar to above, color chaged back to dark grey, cuttings S. moist, soft.

84 - 90 Similar to above, color grading back to dark brown, cuttings S. moist.

90 - 102 Similar to above, color grading back to dark grey. Cuttings dry to moist.

102 - 113 Formation somewhat harder (slower drilling), otherwise, similar to above

COMPLETED	5/19/97
CONTRACTOR	O'Keefe Drilling
GEOLOGIST	Jeff Martin

WELL MW - 248d

[illegible]

QST ENVIRONMENTAL

FIELD SAMPLE DATA SHEET

Page 3 of ____

PROJECT NAME: ARWW-II

PROJECT NUMBER: 829-7031-0100-8200

WELL/STATION MW248 d DATE 6-9-97 ARRIVAL TIME 1013

SAMPLING PERSONNEL JP LJM WEATHER CONDITIONS Sunny, Mild

SKETCH ON BACK: Yes___ No ✓ PHOTOGRAPHS: Yes___ No ✓ ROLL#____ EXPOSURE#____

PURGE DATA:

PURGE METHOD	Grunfos Redi-Flo II	WELL DEPTH	110.0	Feet
START PURGING	1027	DEPTH TO WATER	45.5	Feet
PURGE RATE	3.2 [✓ GPM] LPM	COLUMN HEAD	64.5	Feet
RATE CHANGE	1)Time 1607 Rate <2gpm	CASING DIAMETER	4	Inch
	2)Time____ Rate____	3 WELL VOLUMES	126.4	Gal.
SAMPLE TIME	1608	TOTAL PURGE VOLUME	128	Gal.

SAMPLE DATA:

SAMPLE ID	SAMPLE #	TAG #	VOLUME	CHECK IF FILTERED	PRES.	ANALYSIS REQUESTED
MW248d-01	GW0027	00054	500 mL	✓	HNO_3	Diss. As. Ca. Fe. K. Mg. Mn. Na. Sb
MW248d-02	"	00055	500 mL		NONE	HCO_3, Cl. SO_4, TDS

TIME	TEMP (°C)	pH	SC (mmhos/cm @ 25°C)		EH (MV)	DO (mg/L)
1035	10.13	8.79	0.472	Turbidity 6.8 NTU	229	4.36
1043	10.46	8.94	0.469	9.8 NTU	213	3.68
1051	11.06	8.86	0.471	10.8 NTU	205	3.47
1059	11.87	8.90	0.471	10.6 NTU	198	3.45
1607	12.05	8.89	0.471	10.1 NTU	198	3.46
****************** FINAL FIELD PARAMETERS PRIOR TO SAMPLING ******************						
1607	12.06	8.89	0.471	10.1 NTU	198	3.46

FIELD EQUIPMENT Q/A AND CALIBRATION: Recorded in field logbook

FIELD REMARKS: Pump set @ 105'

FIELD SAMPLE DATA SHEET

Page 2 of ____

PROJECT NAME: ARWW-TI

PROJECT NUMBER: 829-7031-0100-8200

WELL/STATION NGP1 DATE 5-15-97 ARRIVAL TIME 1346

SAMPLING PERSONNEL JC | MP WEATHER CONDITIONS P. cloudy, warm

SKETCH ON BACK: Yes___ No ✓ PHOTOGRAPHS: Yes___ No ✓ ROLL#____ EXPOSURE#____

PURGE DATA:

PURGE METHOD Jack Rabbit Parastaltic

WELL DEPTH 16.45 Feet

START PURGING 1350

DEPTH TO WATER 6.45 Feet

PURGE RATE ______ GPM LPM

COLUMN HEAD 10.00 Feet

RATE CHANGE 1)Time_____ Rate_____

CASING DIAMETER 1 Inch

2)Time_____ Rate_____

3 WELL VOLUMES 1.23 Gal.

SAMPLE TIME 1405

TOTAL PURGE VOLUME ______ Gal.

SAMPLE DATA:

SAMPLE ID	SAMPLE #	TAG #	VOLUME	CHECK IF FILTERED	PRES.	ANALYSIS REQUESTED
NGP1-01	GW0004	00007	500 mL	✓	HNO_3	Diss. As. Ca. Fe. K. Mg. Mn. Na. Sb
NGP1-02	〃	00008	500 mL		NONE	HCO_3, Cl. SO_4, TDS

TIME	TEMP (°C)	pH	SC (mmhos/cm @ 25°C)	EH (MV)	DO (mg/L)
	8.50	6.71	0.625	144	NA
	7.36	6.80	0.623	140	NA
	6.92	6.85	0.625	136	NA
****************** FINAL FIELD PARAMETERS PRIOR TO SAMPLING ******************					
	6.92	6.85	0.425	136	NA

FIELD EQUIPMENT Q/A AND CALIBRATION: Recorded in field logbook

FIELD REMARKS: Flow in channel present

FIELD SAMPLE DATA SHEET

Page 1 of 5

PROJECT NAME: ARWW-TI

PROJECT NUMBER: 829-7031-0100-8200

WELL/STATION WGP2 DATE 5-15-97 ARRIVAL TIME 1205

SAMPLING PERSONNEL AP | MP WEATHER CONDITIONS ____

SKETCH ON BACK: Yes___ No ✓ PHOTOGRAPHS: Yes___ No ✓ ROLL#____ EXPOSURE#____

PURGE DATA:

PURGE METHOD Jack Rabbit Pump

START PURGING 1207

PURGE RATE NA GPM LPM

RATE CHANGE 1)Time____ Rate____

2)Time____ Rate____

SAMPLE TIME 12

WELL DEPTH 27.7 Feet

DEPTH TO WATER 10.85 Feet

COLUMN HEAD 16.85 Feet

CASING DIAMETER 1 Inch

3 WELL VOLUMES 2.07 Gal.

TOTAL PURGE VOLUME ____ Gal.

SAMPLE DATA:

SAMPLE ID	SAMPLE #	TAG #	VOLUME	CHECK IF FILTERED	PRES.	ANALYSIS REQUESTED
WGP2-01	GW0002	00003	500 mL	✓	HNO_3	Diss. As. Ca. Fe. K. Mg. Mn. Na. Sb
WGP2-02	4	00004	500 mL		NONE	HCO_3. Cl. SO_4. TDS

TIME	TEMP (°C)	pH	SC (mmhos/cm @ 25°C)	EH (MV)	DO (mg/L)
	10.95	7.30	1.150	108	NA
	10.30	7.11	1.127	33	NA
	9.48	6.93	1.119	-15	NA
	9.38	6.98	1.120	-34	NA
	9.13	6.86	1.124	-50	NA
****************** FINAL FIELD PARAMETERS PRIOR TO SAMPLING ******************					
1219	9.13	6.86	1.124	-50	NA

FIELD EQUIPMENT Q/A AND CALIBRATION: Recorded in field logbook

FIELD REMARKS: Water Slightly turbid w/ trace of H_2S odor
Dupe samples collected here GW0003 Tags 00005 & 00006

Attachment B

MARCH 3, 1849

United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Water Resources Division
Federal Building, Room 428
301 South Park Avenue, Drawer 10076
Helena, Montana 59626-0076

August 29, 1997

Ms. Julie DalSoglio
U.S. Environmental Protection Agency
Drawer 10096
Federal Building
Helena, Montana 59626

Dear Julie:

As you requested, this letter describes a reconnaissance-level inventory of springs and surface-water sampling conducted on May 29, 1997, near the Anaconda Smelter site. This information is provided on a technical-assistance basis only and does not constitute any opinion the Department of Interior may have regarding resources under its trusteeship.

Springs were found by walking up drainages to the highest points where water was evident. Stream sites were located to evaluate surface-water drainage into the East Anaconda Yard area. Sites were located in the field by siting the location on a 1:24,000 topographic map. Altitudes for each site were interpolated from 40-ft contour intervals on the topographic map. Discharge at each site was measured or estimated. Water-quality samples collected were filtered onsite through a 0.45-µm syringe filter and acidified with HNO_3. Samples from 5 springs and 3 streams, along with one field blank and one replicate, were sent to the National Water Quality Laboratory of the U.S. Geological Survey in Arvada, Colo., for analysis of dissolved arsenic.

Results of the inventory and water-quality sampling are listed in the enclosed table. I hope this information is helpful. If you have any questions, please do not hesitate to call (441-1319).

Sincerely,

David A. Nimick

David A. Nimick
Hydrologist

Enclosure

cc: Chris Carrigan, CDM Federal

Table 1. Results of U.S. Geological Survey spring and stream sampling at the Anaconda Smelter NPL site, May 1997

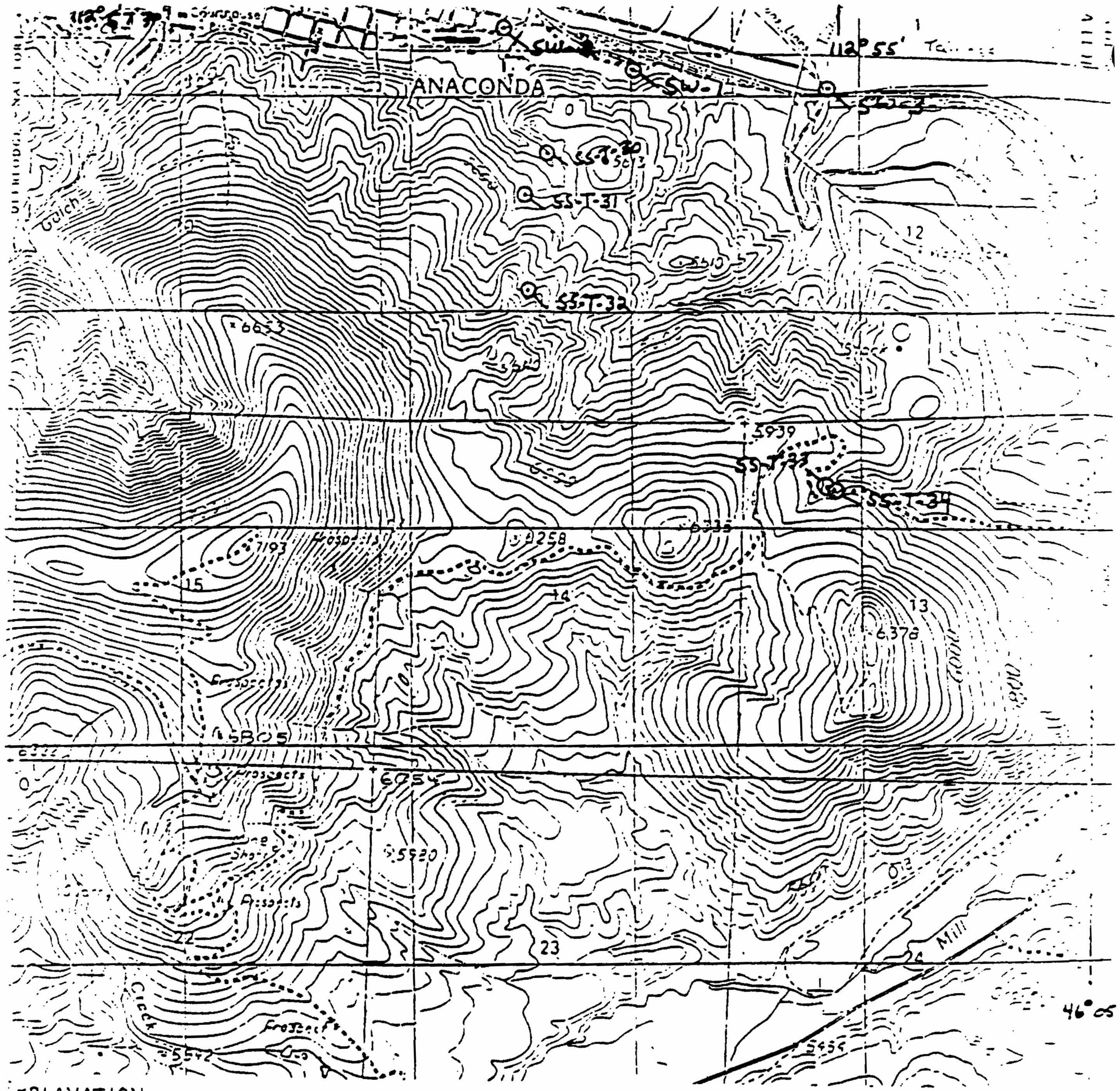
Abbreviations: °C, degrees Celsius; e, estimated; gal/min, gallons per minute; µg/L, micrograms per liter; µS/cm, microsiemens per centimeter at 25° C; Tlv, Lowland Creek Volcanics (Eocene).

Spring or stream number	U.S. Geological Survey site-identification number[1]	Location number[2]	Altitude (feet)	Geo-logic unit	Date inven-toried	Tem-per-ature (°C)	Specific conduct-ance (µS/cm)	Dis-charge (gal/min)	Arsenic, dissolved (µg/L as As)
			SPRINGS						
SS-T-30[3]	460704112560201	04N11W11CAAA01	5,390	Tlv	05-29-97	9.5	610	41	245
SS-T-31	460658112560501	04N11W11BDAB01	5,480	Tlv	05-29-97	10.5	582	e3	324
SS-T-32	460643112560301	04N11W11CABA01	5,760	Tlv	05-29-97	11.5	844	e3	146
SS-T-33	460616112550001	04N11W13BBDA01	5,780	Tlv	05-29-97	8.0	454	15	708
SS-T-34	460615112545901	04N11W13BACB01	5,760	Tlv	05-29-97	7.8	555	e3	777
			STREAMS						
SW-1	460718112554201	04N11W02DCDA01	5,240	--	05-29-97	12.0	860	22	57.9
SW-2	460723112561001	04N11W02CDBA01	5,250	--	05-29-97	10.5	310	31	18.5
SW-3	460715112550201	04N11W01CDCC01	5,200	--	05-29-97	15.0	536	230	512
SW-3	replicate	--	--	--	--	--	--	--	451
SW-3	field blank	--	--	--	--	--	--	--	<1

[1] The site-identification number is the latitude and longitude of the site location, first thirteen digits, followed by a two digit sequence number.

[2] The first eight characters of the location number delineates the township, range and section of the site location. The following four letters divide the section into quarter sections, quarter-quarter sections, quarter-quarter-quarter sections, and quarter-quarter-quarter-quarter sections. The northeast quarter of each quarter is designated as A, northwest B, southwest C and southeast D. The last two digits represent the sequence number of the location.

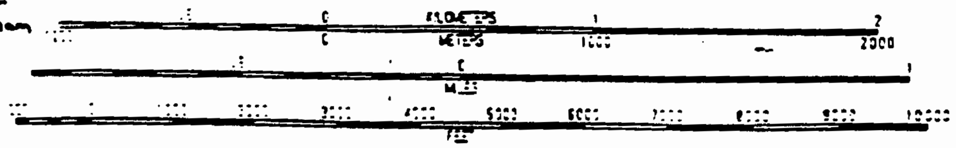
[3] Located 150 feet upstream of well point NGB-1.



EXPLANATION

) SPRING
or
Stream

SCALE 1:24 000



CONTOUR INTERVAL 40 FEET

To convert feet to meters multiply by .3048
To convert meters to feet multiply by 3.2808

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U.S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225
OR RESTON, VIRGINIA 22092

ANACONDA SOUTH, MONT

PROVISIONAL EDITION

QUADRANGLE LOCATION

1	2	3
4		5
6	7	8

1 West Valley
2 Anaconda North
3 Warm Springs
4 Mount Haggin
5 Opportunity
6 [illegible] Gulch
7 Dickie Peak
8 Burnt Mountain

ADJOINING 7.5' QUADRANGLE NAMES

Attachment C

MEMORANDUM

To: Julie DalSoglio, EPA

From: Chris Carrigan, CDM Federal

Date: December 24, 1996

Subject: Summary of Domestic Wells in the Aspen Hills Area of the Smelter Hill Subarea

For purposes of future data collection in the Smelter Hill TI zone Area, I have completed a search of well bore logs and/or drilling permits in the Aspen Hills Area (T4N, R11W) from records at the office of the Montana Department of Natural Resources and Conservation (DNRC) in Helena, Montana. The conclusion of this search indicate at least eight domestic wells currently exist in the Aspen Hills area as a result of recent residential development (Table 1). All eight wells identified as a result of this search are located just beyond the southwest boundary of the Smelter Hill TI zone area for the bedrock aquifer (Figure 1). According to completion records, the total depth for domestic wells in the Aspen Hills area range from 60 feet below ground surface (bgs) to 360 feet. Well perforations range from a depth bgs of 40 feet to 360 feet. Depth to ground water in the areas ranges from 10 feet bgs to 65 feet. All eight wells appear to be completed in the bedrock aquifer, which is generally described as granite, rock, decomposed bedrock, or decomposed granite. Copies of well bore logs obtained by CDM Federal from files at DNRC are provided in Attachment A.

Although all eight wells are located outside the current boundary of the Smelter Hill TI zone area for the bedrock aquifer, samples collected from these wells would be useful for verifying the position of the TI zone boundary for the bedrock in this area. Domestic wells of particular interest to the TI evaluation due to their relatively shallow completion depth include the Dishman well (47 to 53 feet bgs) located near the intersection of sections 22, 26, and 27, T4N, R11W, the Pope well (40 to 80 feet bgs) located in section 26, T4N, R11W, and the Haas well (40 to 120 feet bgs) located in section 26, T4N, R11W. Please note that the Martin well located in section 27, T4N, R11W was sampled by MSE during the 1995 field season. Sample results for the Martin well (DW-AH23) were reported by Titan in August 12996 in the *ARWWS OU Final Feasibility Study Supplemental Field Investigation Data Summary Report.*

At your convenience, we can discuss a plan for obtaining access to all or some of the domestic wells identified in this search for future collection of ground water samples pertaining to characterization of the bedrock aquifer in the Smelter Hill TI zone area.

cc: Bob Rennick, CDM Federal

dal57.wcc

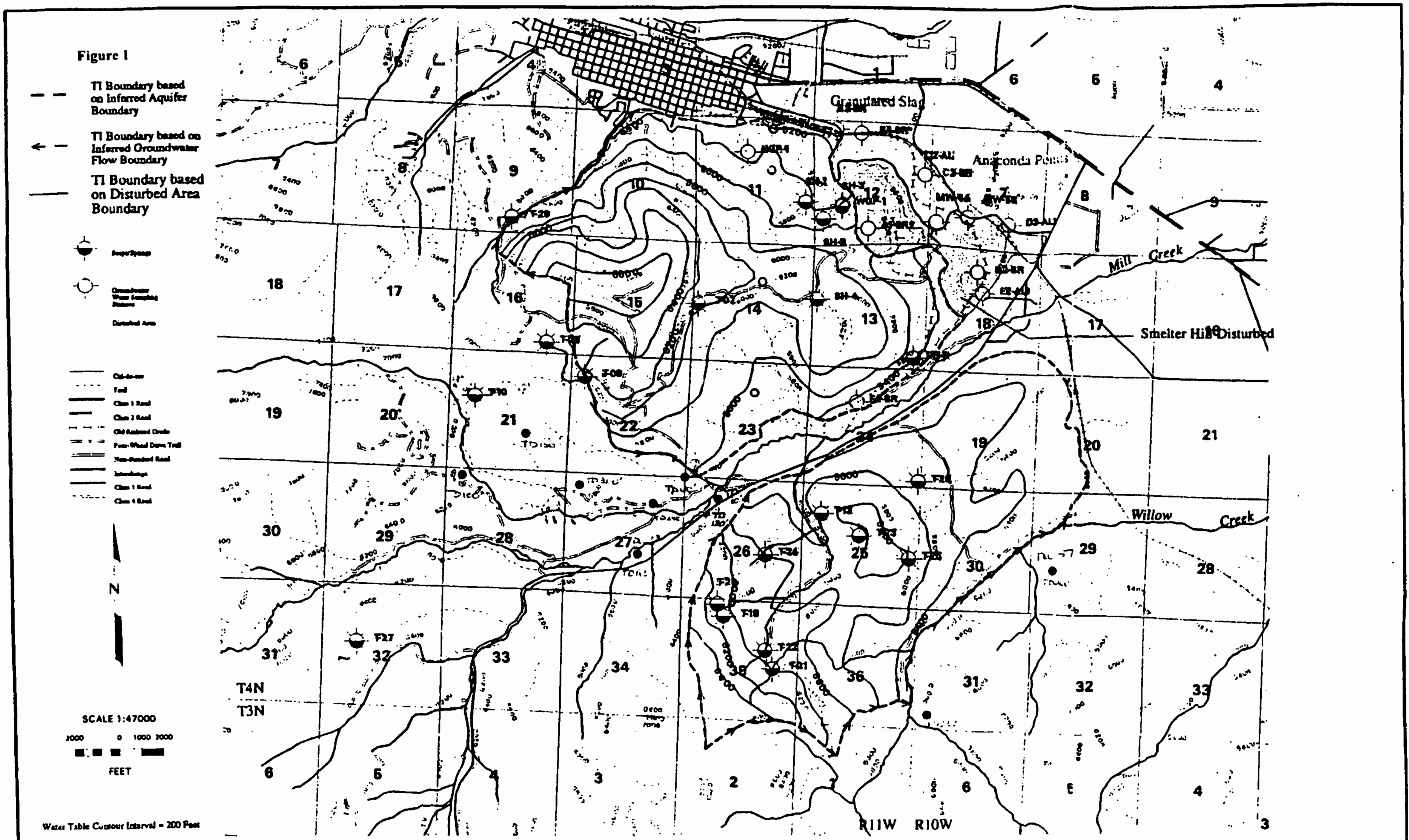
TABLE 1

Summary of Domestic Wells in the Aspen Hills Area

Owner	Address	Location	Total Depth	Perforations	WL Depth
Joe & Sherry Prete	P.O. Box 563 Anaconda, MT 59711	NWSE21, T4N, R11W	150'	90 to 150'	65'
Ted Dishman	P.O. Box 952 Anaconda, MT 59711	22, 23, 26, and 27, T4N , R11W	60'	47 to 53'	20'
Clyde Pope	General Delivery Butte, MT 59701	SENW26, T4N, R11W	80'	40 to 80'	25'
James Haas	P.O. Box 852 Anaconda, MT 59711	SENW26, T4N, R11W	120'	40 to 120'	10'
Charles & Lolita Martin	1345 Stanley Avenue Chico, CA 95928	S2NWSE27, T4N, R11W	182'	140 to 180'	48'
Keith Walsh	2011 Banks Butte, MT 59701	NE27, T4N,R11W	240'	NR	56'
Greg Kinney Kathy Wright	P.O. Box 776 Anaconda, MT 59711	NW27, T4N, R11W	360'	320 to 360'	NR
James Luman	25935 Dry Pond Road Clovis, CA 93611-9628	NWNWNW28, T4N, R11W	100'	90 to 100'	30'

NR = Not Reported

Figure 1


TI Boundary based on Inferred Aquifer Boundary
TI Boundary based on Inferred Groundwater Flow Boundary
TI Boundary based on Disturbed Area Boundary
Seeps/Springs
Groundwater Water Sampling Stations
Disturbed Area
Cul-de-sac
Trail
Class 1 Road
Class 2 Road
Old Railroad Grade
Four-Wheel Drive Trail
Non-Standard Road
Interchange
Class 3 Road
Class 4 Road
N
SCALE 1:47000
2000 0 1000 2000
FEET
Water Table Contour Interval = 200 Feet
Granulated Slag
Anaconda Ponds
Mill Creek
Smelter Hill Disturbed
Willow Creek
T4N
T3N
R11W
R10W
F-29
F-08
F-09
T-10
F25
F23
F24
F26
F28
F19
F22
F21
F27
MGR-1
SH-4
SH-6
SH-8
T-02
EE-AL
EE-BR
DS-AL
CZ-AL
CZ-BR
MW-56
6
5
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ATTACHMENT A

WELL LOG REPORT

1. WELL OWNER

Name PRETE, JOE & SHERRY

2. CURRENT MAILING ADDRESS

P.O. BOX 563
ANACONDA, MT 59711

3. WELL LOCATION MILL CREEK

County Deer Lodge
Township 4 [✓ N]/S Range 11 E/[✓ W]
NW 1/4 SE 1/4 SECTION 21
Lot ________ Block ________
Subdivision ________
Tract Number ________

4. PROPOSED USE Domestic X
Irrigation ________ Stock ________
Other: ________

5. DRILLING METHOD _____ Cable
Rotary X Air _____ FWD _____ Reverse
_____ Jetted _____ Other: ________

6. WELL LOG

From	To	Formation
0	55	SAND & GRAVEL
55	62	SANDY CLAY
62	150	ROCK

11. DRILLER/CONTRACTOR'S CERTIFICATION

This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

Date: 5/24/93

O'Keefe Drilling Company
P.O. Box 3810 2000 Four Mile Road
Butte, MT 59702

Doug Beck ________ WWD-048
Signature License No.
Doug Beck

7. WELL CONSTRUCTION

Hole Size	Casing Size	From Feet	To Feet
6"	Steel 6 5/8" X .250	+1 1/2	59
4"	PVC	10	150

COMPLETIONS
perforations ________ screen ________

Kind	From feet	To feet
Skill Saw	90	150

Was casing left open? NO
Was a packer/seal used? NO
Well gravel packed? NO
To What depth Well grouted? 40 FT
Grouting Material: Bentonite Crumbles
Well head completion :
Pitless adapter NO
Top of casing 18" or greater above grade YES

8. WELL TEST DATA

All wells under 100 GPM must be tested for a minimum of one hour and provide:

A. Air X Pump _____ Bailer _____
B. Static Water Level before: 65 FT
If flowing closed in pressure
_____ PSI _____ GPM
Controlled by:
C. Depth of Pump for Test 145 FT
D. Pumping Rate & Discharge 2 GPM
E. Maximum Drawdown for test 150 FT
F. Duration of test:
Pumping time: 1 HRS.
Recovery Time: 2 HRS.
G. Recovery Water Level 65 FT
Time after pumping recovery water data was taken 2 HRS.

9. WELL PLUGGED OR ABANDONED? NO
If yes, how?

10. DATE COMPLETED 5/24/93

MONTANA DEPARTMENT OF NATURAL RESOURCES
1520 East 6th Ave Helena, MT 59620-2301 406-444-6610

WELL LOG REPORT

1. WELL OWNER

Name DISHMAN, TED

2. CURRENT MAILING ADDRESS

P.O. BOX 952
ANACONDA, MT 59711

3. WELL LOCATION ROCKY MTN TIMBER L

County DEER LODGE /

Township 4 [✓ N] S Range 11 E [✓ W], Pmm

____ 1/4 ____ 1/4 SECTION 22, 26+27

Lot ____ Block ____

Subdivision ____

Tract Number ____

4. PROPOSED USE Domestic X

Irrigation ____ Stock ____

Other: ____

5. DRILLING METHOD ____ Cable

Rotary X Air ____ FWD ____ Reverse

____ Jetted ____ Other: ____

6. WELL LOG

From	To	Formation
0	2	TOP SOIL
2	5	CLAY
5	25	SAND & GRAVEL
25	35	DECOMPOSED BEDROCK
35	42	SILTY SAND
42	60	DECOMPOSED BEDROCK

11. DRILLER/CONTRACTOR'S CERTIFICATION

This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

Date: 5-18-93

O'Keefe Drilling Company
P.O. Box 3810 2000 Four Mile Road
Butte, MT. 59702

Doug Beck ____ WWD-048

Signature License No.

DOUG BECK

7. WELL CONSTRUCTION

Hole Size	Casing Size	From Feet	To Feet
6"	Steel 6 5/8" X .250	+2	55
4"	PVC		

COMPLETIONS

perforations ____ screen ____

Kind	From feet	To feet
Skill Saw	47	53

Was casing left open? YES

Was a packer/seal used? NO

Well gravel packed? NO

To What depth Well grouted? 20 FT

Grouting Material: Bentonite Crumbles

Well head completion :

Pitless adapter NO

Top of casing 18" or greater above grade YES

8. WELL TEST DATA

All wells under 100 GPM must be tested for a minimum of one hour and provide:

A. Air X Pump ____ Bailer ____

B. Static Water Level before: 20 FT

If flowing closed in pressure

____ PSI ____ GPM

Controlled by:

C. Depth of Pump for Test Air FT

D. Pumping Rate & Discharge 10 GPM

E. Maximum Drawdown for test FT

F. Duration of test:

Pumping time: 1.5 HRS.

Recovery Time: HRS.

G. Recovery Water Level FT

Time after pumping recovery water data was taken HRS.

9. WELL PLUGGED OR ABANDONED? NO

If yes, how?

10. DATE COMPLETED 5-18-93

DNRC

76G-C095610-00

Domestic Water Wells
Large Irrigation Wells
Pumps - Sales & Service
Monitor Holes
Mineral Exploration

WELL LOG REPORT

LINDSAY & SON DRILLING

(406) 933-5511
Box 67
Clancy, Montana 59634

1. WELL OWNER:
Clyde Pope

2. CURRENT MAILING ADDRESS:
General Delivery

Anaconda, Mt. 59701

3. WELL LOCATION:
SE 1/4 NW 1/4 SECTION: 26
TOWNSHIP: 4N RANGE: 11W
COUNTY: Deer Lodge

4. PROPOSED USE: Domestic

5. DRILLING METHOD: Air Rotary

6. WELL LOG CONSTRUCTION:
PERFORATIONS:50 - 80
SCREEN: none
GROUT: Bentonite
GROUT DEPTH: 20 ft.

7. WELL TEST DATA:
A) TESTING MEANS: Air
B) STATIC LEVEL: 25
C) DEPTH OF TEST: 77
D) GPM: 20
E) MAXIMUM DRAWDOWN: 75
F) PUMPING TIME: 2 hours
G) RECOVERY WATER LEVEL: 25
H) RECOVERY TIME: 2 hours

8. WELL LOG FORMATION:

0 - 2	Topsoil
2 - 30	Boulders & gravel
30 - 35	Decomposed granite
35 - 80	Granite bedrock

HOLE SIZE	CASING SIZE	FROM TO
6	6	+2 - 37
6	4 5/8	20 - 80

9. WAS WELL ABANDONED? No

10. DATE COMPLETED: 95/06/30

DRILLER/CONTRACTOR CERTIFICATION:
THIS WELL WAS DRILLED UNDER MY JURISDICTION.
THIS REPORT IS TRUE TO THE BEST OF MY KNOWLEDGE.

Signed License # 253
LINDSAY DRILLING INC.

Lindsay Drilling

Celebrating 46 years in business!!

DATE: 95/06/30

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION (DNR
1520 E. sixth ave. Helena, Mt. 59620-2301 444-6810

Domestic Water Wells
Large Irrigation Wells
Pumps - Sales & Service
Monitor Holes
Mineral Exploration

WELL LOG REPORT

LINDSAY & SON DRILLING

(406) 933-5511
Box 67
Clancy, Montana 59634

1. WELL OWNER:
James D. Hass

2. CURRENT MAILING ADDRESS:
P.O. Box 852

Anaconda, MT 59711

3. WELL LOCATION:
SE 1/4 NW 1/4 SECTION26
TOWNSHIP: 4N RANGE: 11W

COUNTY: Deer Lodge

4. PROPOSED USE: Domestic

5. DRILLING METHOD: Air Rotary

6. WELL LOG CONSTRUCTION:
PERFORATIONS: 40 -120
SCREEN: none
GROUT: Bentonite
GROUT DEPTH: 20 ft.

7. WELL TEST DATA:
A) TESTING MEANS: Air
B) STATIC LEVEL: 10
C) DEPTH OF TEST: 117
D) GPM: 20
E) MAXIMUM DRAWDOWN: 115
F) PUMPING TIME: 2 hours
G) RECOVERY WATER LEVEL: 10
H) RECOVERY TIME: 2 hours

8. WELL LOG FORMATION:

0 - 4	Topsoil
4 - 35	Boulders & gravel
35 - 40	Decomposed Granite
40 - 120	Granite bedrock

HOLE SIZE	CASING SIZE	FRM-TO
6	6	+2 - 40
6	4 5/8	20 - 120

9. WAS WELL ABANDONED? No

10. DATE COMPLETED: 95/07/12

RECEIVED
SEP 5 1995
MONTANA DNRC
HELENA FIELD OF

DRILLER/CONTRACTOR CERTIFICATION:
THIS WELL WAS DRILLED UNDER MY JURISDICTION.
THIS REPORT IS TRUE TO THE BEST OF MY KNOWLEDGE.

Terry Lindsay
Signed License # 253
LINDSAY DRILLING INC.

Lindsay Drilling—
Celebrating 46 years in business!!

DATE: 95/07/12

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION (DNRC)
1520 E. sixth ave. Helena, Mt. 59620-2301 444-6610

WELL LOG REPORT

1.WELL OWNER

Name MARTIN, CHARLES & LOLITA

2.CURRENT MAILING ADDRESS

1345 STANLEY AVE.
CHICO, CA 95928

3. WELL LOCATION MILL CREEK

County DEER LODGE

Township 4 [✓ N]/S Range 11 E/[✓ W] P.M.M.

S½ NW¼ SE¼ SECTION 27

Lot 3 Block

Subdivision ASPEN HILLS I

Tract Number 3

SURVEY 86B - ~~SW¼ NE¼ SE¼ SW¼ S½ NW¼~~

4. PROPOSED USE Domestic X

Irrigation ______ Stock ______

Other: ______

5. DRILLING METHOD

______ Cable

Rotary: X Air ______ FWD ______ Reverse

______ Jetted ______ Other: ______

6. WELL LOG

From	To	Formation
0	182	ROCK & CLAY

11. DRILLER/CONTRACTOR'S CERTIFICATION

This well was drilled under my jurisdiction and this report is true to the best of my knowledge.

Date: 6/13/94

O'Keefe Drilling Company
P.O. Box 3810 2000 Four Mile Road
Butte, MT 59702

Signature ______ 462 License No.

Dan O'Keefe

7. WELL CONSTRUCTION

Hole Size	Casing Size	From Feet	To Feet
6"	Steel 6 5/8" X .250	+1 1/2	40
4"	PVC	0	180

COMPLETIONS

perforations ______ screen ______

Kind	From feet	To feet
Torch	140	180

Was casing left open?	YES
Was a packer/seal used?	NO
Well gravel packed?	NO
To What depth Well grouted?	20 FT
Grouting Material:	Bentonite/ Hole Plug
Well head completion :	
Pitless adapter	NO
Top of casing 18" or greater above grade	YES

8. WELL TEST DATA

All wells under 100 GPM must be tested for a minimum of one hour and provide:

A. Air X Pump ______ Bailer ______

B. Static Water Level before: ______ FT

If flowing closed in pressure ______ PSI ______ GPM

Controlled by:

C. Depth of Pump for Test 48 FT

D. Pumping Rate & Discharge 8 GPM

E. Maximum Drawdown for test ______ FT

F. Duration of test:

Pumping time: 2 HRS.

Recovery Time: 2 HRS.

G. Recovery Water Level 48 FT

Time after pumping recovery water data was taken 1 HRS.

9. WELL PLUGGED OR ABANDONED? NO

If yes, how?

10. DATE COMPLETED 6/13/94

MONTANA DEPARTMENT OF NATURAL RESOURCES
1520 East 6th Ave Helena, MT 59620-2301 406-444-6610

RECEIVED
AUG 21 1996
DNRC

WELL LOG REPORT

1.WELL OWNER
Name WALSH, KEITH

2.CURRENT MAILING ADDRESS
2011 BANKS
BUTTE, MT 59701

3. WELL LOCATION ASPEN HILLS
County DEER LODGE
Township 4 N Rang 11 W
1/4 NE 1/4 SECTION 27
Lot 15 Block
Subdivision
Tract Number AH-15 SURVEY 86-B

4. PROPOSED USE
Domestic X
Irrigation Stock
Other:

5. DRILLING METHOD
Cable
Rotary: X Air FWD Reverse
Jetted Other:

6. WELL LOG

From	To	Formation
0	80	BOULDERS
80	160	SILT & DECOMPOSED
160	240	DECOMPOSED

7. WELL CONSTRUCTION

Hole Size	Casing Size	From Feet	To Feet
6"	Steel 6 5/8" X .250	+1 1/2	57
4"	PVC	10	240

COMPLETIONS
perforations screen

Kind	From feet	To feet
Skill Saw		

Was casing left open? YES
Was a packer/seal used? NO
Well gravel packed? NO
To What depth Well grouted? 20 FT
Grouting Material: Bentonite/ Hole Plug
Well head completion :
Pitless adapter NO
Top of casing 18" or greater above grade YES

8. WELL TEST DATA
All wells under 100 GPM must be tested for a minimum of one hour and provide:

A. Air X Pump Bailer
B. Static Water Level before: 56 FT
If flowing closed in pressure
PSI GPM
Controlled by:
C. Depth of Pump for Test 238 FT
D. Pumping Rate & Discharge 12 GPM
E. Maximum Drawdown for test FT
F. Duration of test:
Pumping time: 1.5 HRS.
Recovery Time: 0.25 HRS.
G. Recovery Water Level 56 FT
Time after pumping recovery water data was taken 1 HRS.

9. WELL PLUGGED OR ABANDONED? NO
If yes, how?

10. DATE COMPLETED 01/10/96

11. DRILLER/CONTRACTOR'S CERTIFICATION
This well was drilled under my
jurisdiction and this report is
true to the best of my knowledge.
Date: 1/10/96

O'Keefe Drilling Company
P.O. Box 3810 2000 Four Mile Road
Butte, MT 59702

Dan O'Keefe 462
Signature License No.
Dan O'Keefe

MONTANA DEPARTMENT OF NATURAL RESOURCES
1520 East 6th Ave Helena, MT 59620-2301 406-444-6610

766-C095698-CC

WELL LOG REPORT

1. WELL OWNER
Name KINNEY, GREGG and Kathryn Wright

2. CURRENT MAILING ADDRESS
P.O. BOX 778
ANACONDA, MT 59711

3. WELL LOCATION MILL CREEK
County Deer Lodge
Township 4 [✓ N]/S Range 11 E/[✓ W]
NW 1/4 NW 1/4 SECTION 27
Lot 19 Block
Subdivision Aspen Hills
Tract Number

4. PROPOSED USE Domestic X
Irrigation Stock
Other:

5. DRILLING METHOD Cable
Rotary: X Air FWD Reverse
Jetted Other:

6. WELL LOG

From	To	Formation
0	100	BOULDERS, SAND & GRAVEL
100	140	SAND
140	360	GRANITE

11. DRILLER/CONTRACTOR'S CERTIFICATION
This well was drilled under my jurisdiction and this report is true to the best of my knowledge.
Date: 5/31/96

O'Keefe Drilling Company
P O. Box 3810 2000 Four Mile Road
Butte, MT 59702

Dan O Keefe 482
Signature License No.
Dan O'Keefe

7. WELL CONSTRUCTION

Hole Size	Casing Size	From Feet	To Feet
6"	Steel 6 5/8" X .250	+1 1/2	100
4"	PVC	40	360

COMPLETIONS
perforations ________ screen ________

Kind	From feet	To feet
Skill Saw	320	360

Was casing left open? YES
Was a packer/seal used? NO
Well gravel packed? NO
To What depth Well grouted? 20 FT
Grouting Material: Bentonite/ Hole Plug
Well head completion :
Pitless adapter NO
Top of casing 18" or greater above grade YES

8. WELL TES ATA
All wells un) GPM must be tested for a minimum of one hour and provide:

A. Air X Pump ____ Bailer ____
B. Static Water Level before: ____ FT
If flowing closed in pressure
____ PSI ____ GPM
Controlled by:
C. Depth of Pump for Test 358 FT
D. Pumping Rate & Discharge 2 GPM
E. Maximum Drawdown for test ____ FT
F. Duration of test:
Pumping time: 1.5 HRS.
Recovery Time: 0.5 HRS.
G. Recovery Water Level ____ FT
Time after pumping recovery water data was taken 1 HRS.

9. WELL PLUGGED OR ABANDONED? NO
If yes, how?

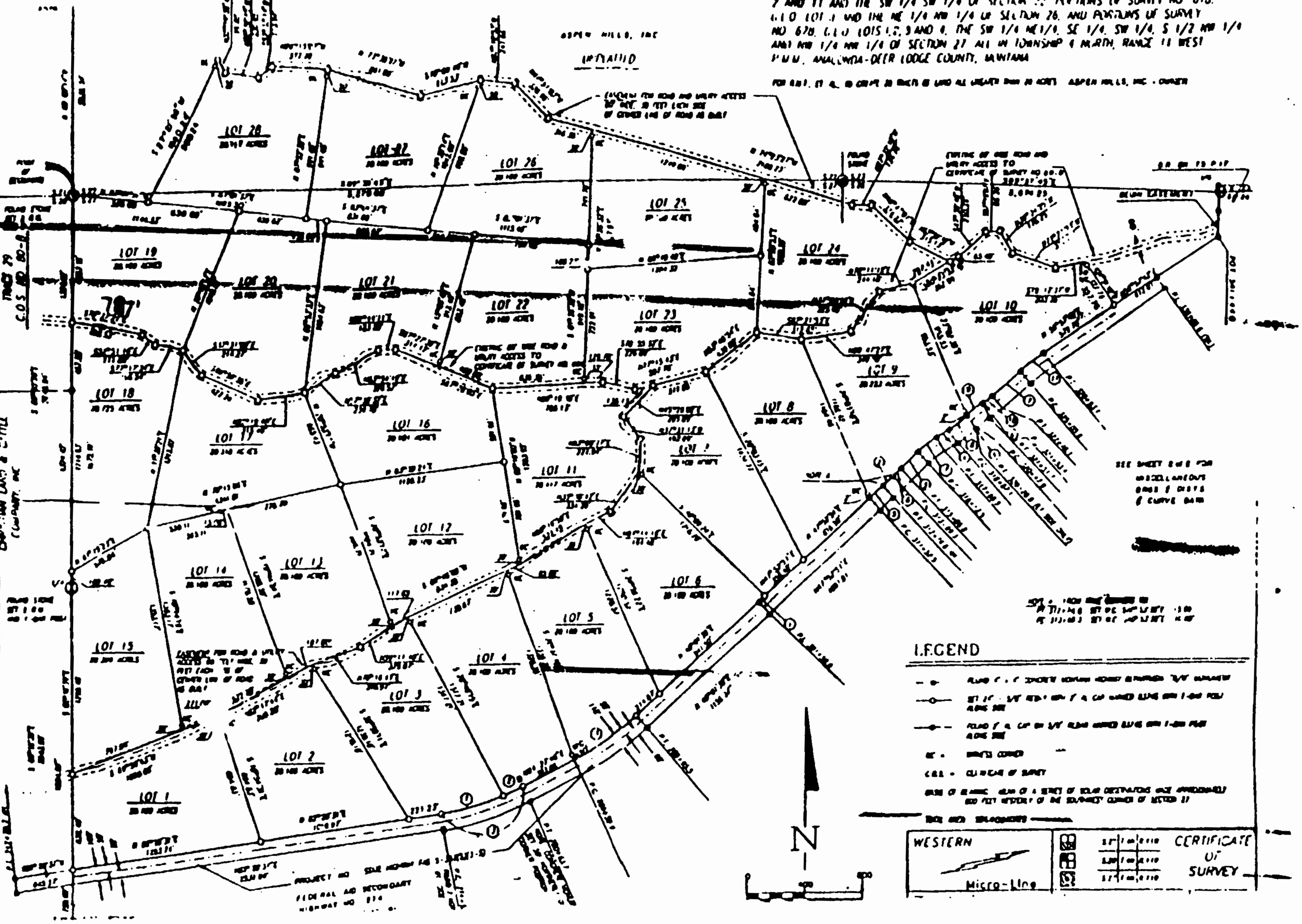
10. DATE COMPLETED 5/31/96

MONTANA DEPARTMENT OF NATURAL RESOURCES
1520 East 6th Ave Helena, MT 59620-2301 406-444-6610

766-0095698-CC
T4N R11W Sec. 27

28 TRACTS OF LAND, BEING LOCATED IN PORTIONS OF SURVEY NO. 573, G.L.O. LOTS 2 AND 11 AND THE SW 1/4 SW 1/4 OF SECTION 22, PORTIONS OF SURVEY NO. 678, G.L.O. LOT 1 AND THE NE 1/4 NW 1/4 OF SECTION 26, AND PORTIONS OF SURVEY NO. 678, G.L.O. LOTS 1, 2, 3 AND 4, THE SW 1/4 NE 1/4, SE 1/4, SW 1/4, S 1/2 NW 1/4 AND NW 1/4 NW 1/4 OF SECTION 27 ALL IN TOWNSHIP 4 NORTH, RANGE 11 WEST P.M.M., ANACONDA-DEER LODGE COUNTY, MONTANA

FOR [illegible] ASPEN HILLS, INC. - OWNER



LEGEND

[illegible]

C.O.S. - CERTIFICATE OF SURVEY

WESTERN Micro-Line

CERTIFICATE OF SURVEY

Owner 41I-[illegible]

Domestic Water Wells
Large Irrigation Wells
Pumps - Sales & Service
Monitor Holes
Mineral Exploration

WELL LOG REPORT

LINDSAY & SON DRILLING

(406) 933 5511
Box 67
Clancy, Montana 596[illegible]

1. WELL OWNER:
James R. Luman

2. CURRENT MAILING ADDRESS:
25935 Dry Pond Rd.

Clovis, California 93611-9628

3. WELL LOCATION:
NWNW ~~NE~~ 1/4 ~~SW~~ NW 1/4 SECTION: 28
TOWNSHIP: 4N RANGE: 11W
COUNTY: Deerlodge

4. PROPOSED USE: Domestic

5. DRILLING METHOD: Air Rotary

6. WELL LOG CONSTRUCTION:
PERFORATIONS: 90 - 100
SCREEN: none
GROUT: Bentonite
GROUT DEPTH: 20 ft.

7. WELL TEST DATA:
A) TESTING MEANS: Air
B) STATIC LEVEL: 30
C) DEPTH OF TEST: 97
D) GPM: 30+
E) MAXIMUM DRAWDOWN: 95
F) PUMPING TIME: 2 hours
G) RECOVERY WATER LEVEL: 30
H) RECOVERY TIME: 2 hours

8. WELL LOG FORMATION:

0 - 4	Topsoil & cobbles
4 - 50	Boulders & gravel
50 - 85	Broken rock & gravel
85 - 90	Decomposed granite
90 - 100	Granite bedrock

HOLE SIZE	CASING SIZE	FROM - TO
6	6	+2 - 93
6	4 5/8	80 - 100

9. WAS WELL ABANDONED? No

10. DATE COMPLETED: 94/09/26

Lindsay Drilling—
Celebrating 45 years in business!!

DRILLER/CONTRACTOR CERTIFICATION.
THIS WELL WAS DRILLED UNDER MY JURISDICTION
THIS REPORT IS TRUE TO THE BEST OF MY KNOWLEDGE

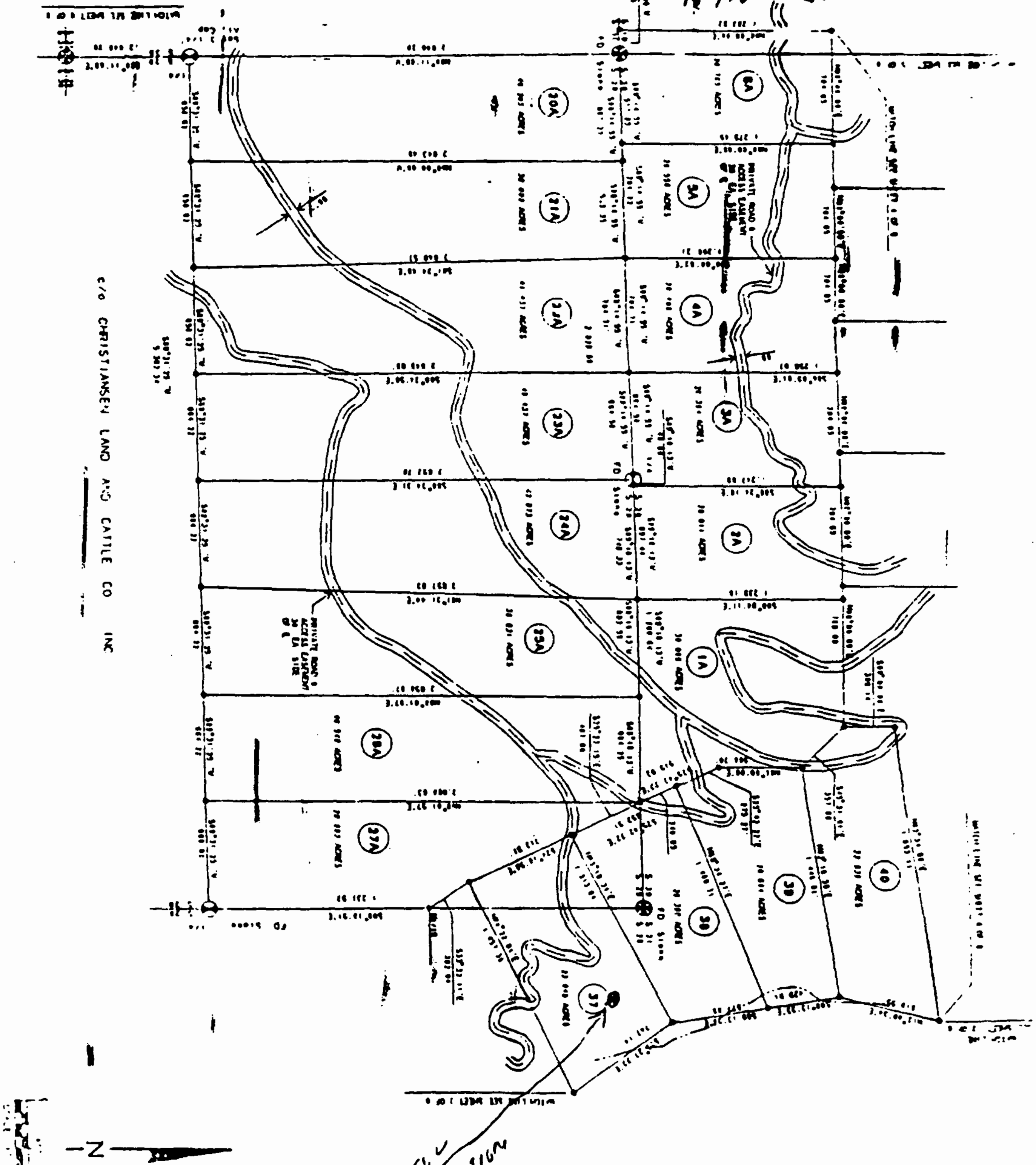
Terry Lindsay
Signed License # 25[illegible]
LINDSAY DRILLING INC.

DATE: 94/09/26

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION
1520 E[illegible] Helena, M[illegible]

CERTIFICATE OF SURVEY NO. ______

4II-C 091654-00
T4N R11W



WELL LOCATION

LOT # 37

WESTERN Micro-Line	CERTIFICATE OF SURVEY
	3 of 6

FIELD SAMPLE DATA SHEET

Page 9 of ____

PROJECT NAME: ARWW-TI

PROJECT NUMBER: 829-7031-0100-8200

WELL/STATION Martin (Aspen Hills) DATE 7-15-92 ARRIVAL TIME 1410

SAMPLING PERSONNEL JP/JM WEATHER CONDITIONS Sunny, warm ≈85°F

SKETCH ON BACK: Yes___ No ✓ PHOTOGRAPHS: Yes___ No ✓ ROLL#____ EXPOSURE#____

PURGE DATA:

PURGE METHOD Grundfos Redi-flo II

START PURGING 1428

PURGE RATE 5 [✓ GPM] LPM

RATE CHANGE 1)Time 1548 Rate <2gpm

2)Time____ Rate____

SAMPLE TIME 1549

WELL DEPTH 184.00 Feet

DEPTH TO WATER 16.58 Feet

COLUMN HEAD 167.42 Feet

CASING DIAMETER 4 Inch

3 WELL VOLUMES 328 Gal.

TOTAL PURGE VOLUME ____ Gal.

SAMPLE DATA:

SAMPLE ID	SAMPLE #	TAG #	VOLUME	CHECK IF FILTERED	PRES.	ANALYSIS REQUESTED
Martin-01	GW-0054	00108	500 mL	✓	HNO_3	Diss. As. Ca. Fe. K. Mg. Mn. Na. Sb
Martin-02	"	00109	500 mL		NONE	HCO_3, Cl. SO_4, TDS

TIME	TEMP (°C)	pH	SC (mmhos/cm @ 25°C)	EH (MV)	DO (mg/L)
1442	7.83	8.09	0.303	-116	1.59
1456	7.92	8.01	0.295	-126	1.76
1510	7.81	7.51	0.272	-64	2.70
1534	7.56	7.14	0.189	10	3.39
1548	7.58	7.09	0.187	9	3.44
****************** FINAL FIELD PARAMETERS PRIOR TO SAMPLING ******************					
1548	7.58	7.09	0.187	9	3.44

FIELD EQUIPMENT Q/A AND CALIBRATION: Recorded in field logbook

FIELD REMARKS: Pump set @ 40'

FIELD SAMPLE DATA SHEET

Page 8 of ____

PROJECT NAME: ARWW-TI
PROJECT NUMBER: 829-7031-0100-8200

WELL/STATION Lost Creek Fire Dept DATE 7-15-97 ARRIVAL TIME 1000
SAMPLING PERSONNEL AP JSM WEATHER CONDITIONS Sunny, warm 75°F
SKETCH ON BACK: Yes__ No ✓ PHOTOGRAPHS: Yes__ No ✓ ROLL#____ EXPOSURE#____

PURGE DATA:

PURGE METHOD Grunfos Redi Flo II
WELL DEPTH 64.95 Feet
START PURGING 1011
DEPTH TO WATER 19.08 Feet
PURGE RATE 5 [✓ GPM] LPM
COLUMN HEAD 45.87 Feet
RATE CHANGE 1)Time 1056 Rate <2gpm
2)Time____ Rate____
CASING DIAMETER 6 Inch
3 WELL VOLUMES 202.14 Gal.
SAMPLE TIME 1057
TOTAL PURGE VOLUME 230 Gal.

SAMPLE DATA:

SAMPLE ID	SAMPLE #	TAG #	VOLUME	CHECK IF FILTERED	PRES.	ANALYSIS REQUESTED
LCFD-01	GW-0052	00104	500 mL	✓	HNO_3	Diss. As, Ca, Fe, K, Mg, Mn, Na, Sb
LCFD-02	"	00105	500 mL		NONE	HCO_3, Cl, SO_4, TDS

TIME	TEMP (°C)	pH	SC (mmhos/cm @ 25°C)	EH (MV)	DO (mg/L)
1020	8.41	7.53	0.274	-103	4.43
1029	8.18	7.51	0.282	30	7.94
1038	8.17	7.53	0.283	49	8.25
1047	8.15	7.54	0.283	63	8.38
1056	8.15	7.55	0.283	69	8.42
****************** FINAL FIELD PARAMETERS PRIOR TO SAMPLING ******************					
1056	8.15	7.55	0.283	69	8.42

FIELD EQUIPMENT Q/A AND CALIBRATION: Recorded in field logbook

FIELD REMARKS: 6" steel well Pump set @ 36'

QST - ARWWS - Joe Griffin
Dissolved Metals
BIF No.: 002885
Results in ug/L

SAMPLE ID	FIELD ID	Sb	As	Ca	Fe	Mg	Mn	K	Na
IDL		2.3	1.4	10.1	24.2	6.0	3.5	14.6	7.2
W020546	GW0060	2.3 U	1.4 U	37000	24.2 U	9580	6.9 B	416 B	33800

Review

LIENT: QST-ARWWS-JOE GRIFFIN **Report Date: 10/10/97** **Page 1**
IELD ID: GW0060 (Kinney Domestic well)
AB ID: W020546
ATE/TIME SAMPLED: 09/24/97 14:45:0
ATE RECEIVED: 9/30/97
IF: 002885

ENERAL

lkalinity Forms			
	Total	154	mg/L as CaCO3
	Carbonate	< 10.0	mg/L as CaCO3
	Bicarbonate	154	mg/L as CaCO3
	Hydroxide	< 10.0	mg/L as CaCO3
hloride		< 5	mg/L
Solids Dissolved (TDS)		212	mg/L
Sulfate		58	mg/L

FROM: Joe Griffin
FAX 443-1933
TO: Chris Corrigan

B.K.H.
Review

(96) 9-24-97

QST: Gary Pierce
Mark Peterson

WTX: Mostly sunny ≈70°F, breezy

Greg Kinney: Domestic Well

TIME	Sample#	Tag#	Pres
1415	GW0060	00118	HNO_3
1415	GW0060	00119	None

Field Parameters:
Temp = 15.3°C
S.C. = 0.332 ms/cm
pH = 7.32
Eh = 211mV
D.O. = Na

Greg wanted additional analysis for well because of CERCLA requirements.

MP 9-24-97

As, Ba, Cd, Chr, Cu, Pb, Hg, Nitrate, Coliform (97)

Ship Results to this address.
6974 Weber Rd
Saline, MI 48176

Purged well for from spigot next to well. Ran water until pump turned on. Water clear & cool.

Calibrated Hydrolab as follows:

pH used 7.00 & 10.00 buffer solutions.

std.	initial	final	temp
7.00	6.93	7.02	21.19°C
10.00	10.16	10.05	21.26°C

SC - used 1.413 mS/cm @ 25°C std

1.413	1.427	1.413	25°C

EH - used 231 mV Zobell std @ 25°C

231	237	225	25°C

Field parameters listed on previous page for above well.

MP 9-24-97

Attachment D

Summary of Analytical Results for Seep/Spring Samples Collected in 1991 and 1992 at the ARWW OU

Station	East (feet)	North (feet)	Date	Basis	Arsenic (ug/L)	Q	Cadmium (ug/L)	Q	Calcium (ug/L)	Q	Copper (ug/L)	Q	Iron (ug/L)	Q	Lead (ug/L)	Q	Magnesium (ug/L)	Q	Manganese (ug/L)	Q	Potassium (ug/L)	Q	Sodium (ug/L)	Q	Zinc (ug/L)	Q	Bicarbonate (mg/L)	Q	Chloride (mg/L)	Q	Fluoride (mg/L)	Q	Sulfate (mg/L)	Q	TDS (mg/L)	Q	pH (SU)	Q	Eh (mv)	Q	Conductivity (mmho/cm)	Q	Aquifer
SH-1	1132040 0	788622 0	29-Oct-92	DIS	394 0		3 8	U	55500 0		19 0		6 8	U	0 8		12500 0		3 1	U	2170 0		57000 0		5 7	U	182 0		8 0		0 5	U	122 0		427 0		6 8		1010 0		0 533		Tv
SH-1	1132040 0	788622 0	29-Oct-92	WET	389 0		3 8	U	51300 0		34 0		65 0		2 7		12200 0		3 1	U	2480 0		81800 0		38 0		182 0		8 0		0 5	U	122 0		427 0		6 8		101 0		0 533		Tv
SH-2	1132821 0	787881 0	30-Oct-92	DIS	817 0		3 8		54500 0		149 0		10 0		1 2		14200 0		3 1	U	4200 0		81800 0		18 0		234 0		11 0		0 5	U	119 0		471 0		6 9		103 0		0 570		Tv
SH-2	1132821 0	787881 0	30-Oct-92	WET	805 0		4 0	U	51400 0		182 0		85 0		2 4		14100 0		3 1	U	4500 0		87700 0		134 0		234 0		11 0		0 5	U	119 0		471 0		6 8		103 0		0 570		Tv
SH-3	1133654 0	788428 0	30-Oct-92	DIS	38 3		4 0		33800 0		81 0		6 8	U	0 9		55300 0		185 0		12400 0		102000 0		48 0		257 0		8 0		1 8		887 0		1740 0		7 4		110 0		1 800		Tv
SH-3	1133654 0	788428 0	30-Oct-92	WET	58 8		3 8	U	32100 0		147 0		378 0		13 1		55800 0		211 0		13700 0		114000 0		483 0		257 0		8 0		1 8		887 0		1740 0		7 4		110 0		1 800		Tv
SH-4	1132528 0	784280 0	30-Oct-92	DIS	1450 0		3 8	U	44500 0		7 0		6 8	U	0 8		10100 0		5 0		2400 0		82800 0		5 7	U	141 0		12 0		0 8		148 0		638 0		7 1		103 0		0 533		Tv
SH-4	1132528 0	784280 0	30-Oct-92	WET	1480 0		3 8	U	43800 0		20 0		157 0		2 4		10800 0		8 0		2980 0		71800 0		28 0		141 0		12 0		0 8		148 0		638 0		7 1		103 0		0 533		Tv
SH-5	1136788 0	781848 0	30-Oct-92	DIS	15 2		3 8	U	433000 0		3 1	U	50 0		0 7		83100 0		3 1	U	15400 0		128000 0		20 0		288 0		12 0		2 2		831 0		2170 0		7 0		122 0		2 080		Tv
SH-5	1136788 0	781848 0	30-Oct-92	WET	18 2		3 8	U	388000 0		18 0		213 0		7 8		81000 0		8 0		18000 0		134000 0		45 0		288 0		12 0		2 2		831 0		2170 0		7 0		122 0		2 080		Tv
SHSS-1			22-Oct-92	DIS	4 3		3 8		488000 0		3 1	U	42 0		5 5		87700 0		144 0		18900 0		148000 0		33 0		328 0		8 0		2 7		1340 0		2450 0		6 8		148 0		1 000		geothermal
SHSS-1			22-Oct-92	WET	13 8		3 8		500000 0		8 0		1150 0		6 8		88800 0		148 0		16500 0		140000 0		24 0		328 0		8 0		2 7		1340 0		2450 0		6 8		148 0		1 000		geothermal
SHSN-1			22-Oct-92	DIS	5 1		3 8		478000 0		3 1	U	37 0		2 8		85800 0		183 0		17700 0		143000 0		28 0		331 0		8 0		2 8		1290 0		2440 0		6 7		130 0		1 000		geothermal
SHSN-1			22-Oct-92	WET	18 7		3 8		474000 0		4 0		2500 0		7 1		82100 0		187 0		15800 0		131000 0		18 0		331 0		8 0		2 8		1290 0		2440 0		6 7		130 0		1 000		geothermal
SP-1	1131081	798752	Jul-91	WET	84 2		2	U	113000 0		836 0		4540 0		33 7		15300 0		32 5		2090 0		71200 0		133 0		130 0		88 2		0 71		289 0		659 0		7 8		184 0		0 747		Tv
SP-1	1131081	798752	Jul-91	DIS	10 8		2	U	113000 0		7 8		12 0	U	1 0	U	15700 0		1 0	U	1110 0		78100 0		2 0	U	130 0		88 2		0 71		289 0		659 0		7 8		184 0		0 747		Tv
SP-2	1129579	800148	Jul-91	WET	81 4		2	U	101000 0		98 0		1280 0		3 4		22200 0		32 5		3110 0		100000 0		31 5		148 0		84 8				308 0		770 0		8 0		138 0		1 084		Tv
SP-2	1129579	800148	Jul-91	DIS	83 8		2	U	105000 0		14 5		12 0	U	1 0	U	23000 0		2 0		2970 0		105000 0		2 0	U	148 0		84 8				308 0		770 0		8 0		138 0		1 084		Tv
SP-3	1134402 0	799938 0	Jul-91	WET	97 8		2	U	102000 0		98 1		1710 0		3 3		17800 0		34 1		4580 0		81100 0		24 0		241 0		47 8				240 0		873 0		8 2		188 0				Tv
SP-3	1134402 0	799938 0	Jul-91	DIS	88 0		2	U	108000 0		33 3		12 0	U	1 0	U	18100 0		3 0		4110 0		88400 0		2 0	U	241 0		47 8				240 0		873 0		8 2		188 0				Tv
OWS-1	1129470 0	798389 0	29-Oct-92	DIS	18 2		3 8	U	113000 0		19 0		15 0		0 7	U	14100 0		3 1	U	1340 0		68100 0		11 0		130 0		89 0		0 5	U	182 0		703 0		7 1		129 0		0 858		Tv
OWS-1	1129470 0	798389 0	29-Oct-92	WET	18 6		3 8	U	108000 0		42 0		90 0		2 8		14300 0		3 1	U	1700 0		75700 0		80 0		130 0		89 0		0 5	U	182 0		703 0		7 1		129 0		0 858		Tv
OWS-2	1134402 0	799938 0	29-Oct-92	DIS	40 5		3 8	U	145000 0		28 0		22 0		0 7	U	28700 0		473 0		2900 0		132000 0		31 0		320 0		80 0		0 5	U	311 0		882 0		6 6		183 0		1 234		Tv
OWS-2	1134402 0	799938 0	29-Oct-92	WET	38 8		3 8	U	137000 0		30 0		484 0		1 5		28400 0		502 0		3310 0		144000 0		37 0		320 0		80 0		0 5	U	311 0		882 0		6 8		183 0		1 234		Tv
OWS-4	1134318 0	798384 0	29-Oct-92	DIS	12 2		3 8	U	29400 0		18 0	U	42 0	U	2 5	U	22800 0		3 1	U	3100 0		108000 0		8 0	U	203 0		6 0		3 8		153 0		502 0		8 0		107 0		0 645		Tv
OWS-4			29-Oct-92	WET	8 0		3 8	U	31100 0		173 0		1080 0		11 5	U	22800 0		28 0	U	2820 0		100000 0		69 0	J	203 0		6 0		3 8		153 0		502 0		8 0		107 0		0 645		Tv

Summary of Analytical Results of Seep/Springs Samples Collected at the ARWWS OU

Station	East (feet)	North (feet)	Date	Basis	Arsenic (ug/L)	Q	Cadmium (ug/L)	Q	Calcium (ug/L)	Q	Copper (ug/L)	Q	Iron (ug/L)	Q	Lead (ug/L)	Q	Magnesium (ug/L)	Q	Manganese (ug/L)	Q	Potassium (ug/L)	Q	Sodium (ug/L)	Q	Zinc (ug/L)	Q	Bicarbonate (mg/L)	Q	Chloride (mg/L)	Q	Fluoride (mg/L)	Q	Sulfate (mg/L)	Q	TDS (mg/L)	Q	pH (SU)	Q	Eh (mv)	Q	Conductivity (mmho/cm)	Q	Aquifer
SS-T-01	1147274 0	773341 0	14-Aug-95	WET	35 0																												35 0										
SS-T-02	1150387 0	772690 0	14-Aug-95	WET	34 0																												68 0										
SS-T-03	1122829 0	808129 0	02-Aug-95	WET	4 0		0 1	U																									30 0				7 7		188 0		0 317		Tw/Kc
SS-T-04	1124474 0	806478 0	18-Aug-95	WET	7 0		0 1	U																									141 0				7 4		31 0		0 788		Tw
SS-T-07	1127224 0	784077 0	15-Aug-95	WET	172 0																												172 0										
SS-T-08	1123393 0	782815 0	04-Aug-95	WET	22 0																												22 0										
SS-T-09	1122183 0	780834 0	04-Aug-95	WET	23 0																												23 0										
SS T 10	1117336 0	770948 0	15-Aug-95	WET	5 0																												5 0										
SS T-13	1131720 0	774285 0	01-Aug-95	WET	129 0																												129 0										
SS-T-14	1128583 0	804160 0	18-Aug-95	WET	104 0		0 1	U																									348 0				7 8		28 0		1 36		Tw
SS-T 15	1124805 0	808544 0	18-Aug-95	WET	25 0		0 1	U																									297 0				7 6		118 0		1 187		Tw
SS-T-16	1130920 0	802477 0	19-Sep-95	WET	39 0		1 3																										472 0				8 7		234 0		1 108		Tw
SS-T-17	1155079 0	780877 0	18-Oct-95	WET	38 0																																						
SS T-18	1155100 0	782125 0	18-Oct-95	WET	32 0																																						
SS-T-19			07-Oct-98	DIS	57 0																																						
SS T-20			07 Oct-98	DIS	94 0																																						
SS-T-21			07 Oct 98	DIS	61 0																																						
SS T 22			07 Oct-98	DIS	52 0																																						
SS-T-23			07 Oct 98	DIS	54 0																																						
SS-T-24			07-Oct-98	DIS	48 0																																						
SS-T 25			08-Oct-98	DIS	210 0																																						
SS T 26			08-Oct 98	DIS	36 0																																						
SS-T-27			08 Oct 98	DIS	76 0																																						
SS-T-28			09-Oct-98	DIS	1 0	U																																			0 85		Tg
SS-T-29			09-Oct-98	DIS																																							

Summary of Analytical Re[redacted]ep/Springs Samples Collected at the ARWWS OU

Station	East (feet)	North (feet)	Date	Basis	Arsenic (ug/L)	Q	Cadmium (ug/L)	Q	Calcium (ug/L)	Q	Copper	Q	Iron (ug/L)	Q	Lead (ug/L)	Q	Magnesium (ug/L)	Q	Manganese (ug/L)	Q	Potassium (ug/L)	Q	Sodium (ug/L)	Q	Zinc (ug/L)	Q	Bicarbonate (mg/L)	Q	Chloride (mg/L)	Q	Fluoride (mg/L)	Q	Sulfate (mg/L)	Q	TDS (mg/L)	Q	pH (SU)	Q	Eh (mv)	Q	Conductivity (mmho/cm)	Q	Aquifer
SP97-1	1119951	804512 5	10-May-97	DIS	40 7				54000				8 8	U			7130		3	U	979		7800																	
SP97-2	1118091	805505 3	10-May-97	DIS	42 9				24400				188				5180		13 1		1840		6770																	
SP97-3	1118267	808611 5	10-May-97	DIS	13 4				94200				8 4				22400		11 2		2030		29200																	
SP97-4	1118578	811974 1	10-May-97	DIS	17 3				8030				78 2				1430		3 7		891		1780																	
SP97 5	1121927	810912 6	19-May-97	DIS	18 2				7910				40 6				898		3	U	1500		1830																	
SP97-6	1116389	813788 4	19-May-97	DIS	2 5				14700				8 8	U			2480		3	U	1020		4810																	
SP97-7	1115185	808672 8	20-May-97	DIS	8 7				368000				147[illegible]				8200		25 3		1200		14700																	
SP97-8	1116621	809015 4	20-May-97	DIS	18 8				101000				27 6				16000		107		3620		21800																	
SP97 9	1132312	783805 7	21-May-97	DIS	1990				45700				18 4				11100		3	U	2270		55800																	
SP97-10	1127842	782082 9	21-May-97	DIS	277				84800				8 8	U			32700		3	U	4850		15800																	
SP97-11	1128600	781428 9	21-May-97	DIS	808				53500				8 8	U			21200		3	U	2220		28400																	
SP97 12	1129467	781480 6	21-May-97	DIS	482				82200				8 8	U			23300		3	U	1880		34500																	
SP97-13	1126253	778792 4	22 May 97	DIS	37 4				74500				8 8	U			19200		3	U	1940		14300																	
SP97 14	1117745	782908 3	22 May-97	DIS	3 8				9170				101				1850		3	U	900		4940																	
SP97-15	1118328	784189 6	22-May-97	DIS	5 7				4870				30 7				1240		8 3		873		2950																	
SP97 16	1117814	783422 2	22-May-97	DIS	1 1	U			6330				227				1280		3	U	810		3440																	
SP97-17	1118185	769798 2	23-May-97	DIS	112				7310				852				911		7 2		1270		3860																	
SP97-18	1115727	789210 4	23-May-97	DIS	87 4				5350				371				942		3	U	883		2820																	
SP97-19	1127718	781803	23-May-97	DIS	[illegible] 2.5				78600				12 2				41200		3	U	2780		20500																	
SP97-20	1127882	802149 5	09-Jun-97	DIS	85 4				98800				8 8	U			21000		80 8		5480		3930																	
SP97-21	1120843	778211 3	10-Jun-97	DIS	147				8860				187				2670		3	U	1320		3800																	
SP97-22	1138302	775015 8	10-Jun 97	DIS	223				42800				288				17800		572		2720		21400																	
SP97 23	1138863	774485 1	10-Jun-97	DIS	42 3				42800				38 6				9010		3	U	1510		16600																	
SP97-24	1129413	778452 2	24-Jun 97	DIS	269				73100				28				32900		18		3370		10800																	
SP97 25	1129582	778953 9	24-Jun-97	DIS	710				59200				37 6				18200		4 3		2210		54300																	
SP97 26	1137381	770510	26-Jun-97	DIS	80 4				45400				75 1				15800		8 6		3540		51100																	
SP97-27	1135885	786418 7	26-Jun-97	DIS	34 8				40100				31 8				5720		4 3		1490		6180																	
SP97 28	1135480	783595 9	26-Jun-97	DIS	50 8				8000				884				748		7 7		2090		18500																	
SP97-29	1138591	785491 8	26-Jun-97	DIS	280				25400				182				477		10 3		1240		74400																	
SP97-30	1140930	789140 5	26-Jun-97	DIS	3 8				22700				139				4540		183		3520		4700																	
SP97 31	1138908	771153 1	26-Jun-97	DIS	74 8				38200				48 1				17100		5 1		2250		14500																	
SP97 32	1125033	770530 1	08-Jul-97	DIS	73 1				31200				38 7				8620		4 4		1100		12100																	
SP97 33	1124738	768411 1	09-Jul-97	DIS	[illegible] 189				17600				74 5				2730		30 1		872		25900																	
SP97-34	1122471	758271 3	09 Jul 97	DIS	42 9				1590				107				198		3	U	998		3480																	
SP97-35	1124930	762828 7	09-Jul 97	DIS	29 3				10400				28 8				875		3 5		447		4590																	
SP97-36	1122548	781815 5	09-Jul 97	DIS	32 3				1890				71 5				229		3 5		588		5740																	
SP97-37	1120818	783012 7	09-Jul-97	DIS	17 4				8470				71 5				451		8		686		8810																	
SP97-38	1119985	782835 8	09-Jul 97	DIS	42 7				5440				3 8				280		8 2		544		3450																	
SP97-39	1115307	765980 4	10-Jul 97	DIS	45 9				3400				175				875		31 6		593		14000																	
SP97 40	1118103	781808 1	10-Jul 97	DIS	20 1				7840				155				508		4 4		337		10500																	
SS-T 30			20-May-97	DIS	245																																				Tv
SS T 31			20-May-97	DIS	324																																				Tv
SS T 32			20 May-97	DIS	146																																				Tv
SS T 33			20-May-97	DIS	708																																				Tv
SS T 34			20-May 97	DIS	777																																				Tv

gw\wssp wk3

Water Quality Data for Bedrock Wells in the Smelter Hill Subarea

Station	East (feet)	North (feet)	Date	Frep Basis	Arsenic (ug/L)
A1-BR2	1134820.0	787444.0	19-Sep-91	WET	4770.0
A1-BR2	1134820.0	787444.0	19-Sep-91	WET	4770.0
A1-BR2	1134820.0	787444.0	19-Sep-91	WET	4580.0
A1-BR2	1134820.0	787444.0	19-Sep-91	DIS	5080.0
A1-BR2	1134820.0	787444.0	19-Sep-91	DIS	5080.0
A1-BR2	1134820.0	787444.0	19-Sep-91	WET	4610.0
A1-BR2	1134820.0	787444.0	19-Sep-91	DIS	5150.0
A1-BR2	1134820.0	787444.0	19-Sep-91	DIS	5150.0
A1-BR2	1134820.0	787444.0	20-Feb-92	DIS	5190.0
A1-BR2	1134820.0	787444.0	20-Feb-92	WET	5380.0
A1-BR2	1134820.0	787444.0	20-Feb-92	DIS	5190.0
A1-BR2	1134820.0	787444.0	20-Feb-92	WET	5380.0
A1-BR2	1134820.0	787444.0	03-Jun-92	WET	4600.0
A1-BR2	1134820.0	787444.0	03-Jun-92	DIS	5020.0
A1-BR2	1134820.0	787444.0	02-Sep-92	WET	4240.0
A1-BR2	1134820.0	787444.0	02-Sep-92	DIS	4450.0
A1-BR2	1134820.0	787444.0	25-Nov-92	WET	4470.0
A1-BR2	1134820.0	787444.0	25-Nov-92	DIS	4780.0
A1-BR2	1134820.0	787444.0	02-Feb-93	DIS	5080.0
A1-BR2	1134820.0	787444.0	02-Feb-93	WET	4890.0
A1-BR2	1134820.0	787444.0	19-May-93	WET	8010.0
A1-BR2	1134820.0	787444.0	19-May-93	DIS	8470.0
A1-BR2	1134820.0	787444.0	23-Jul-93	WET	7220.0
A1-BR2	1134820.0	787444.0	23-Jul-93	DIS	7140.0
A1-BR3	1134824.0	787434.0	03-Jun-92	WET	22.1
A1-BR3	1134824.0	787434.0	03-Jun-92	DIS	24.5
A1-BR3	1134824.0	787434.0	02-Sep-92	DIS	18.1
A1-BR3	1134824.0	787434.0	02-Sep-92	WET	20.0

Water Quality Data for Bedrock Wells in the Smelter Hill Subarea

A1-BR3	1134824.0	787434.0	25-Nov-92	DIS	14.3
A1-BR3	1134824.0	787434.0	25-Nov-92	WET	12.9
A1-BR3	1134824.0	787434.0	02-Feb-93	DIS	15.6
A1-BR3	1134824.0	787434.0	02-Feb-93 1	WET	13.2
A1-BR3	1134824.0	787434.0	02-Feb-93	WET	13.3
A1-BR3	1134824.0	787434.0	02-Feb-93 1	DIS	15.9
A1-BR3	1134824.0	787434.0	19-May-93	DIS	15.6
A1-BR3	1134824.0	787434.0	19-May-93	WET	16.5
A1-BR3	1134824.0	787434.0	22-Jul-93	WET	28.9
A1-BR3	1134824.0	787434.0	22-Jul-93	DIS	33.4

A2-BR	1133432.0	791894.0	16-Sep-91	WET	908.0
A2-BR	1133432.0	791894.0	16-Sep-91	DIS	854.0
A2-BR	1133432.0	791894.0	16-Sep-91	DIS	854.0
A2-BR	1133432.0	791894.0	16-Sep-91	WET	908.0
A2-BR	1133432.0	791894.0	18-Feb-92	WET	958.0
A2-BR	1133432.0	791894.0	18-Feb-92	DIS	979.0
A2-BR	1133432.0	791894.0	18-Feb-92	DIS	979.0
A2-BR	1133432.0	791894.0	18-Feb-92	WET	958.0
A2-BR	1133432.0	791894.0	01-Jun-92	WET	1050.0
A2-BR	1133432.0	791894.0	01-Jun-92	DIS	1150.0
A2-BR	1133432.0	791894.0	02-Sep-92	WET	945.0
A2-BR	1133432.0	791894.0	02-Sep-92	DIS	843.0
A2-BR	1133432.0	791894.0	25-Nov-92	DIS	1030.0
A2-BR	1133432.0	791894.0	25-Nov-92	WET	991.0
A2-BR	1133432.0	791894.0	04-Feb-93	WET	1180.0
A2-BR	1133432.0	791894.0	04-Feb-93	DIS	1200.0
A2-BR	1133432.0	791894.0	18-May-93	WET	2350.0
A2-BR	1133432.0	791894.0	18-May-93	DIS	2410.0
A2-BR	1133432.0	791894.0	20-Jul-93	WET	1390.0
A2-BR	1133432.0	791894.0	20-Jul-93	DIS	1340.0

Water Quality Data for Bedrock Wells in the Smelter Hill Subarea

B4-BR	1134537.0	791710.0	16-Sep-91	WET	1100.0
B4-BR	1134537.0	791710.0	16-Sep-91	DIS	1120.0
B4-BR	1134537.0	791710.0	16-Sep-91	DIS	1120.0
B4-BR	1134537.0	791710.0	16-Sep-91	WET	1100.0
B4-BR	1134537.0	791710.0	18-Feb-92	DIS	1330.0
B4-BR	1134537.0	791710.0	18-Feb-92	WET	1260.0
B4-BR	1134537.0	791710.0	18-Feb-92	DIS	1330.0
B4-BR	1134537.0	791710.0	18-Feb-92	WET	1260.0
B4-BR	1134537.0	791710.0	01-Jun-92	DIS	1660.0
B4-BR	1134537.0	791710.0	01-Jun-92	WET	1260.0
B4-BR	1134537.0	791710.0	02-Sep-92	WET	1220.0
B4-BR	1134537.0	791710.0	02-Sep-92	DIS	1210.0
B4-BR	1134537.0	791710.0	25-Nov-92	WET	1170.0
B4-BR	1134537.0	791710.0	25-Nov-92	DIS	1220.0
B4-BR	1134537.0	791710.0	03-Feb-93	WET	1280.0
B4-BR	1134537.0	791710.0	03-Feb-93	DIS	1320.0
B4-BR	1134537.0	791710.0	18-May-93	DIS	1190.0
B4-BR	1134537.0	791710.0	18-May-93	WET	1200.0
B4-BR	1134537.0	791710.0	16-Jul-93	DIS	1130.0
B4-BR	1134537.0	791710.0	16-Jul-93	WET	1170.0

WET = Total Recoverable Metals
DIS = Dissolved Metals

Water Quality Data for Bedrock Wells in the Smelter Hill Subarea

Station	East (feet)	North (feet)	Date	Frep	Basis	Arsenic (ug/L)	Qual
C2-AL	1137332.0	789850.0	02-Oct-91		DIS	2440.0	
C2-AL	1137332.0	789850.0	02-Oct-91		DIS	2440.0	
C2-AL	1137332.0	789850.0	02-Oct-91		WET	2470.0	
C2-AL	1137332.0	789850.0	02-Oct-91		WET	2470.0	
C2-AL	1137332.0	789850.0	19-Feb-92		DIS	2440.0	
C2-AL	1137332.0	789850.0	19-Feb-92		DIS	2440.0	
C2-AL	1137332.0	789850.0	19-Feb-92		WET	2270.0	
C2-AL	1137332.0	789850.0	19-Feb-92		WET	2270.0	
C2-AL	1137332.0	789850.0	02-Jun-92		WET	2110.0	
C2-AL	1137332.0	789850.0	02-Jun-92		DIS	2370.0	
C2-AL	1137332.0	789850.0	02-Sep-92		DIS	2010.0	
C2-AL	1137332.0	789850.0	02-Sep-92	12	DIS	2030.0	
C2-AL	1137332.0	789850.0	02-Sep-92		WET	2060.0	
C2-AL	1137332.0	789850.0	02-Sep-92		DIS	2010.0	
C2-AL	1137332.0	789850.0	02-Sep-92	12	WET	2320.0	
C2-AL	1137332.0	789850.0	02-Sep-92		WET	2060.0	
C2-AL	1137332.0	789850.0	02-Sep-92	12	DIS	2030.0	
C2-AL	1137332.0	789850.0	02-Sep-92	12	WET	2320.0	
C2-AL	1137332.0	789850.0	27-Nov-92		DIS	2120.0	
C2-AL	1137332.0	789850.0	27-Nov-92		WET	2140.0	
C2-AL	1137332.0	789850.0	03-Feb-93		DIS	2380.0	
C2-AL	1137332.0	789850.0	03-Feb-93		WET	2310.0	J
C2-AL	1137332.0	789850.0	18-May-93		WET	2400.0	
C2-AL	1137332.0	789850.0	18-May-93		DIS	2450.0	
C2-AL	1137332.0	789850.0	22-Jul-93		DIS	2240.0	
C2-AL	1137332.0	789850.0	22-Jul-93		WET	2220.0	J
C2-BR	1137338.0	789862.0	02-Jun-92		DIS	1240.0	
C2-BR	1137338.0	789862.0	02-Jun-92		WET	1010.0	

Water Quality Data for Bedrock Wells in the Smelter Hill Subarea

C2-BR	1137338.0	789862.0	02-Sep-92	DIS	1000.0	
C2-BR	1137338.0	789862.0	02-Sep-92	WET	947.0	
C2-BR	1137338.0	789862.0	27-Nov-92	DIS	979.0	
C2-BR	1137338.0	789862.0	27-Nov-92	WET	1040.0	
C2-BR	1137338.0	789862.0	03-Feb-93	DIS	1240.0	
C2-BR	1137338.0	789862.0	03-Feb-93	WET	1130.0	J
C2-BR	1137338.0	789862.0	18-May-93	DIS	1200.0	
C2-BR	1137338.0	789862.0	18-May-93	WET	1170.0	
C2-BR	1137338.0	789862.0	22-Jul-93	WET	1140.0	J
C2-BR	1137338.0	789862.0	22-Jul-93	DIS	1150.0	

F2-BR	1134267.0	779676.0	18-Sep-91	WET	10.6	
F2-BR	1134267.0	779676.0	18-Sep-91	DIS	14.6	
F2-BR	1134267.0	779676.0	18-Sep-91	DIS	14.6	
F2-BR	1134267.0	779676.0	18-Sep-91	WET	10.6	
F2-BR	1134267.0	779676.0	19-Feb-92	DIS	1.0	U
F2-BR	1134267.0	779676.0	19-Feb-92	DIS	1.0	U
F2-BR	1134267.0	779676.0	19-Feb-92	WET	1.6	
F2-BR	1134267.0	779676.0	19-Feb-92	WET	1.6	
F2-BR	1134267.0	779676.0	02-Jun-92	DIS	1.4	J
F2-BR	1134267.0	779676.0	02-Jun-92	WET	1.0	UJ
F2-BR	1134267.0	779676.0	02-Sep-92	WET	0.9	UJ
F2-BR	1134267.0	779676.0	02-Sep-92	DIS	2.9	U
F2-BR	1134267.0	779676.0	19-Nov-92	DIS	1.3	U
F2-BR	1134267.0	779676.0	19-Nov-92	WET	1.3	U
F2-BR	1134267.0	779676.0	11-Feb-93	DIS	3.7	
F2-BR	1134267.0	779676.0	11-Feb-93	WET	1.3	U
F2-BR	1134267.0	779676.0	15-May-93	DIS	1.3	UR
F2-BR	1134267.0	779676.0	15-May-93	WET	2.2	J

Water Quality Data for Bedrock Wells in the Smelter Hill Subarea

F2-BR	1134267.0	779676.0	16-Jul-93	WET	1.2 UJ
F2-BR	1134267.0	779676.0	16-Jul-93	DIS	5.4 U

WET = Total Recoverable Metals
DIS = Dissolved Metals

Attachment E

CDM Federal Programs Corporation
A subsidiary of Camp Dresser & McKee Inc.

PROJECT [illegible] JOB NO. TI Eval DATE [illegible]
COMPUTED BY [illegible] CHECKED BY ____ DATE CHECKED ____
CLIENT EPA PAGE NO. [illegible]

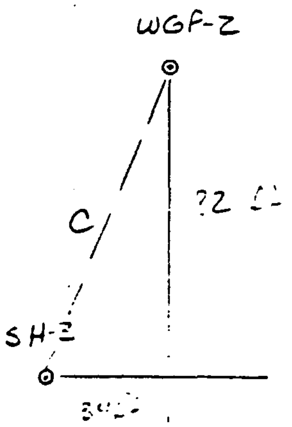
	East	North
SH-2	1133654	788428
WGP-2	1133688	788510

difference

East 1133688 - 1133654 = 34 feet

North 788510 - 788428 = 82 feet

Map view:



Ca[illegible] Pythagorean [illegible]

$$c^2 = 82^2 + 34^2 = 6724 + 1156 = 7880$$

$$c = \sqrt{7880} = 88.? \text{ ft} \approx 89 \text{ feet}$$

CDM Federal Programs Corporation
A subsidiary of Camp Dresser & McKee Inc.

PROJECT ________ JOB NO. ________ DATE ________
COMPUTED BY ________ CHECKED BY ________ DATE CHECKED ________
CLIENT ________ PAGE NO. ________

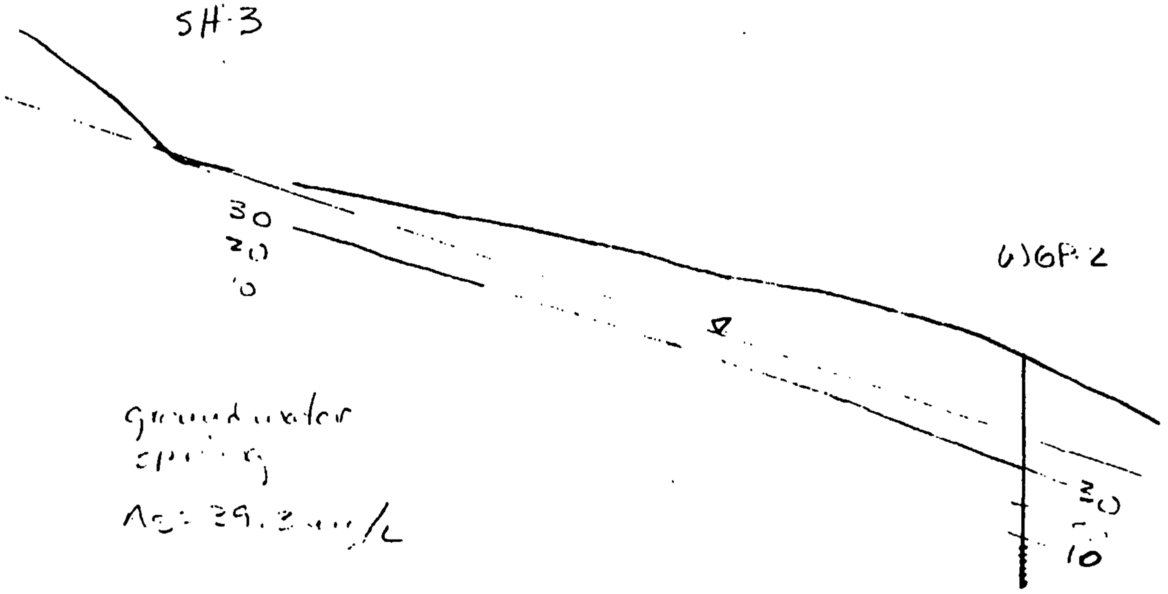
Figure ____.

Sal-dist.cre

South

North

horizontal scale 1":20'
vertical scale 1":20'



groundwater
spring
As: 39.2 mg/L

TD: 26.5 feet
5-foot screen 21-26' bgs
depth to groundwater = 9-feet
As: 3.2 to 11.2 mg/L

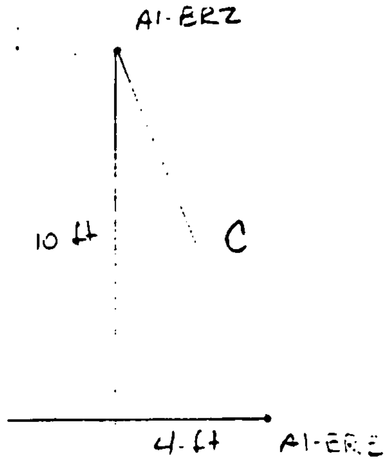
Attachment F

CDM Federal Programs Corporation
A subsidiary of Camp Dresser & McKee Inc.

PROJECT [illegible] JOB NO. ______ DATE 12-[illegible]
COMPUTED BY [illegible] CHECKED BY ______ DATE CHECKED ______
CLIENT EPA PAGE NO. ______

	East (ft)	North (ft)
A1-ERZ	1134820	787444
A1-ERZ	1134824	787434
diff	4	10

Map View:



Calculate distance using Pythagorean Theorem

$$c^2 = a^2 + b^2$$

$$c^2 = (4)^2 + (10)^2$$

$$c^2 = 16 + 100$$

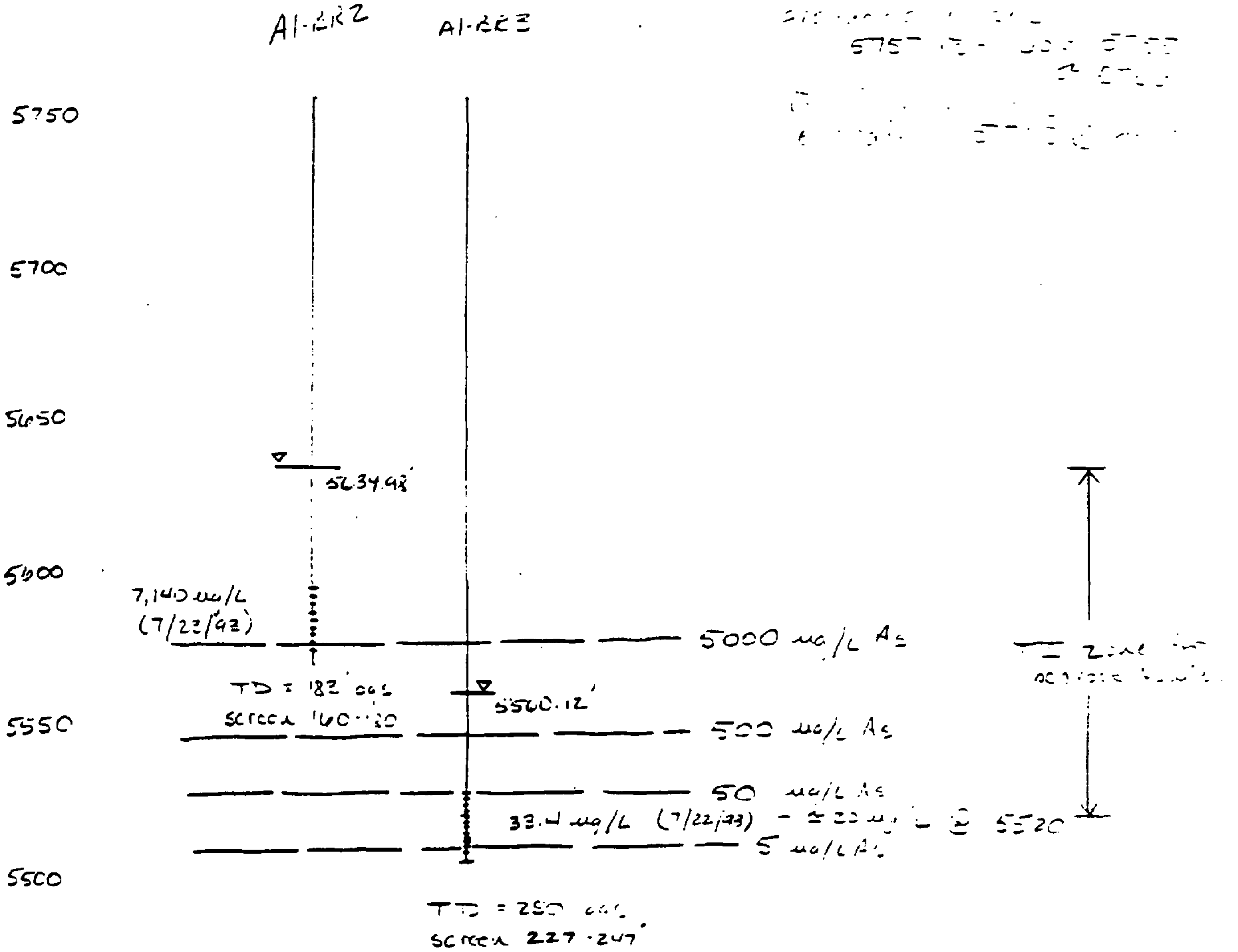
$$c = \sqrt{116}$$

c 10.8 feet

CDM Federal Programs Corporation
A subsidiary of Camp Dresser & McKee Inc.

PROJECT ______ JOB NO. ______ DATE ______
COMPUTED BY ______ CHECKED BY ______ DATE CHECKED ______
CLIENT ______ PAGE NO. ______

[illegible]

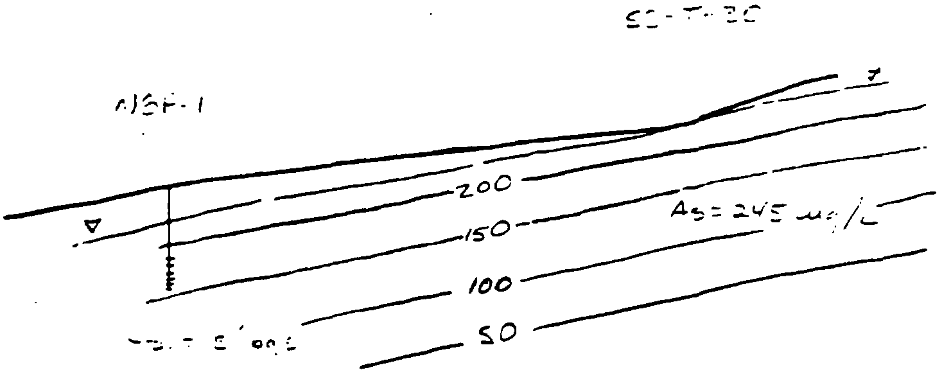


Estimated depth of dissolved arsenic > 5 ug/L is 5634.98 - 5520 = 114.98' ≈ 115 feet below the top of the bedrock aquifer.

Station	MP Elevation	Date	Basis	Units	Arsenic	Qual	WL Depth	WL Elevation
A1-BR2	5757.04	09/19/91	DIS	µg/l	5150.0		137.04	5620
A1-BR2	5757.04	02/20/92	DIS	µg/l	5190.0			
A1-BR2	5757.04	06/03/92	DIS	µg/l	5020.0		135.64	5621.4
A1-BR2	5757.04	09/02/92	DIS	µg/l	4450.0			
A1-BR2	5757.04	11/25/92	DIS	µg/l	4780.0			
A1-BR2	5757.04	02/02/93	DIS	µg/l	5080.0		136.78	5620.26
A1-BR2	5757.04	05/19/93	DIS	µg/l	8470.0		132.08	5624.96
A1-BR2	5757.04	07/23/93	DIS	µg/l	7140.0		122.06	5634.98
				Max	8470			
				Min	4450			
				Mean	5660			

Station	MP Elevation	Date	Basis	Units	Arsenic	Qual	WL Depth	WL Elevation
A1-BR3	5757.13	06/03/92	DIS	µg/l	24.5		206.76	5550.37
A1-BR3	5757.13	09/02/92	DIS	µg/l	18.1			
A1-BR3	5757.13	11/25/92	DIS	µg/l	14.3			
A1-BR3	5757.13	02/02/93	DIS	µg/l	15.9		205.14	5551.99
A1-BR3	5757.13	05/19/93	DIS	µg/l	15.6		195.97	5561.16
A1-BR3	5757.13	07/22/93	DIS	µg/l	33.4		197.01	5560.12
				Max	33.4			
				Min	14.3			
				Mean	20.3			

Attachment G



[illegible] = 5' bgs
screen = 10-[illegible] bgs
depth to gw: 5' (5/15/97)
As = [illegible]76 ug/L

Based on isoconcentration analysis for [illegible] arsenic in the bedrock aquifer of ≅ 70 ug/L / 10-feet of aquifer depth, [illegible] for the depth of [illegible] < 18 ug/L [illegible] the bedrock aquifer in the vicinity of NGF-1 and SS-T-2C is 32 feet (See Calculation [illegible])

Calculation:

245 ug/L - 18 ug/L = 227 ug/L = decrease [illegible]

Depth [illegible] < 18 ug/L equals

D = 227 ug/L / 70 ug/L/10-feet [illegible] =

D = 3.243 × 10 ft = 32.4 feet

D = 32 ft

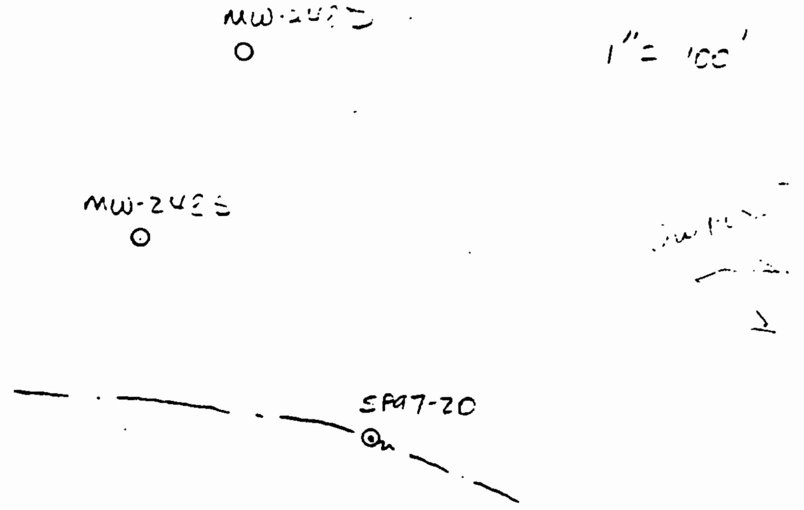
Attachment H

CDM Federal Programs Corporation
A subsidiary of Camp Dresser & McKee Inc.

PROJECT ________ JOB NO. ________ DATE ________
COMPUTED BY ________ CHECKED BY ________ DATE CHECKED ________
CLIENT ________ PAGE NO. ________

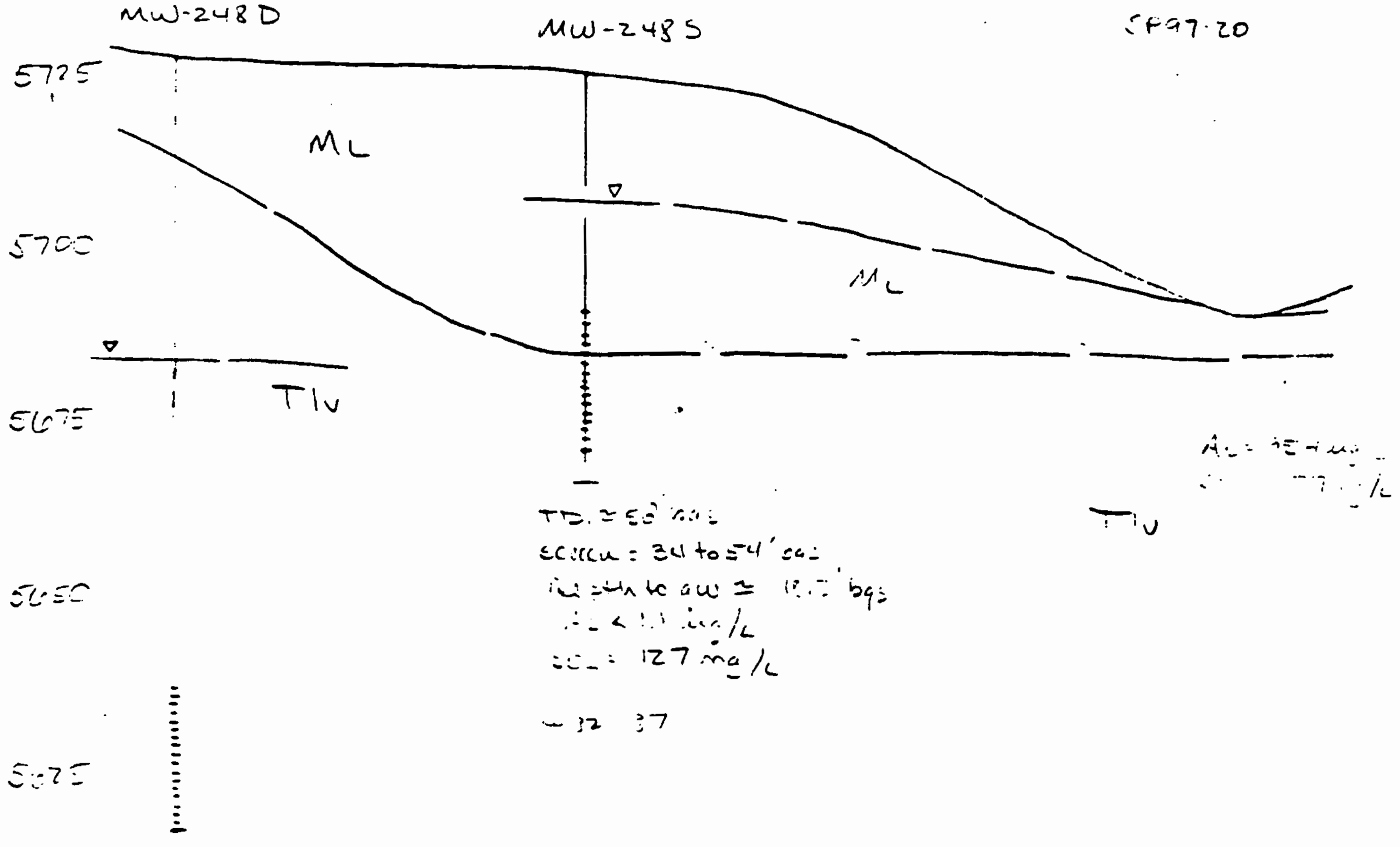
Map View:

Ground	Elevation
MW-248S	5725'
MW-248D	5727
SP97-20	5690



Cross Section

scale horizontal 1"=50'
vertical 1"=25'



TD = 58' bgs
screen = 34 to 54' bgs
depth to gw ≈ 17.7' bgs
[illegible] < 1.1 mg/L
SO4 = 127 mg/L

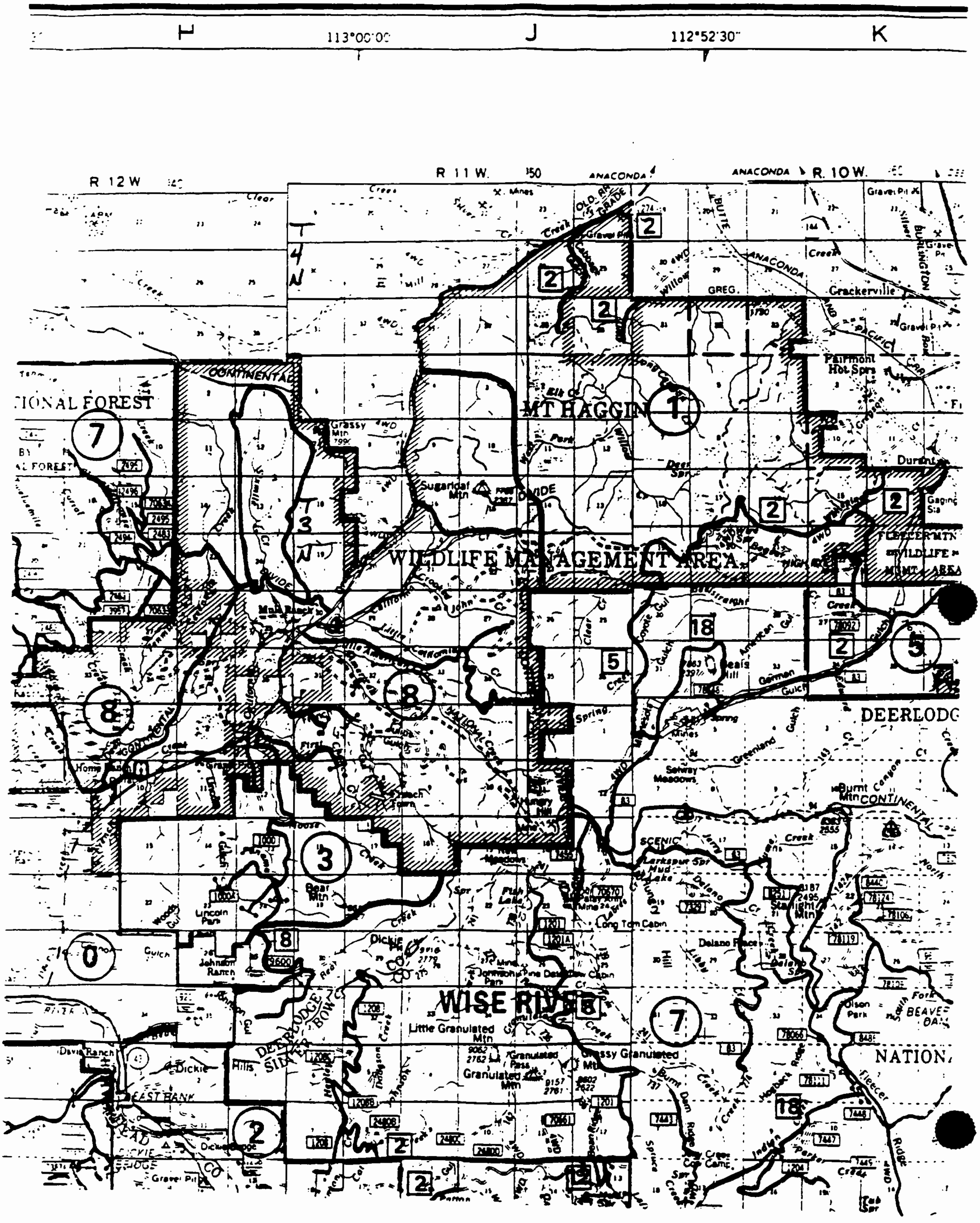
~32 37

As = 3E-4 mg/L
[illegible] 7 mg/L

5600

TD = 112' bgs
screen 90-110 bgs
depth to gw ≈ 48'
As = 28.9 mg/L
SO4 = 22 mg/L

Attachment I

H
113°00'00"
J
112°52'30"
K
R 12 W
R 11 W.
ANACONDA
R. 10 W.
T 4 N
T 3 N
NATIONAL FOREST
MT HAGGIN
WILDLIFE MANAGEMENT AREA
CONTINENTAL
DIVIDE
Grassy Mtn
Sugarloaf Mtn
Mule Ranch
California Cr
Little California
Clear Cr
Spring
Coyote Gul
American Gul
Seals Hill
German Gulch
Greenland Gulch
Selway Meadows
Crackerville
Fairmont Hot Sprs
Durant
FLEECER MTN WILDLIFE MGMT. AREA
DEERLODGE
GREG.
BUTTE
ANACONDA
PACIFIC
Gravel Pit
OLD AR GRADE
Elk Cr
Deer Spr
Burnt Mtn
Burnt Canyon
SCENIC
Larkspur Spr
Mud Lake
Delano
Starlight Mtn
Delano Place
Olson Park
South Fork
BEAVERHEAD
NATIONAL
Fleecer
Ridge
Parker Creek
Tab Spr
Hogback Ridge
Dam Ridge
Cow Creek Cow Camp
Spruce Creek
Home Ranch
Lincoln Park
Johnson Ranch
Bear Mtn
Woods Gul
Dickie Peak
Johnson Pine Dean Cabin
Long Tom Cabin
Patsy Anne Mine
Fish Lake
WISE RIVER
Little Granulated Mtn
Granulated Pass
Granulated Mtn
Grassy Granulated Mtn
DEERLODGE SILVER BOW
Davis Ranch
Dickie
Hills
EAST BANK
Dickie Bridge
Gravel Pit
Moose
1
2
3
5
7
8
18
0

APPENDIX E

Revised Alternative Cost Assumptions and Spreadsheets

ANACONDA SMELTER NPL SITE
REMEDIAL ALTERNATIVE COST ASSUMPTIONS FOR ARWW&S OU

Presented in this appendix are the details associated with the costs for each remedial alternative at the ARWW&S OU. Changes in the cost assumptions since the Proposed Plan (October 1997) are shown in redline/strikeout text. Cost changes primarily involve state-of-the-science knowledge of insitu reclamation technology and new estimates of cover soil hauling distances from the borrow areas to the Opportunity and Anaconda Tailings Ponds.

Costs are expected to provide an accuracy of -30 to +50 percent based on data available from the RI and information obtained since the RI was prepared. A present worth analysis was used to evaluate expenditures that occur over different time periods by discounting all costs incurred in the future to a common base year. This allows the cost of remedial action alternatives to be compared on the basis of a single figure representing the amount of money that, if invested in the base year and disbursed as needed, would be sufficient to cover all costs associated with the remedial action over its planned life.

In conducting the present worth analysis, a discount rate of 7 percent was applied. In addition, the period of performance for costing purposes, as recommended by Superfund, does not exceed 30 years for the purpose of the detailed analysis.

The information contained in this appendix is for solid media only and is presented in four parts: 1) general costing assumptions for the remedial alternatives at the site, 2) a table summarizing the estimated haul distances for cover soil material, 3) example cost calculation sheets for each alternative, and 4) detailed cost sheets for each Area of Concern/Remedial Alternative combination. These newly revised Area of Concern/Remedial Alternative cost sheets reflect changes in costing assumptions since the Proposed Plan was issued.

All Operating and Maintenance costs for revegetation and/or repair work was revised to reflect state-of-the-science knowledge. All capping, soil cover, reclamation/soil cover, partial removal and removal alternatives have been revised to reflect 100 % availability of onsite borrow material. Haul distances have been revised for this material per the attached table.

No Further Action Alternatives

- Site reviews conducted every 5 years and maintenance/repairs only on previously reclaimed areas.
- No indirect capital costs for (1) field indirect, (2) design, and (3) resident engineering.
- Credit was given for deed restrictions, land use designations and existing remediation.

Capping Alternatives

- Site preparation included light clearing.
- Foundation layer included ripping and compacting 2 feet of soil.

- Cap consists of a geosynthetic clay liner and ~~2 feet~~ 18" of protective soil cover. Soil cost included material, ~~transportation~~, and placement~~, and compaction~~. Haul distances were listed as a separate line item.
- Assumed ~~large quantities of soil would be available. Borrow source pits have not been identified. Used 50 miles round trip for hauling distance.~~ that 100 % borrow material is available onsite. Cost revised to reflect haul distances for this material as outlined in the attached table.
- Vegetation: used revised Level I reclamation cost (upper end of the cost range). Source: *MSU 1998. Letter from Reclamation Research Unit to Bob Rennick (CDM) and Matt Marsh (MDEQ). Re: In-situ Land Reclamation Cost Analysis Revisions. March 18.*
- Air monitoring costs include stations and analysis.
- Temporary roads were estimated at ~~200~~ 100 linear feet for each acreage of land.
- Storm water drainage ditches were estimated at ~~200~~ 100 linear feet of V-ditch for each acreage of land.
- Areas with existing established vegetation or previously reclaimed acres were not included in the acreage used to cost this alternative.
- Cap/vegetation repair was estimated at 0.5 percent of the total acreage of the area capped and previously reclaimed areas.
- Dust control was based on using a water truck ~~two~~ six months per year.
- Air Monitoring consists of 6 stations per year (4 stations for the smaller areas) and cost includes analysis.
- Production rate to estimate completion time was ~~100~~ 150 acres/year. This figure is based on a vendor estimate for installation of the geosynthetic clay layer.
- Varied indirect capital costs, changes dependent on area: if <200 acres, no change; if between 200 and 1,000 acres, 4 percent for design and 3 percent for resident engineer; if >1,000 acres, 2 percent design and 2 percent resident engineer.

Soil Cover Alternatives

- Site preparation ~~included light clearing~~ does not include any clearing or grubbing.
- Soil cover consists of ~~2.0~~ 1.5 feet of soil (0.5 ft of fill material and 1 ft of soil). Cost included~~ material,~~ transportation, and placement. Cost for borrow material were not included since this material is being supplied by ARCO. Compaction costs were not included as distribution of soil by a dozer provides adequate compaction (per K. Brockman).
- Assumed ~~large quantities fo soil would be available. Borrow source pits have not been identified. Use 50 miles round trip for hauling distance. two sources of borrow material: Offsite (assume a 10 mile round trip hauling distance and 20 cy trailers) and Onsite (assume pits adjacent to each site, 2 mile hauling distance and 40 cy dump trucks).~~ all borrow material is onsite and is available in 40 cy trucks. Haul distances were revised as indicated in the attached table and listed as a separate line item. ~~Assumed 50 % of required borrow material supplied from offsite source and 50% from onsite source.~~
- Vegetation: used Level I reclamation cost (upper end of the cost range).
- Used manure amendment at 4% of weight (173.2 cy/ac).
- Air monitoring costs include stations and analysis.
- Temporary roads were estimated at ~~200~~ 100 linear feet for each acreage of land.

- Stormwater drainage ditches were estimated at ~~200~~ 100 linear feet of V-ditch for each acreage of land.
- Cover/vegetation repair was estimated at 0.5 percent of the total acreage of the soil cover and previously reclaimed areas.
- Dust control was based on using a water truck ~~two~~ six months per year.
- Air Monitoring consists of 6 stations per year (4 stations for the smaller areas) and cost includes analysis.
- Production rate to estimate completion time was ~~100 acres/year~~ 275 acres per year for 100% onsite borrow. ~~200 acres/year which is an average of the production rates for 50% onsite borrow and 50% offsite borrow material~~. Production for each borrow source assume 10 loads per hour for 10 hour per day, 5 days per week, 38 weeks per year.
- Consolidation was added as needed (specifically, Opportunity Ponds).
- Varied indirect capital costs, changes dependent on area: if <200 acres, no change; if between 200 and 1,000 acres, 4 percent for design and 3 percent for resident engineer; if >1,000 acres, 2 percent design and 2 percent resident engineer.
- Areas with existing established vegetation or previously reclaimed acres were not included in the acreage used to cost this alternative.

Land Reclamation Alternatives

- ~~The upper end of the cost range for each Reclamation Category was used.~~ Both a maximum and minimum cost range for each reclamation category was used based on the latest insitu land reclamation costs developed by MSU in a memo dated March 18, 1998.
- Stormwater drainage ditches were estimated at ~~200~~ 100 linear feet of V-ditch for each acreage of land reclaimed.
- Repair/maintenance repair was estimated at 0.5 percent of the total acreage of the reclaimed and previously reclaimed areas.
- Site preparation included light clearing.
- Dust control was based on using a water truck ~~two~~ six months per year.
- Air Monitoring consists of 6 stations per year (4 stations for the smaller areas) and cost includes analysis.
- Production rate to estimate completion time was 500 acres/year.
- Varied indirect capital costs, changes dependent on area: if <200 acres, no change; if between 200 and 1,000 acres, 4 percent for design and 3 percent for resident engineer; if >1,000 acres, 2 percent design and 2 percent resident engineer.
- Areas with existing established vegetation or previously reclaimed acres were not included in the acreage used to cost this alternative

Partial Land Reclamation Alternatives

- ~~The upper end of the cost range for each Reclamation Category was used.~~ Both a maximum and minimum cost range for each Reclamation Category was used based on the latest insitu land reclamation costs developed by MSU in a memo dated March 18, 1998.
- Stormwater drainage ditches were estimated at ~~200~~ 100 linear feet of V-ditch for each acreage of land reclaimed.
- Stormwater runoff was routed to Opportunity Ponds.

- Repair/maintenance repair was estimated at 0.5 percent of the total acreage of the reclaimed, previously reclaimed areas, and adequate natural vegetated areas.
- Site preparation included light clearing.
- Dust control was based on using a water truck ~~two~~ six months per year.
- Air Monitoring consists of 6 stations per year (4 stations for the smaller areas) and cost includes analysis.
- Production rate to estimate completion time was 500 acres/year.
- Varied indirect capital costs, changes dependent on area: if <200 acres, no change; if between 200 and 1,000 acres, 4 percent for design and 3 percent for resident engineer; if >1,000 acres, 2 percent design and 2 percent resident engineer.

Reclamation/Soil Cover Alternatives

- This alternative is a combination of reclamation (Level III, 12 inches deep) and soil cover (6 inches).
- Derived cost for the vegetation portion of this alternative separately from ARTS costs.
- ~~Assumed large quantities fo soil would be available. Use 50 miles round trip for hauling distance. Assumed two sources of borrow material: Offsite (assume a 10 mile round trip hauling distance and 20 cy trailers) and Onsite (assume pits adjacent to each site, 2 mile hauling distance and 40 cy dump trucks)~~Assumed all borrow material is onsite and is available in 40 cy trucks. Haul distances were revised as indicated in the attached table and listed as a separate line item.
- Vegetation: ~~used Level I reclamation cost (upper end of the cost range).~~ The maximum and minimum cost values for each Reclamation Category used was based on the latest insitu land reclamation costs developed by MSU in a memo dated March 18, 1998.
- Stormwater drainage ditches were estimated at ~~200~~ 100 linear feet of V-ditch for each acreage of land.
- Vegetation repair was estimated at 0.5 percent of the total acreage of the area reclaimed and previously reclaimed.
- Site preparation included light clearing.
- Consolidated the toe waste soils in Opportunity Ponds.
- Areas with existing established vegetation or previously reclaimed acres were not included in the acreage used to cost this alternative.
- Dust control was based on using a water truck six months per year.
- Air Monitoring consists of 6 stations per year (4 stations for the smaller areas) and cost includes analysis.
- Production rate to estimate completion time was 450 acres/year.
- Varied indirect capital costs, changes dependent on area: if <200 acres, no change; if between 200 and 1,000 acres, 4 percent for design and 3 percent for resident engineer; if >1,000 acres, 2 percent design and 2 percent resident engineer.

Rock Amendment Alternatives

- Site preparation included light clearing.
- Surface grading included rough grading.
- Rock amendment includes placing a 4-inch layer of pea gravel.

- West stack slag was not used as a costing option for the rock amendment alternatives in the Smelter Hill area. Use of this material should be evaluated in the detailed design phase of any rock amendments chosen as a remedy in the ROD.
- Assumed large quantities of pea gravel would be available. Borrow source pits have not been identified. Used 40 miles round trip for hauling distance.
- Temporary roads were estimated at ~~200~~ 100 linear feet for each acreage of land.
- Storm water drainage ditches were estimated at 200 linear feet of V-ditch for each acreage of land.
- Storm water runoff was routed to Opportunity Ponds for the Anaconda Ponds and Disturbed Area areas of concern.
- Repair was estimated at 0.5 percent of the total acreage of the area amended and previously reclaimed.
- Dust control was based on using a water truck ~~two~~ six months per year.
- Air Monitoring consists of 6 stations per year and cost includes analysis.
- Production rate to estimate completion time was 425 acres/year.
- Varied indirect capital costs, changes dependent on area: if <200 acres, no change; if between 200 and 1,000 acres, 4 percent for design and 3 percent for resident engineer; if >1,000 acres, 2 percent design and 2 percent resident engineer.
- Areas with existing established vegetation or previously reclaimed acres were not included in the acreage used to cost this alternative

Removal

- Removal unit costs are based on costs prepared by Titan (Titan 1996). A 3 percent interest rate was used to adjust the 1992 and 1993 costs to 1996.
- For this cost estimate, large quantities of backfill soil was assumed to be available. ~~Borrow source pits have not been identified. Used 50 miles round trip for hauling distance~~. **Assumed all borrow material for backfill is onsite and is available in 40 cy trucks. Haul distances were revised as indicated in the attached table and listed as a separate line item.**
- Final grading is rough.
- Vegetation: used revised Level I reclamation cost (upper end of the cost range).
- Estimated time frames to complete the work are based on continual work without interruption due to funding, weather, or contractor problems.
- Air Monitoring consists of 6 stations per year (4 stations for the smaller areas) and cost includes analysis.
- The percentage applied (to total direct costs) for estimating design and engineering indirect costs varied between sites relative to the volume of waste removed.

End of cost assumptions for solid media.

Capping and Soil Cover Haul Distance [1] Assumptions

Alternative Type	Area of Concern	Subarea	Haul Distance (miles)
Capping	Warm Springs Creek SST	North Opportunity	2
	South Lime Ditch	Opportunity Ponds	2
	East Anaconda Yards	Smelter Hill	4
	Willow Creek SST	South Opportunity	4
	Yellow Ditch	South Opportunity	4
Soil Cover	High Arsenic Soils	North Opportunity	2
	High Arsenic Soils	Opportunity Ponds	2
	High Arsenic Soils	Old Works/Stucky Ridge	2
	High Arsenic Soils	Smelter Hill	2
	South Lime Ditch	Opportunity Ponds	1
	Cell A	Opportunity Ponds	2
	Triangle Waste	Opportunity Ponds	1
	Anaconda Ponds	Smelter Hill	2
	Opportunity Ponds	Opportunity Ponds	2
	Disturbed Area	Smelter Hill	2
	East Anaconda Yards	Smelter Hill	4
	Yellow Ditch	South Opportunity	4
Land Reclamation/Soil Cover	Anaconda Ponds	Anaconda Ponds	2
	Opportunity Ponds	Opportunity Ponds	2

[1] Haul distance assumptions were modified based upon comments received on the Proposed Plan and upon preliminary results of the ARWW&S OU Borrow Source investigation conducted in 1998 by MSU for the Montana DEQ.

Anaconda Smelter Site
Anaconda Regional Water, Waste, and Soils Operable Unit
Remedial Alternative Cost Calculation Summaries

COST CALCULATION SUMMARY
CAPPING ALTERNATIVE

PURPOSE: Determine the cost to construct a cap. Calculated cost per acre.

CAP DESCRIPTION:

- Vegetation
- 1.5 feet Soil Cover Layer
- Geosynthetic Clay Liner
- 2 feet Compacted Waste (i.e., foundation layer - ripped and compacted)

DATE: Initial: December 1996; last revision: September 1998

Mobilization/Demobilization:		
Engineering Estimate		$100/acre
Site Preparation (Subgrade)		
Clearing and Grading (ref. Means)		$2,850/acre
Foundation Layer:		
Ripping (ref. Means)	$1.94/cy	
Compaction (ref. Means)	0.24	
	$2.18/cy	$8,100/acre
Geosynthetic Clay Layer (GCL):		
Installed cost = $0.50/sf (ref. phone conversation w/Colo. Lining)		$22,500/acre
Protective Soil Cover Layer:		
Excavate w/front end loader (ref. Means)	$1.06/cy	
Load, 15% of excavation (ref. Means)	0.16	
Place w/bulldozer (ref. Means)	1.55	
	$2.77/cy	$6,703/acre
Vegetation:		
Land Reclamation Level I ($945 to $1,290/acre)		$1,290/acre
Haul Soil Cover Material:		
Off Highway, 40 cy, 2 miles round trip, $2.26/cy (ref. Means)		$5,469/acre
Stormwater Drainage Ditches:		
100 lf/acre, "v" ditch, 4.06/cy (ref. Means)		$90/acre

Roads - Temporary

100 lf/acre, 10 ft wide	
Gravel fill road, 8 inch gravel (ref. Means) $4.23/cy	$470/acre

Dust Control:

Water Truck, rented (ref. Means)	$3,225/mo	
Crew (ref. Means)	3,200	
	$6,425/mo	
Production = 150 ac/yr (use as average value for all alternatives)		
Dust for half the construction time, 4.5 mo		
Cost/acre = $6,425/mo x 4.5 mo x 1 yr/150 ac =		$200/acre

Air Monitoring:

Air Monitoring Station (ref. Kleinfelder 1996)	$2,700	
Monitoring during construction (ref. Kleinfelder 1996)	650	
	$3,350	$3,350/station

Consolidation (as needed):

Excavate w/trackhoe (ref. Means)	$1.38/bcy	
Load, 15% of excavation (ref. Means)	0.21	
Haul, 12 cy 2 mi RT (ref. Means)	2.83	
Place w/bulldozer (ref. Means)	1.55	
Compact (ref. Means)	0.21	
	$6.18/bcy or $5.37/cy	$5.37/cy

Quarterly Inspection:

Inspection, 1day/100ac x 8 hr/day x $50/hr = $4/ac

Maximum = 2 wks/site = $4,000

Minimum = 1 day/site = $400

Report = $2,500

Total = $4/ac+$2,500, max = $6,500, min = $2,900

<u>Maintenance</u>

Cap Repair:

1% of acreage

Repair:

Excavate (ref. Means)	$1.06/cy		
Load (ref Means)	0.16		
Place (ref. Means)	1.55		
	$2.77/cy =	$6,703/ac	
Haul		$5,469	
Vegetation		$1,290	
		$13,462/ac	$13,462/ac

Site Reviews

Report: Estimate	40 hr X $50= $2,000	
Materials: Estimate	530	
Field Time: Estimate	16 hr X $50 = 800	
		$3,330

COST CALCULATION SUMMARY
SOIL COVER ALTERNATIVE

PURPOSE: Determine the cost to construct a soil cover. Calculated cost per acre.

SOIL COVER DESCRIPTION:

- Vegetation
- 1.5 feet Soil Cover Layer

DATE: Initial: December 1996; last revision: September 1998

Mobilization/Demobilization:		
Engineering Estimate		$100/acre
Site Preparation:		
Clearing and Grading (ref. Means)		$800/acre
Soil Cover Layer:		
Excavate w/front end loader (ref. Means)	$1.06/cy	
Load, 15% of excavation (ref. Means)	0.16	
Place w/bulldozer (ref. Means)	1.55	
	$2.77/cy	$6,700/acre
Haul Soil Cover Material:		
Off Highway, 40 cy, 2 miles round trip, $2.26/cy (ref. Means)		$5,469/acre
Off Highway, 40 cy, 4 miles round trip, $3.51/cy (ref Means)		$8,494/acre
Vegetation:		
Land Reclamation Level I ($945 to $1,290/acre)		$1,290/acre
Stormwater Drainage Ditches:		
100 lf/acre, "v" ditch, 4.06/cy (ref. Means)		$90/acre
Roads - Temporary		
100 lf/acre, 10 ft wide		
Gravel fill road, 8 inch gravel (ref. Means) $4.23/cy		$470/acre
Dust Control:		
Water Truck, rented (ref. Means)	$3,225/mo	
Crew (ref. Means)	3,200	
	$6,425/mo	

Production = 150 ac/yr (use as average value for all alternatives)
Dust for half the construction time, 4.5 mo
Cost/acre = $6,425/mo x 4.5 mo x 1 yr/150 ac = $200/acre $200/acre

Air Monitoring:

Air Monitoring Station (ref. Kleinfelder 1996)	$2,700	
Monitoring during construction (ref. Kleinfelder 1996)	650	
	$3,350	$3,350/station

Quarterly Inspection:
Inspection, 1day/100ac x 8 hr/day x $50/hr = $4/ac
Maximum = 2 wks/site = $4,000
Minimum = 1 day/site = $400
Report = $2,500
Total = $4/ac+$2,500; max = $6,500, min = $2,900

Soil Cover Repair:
1% of acreage
Repair:

Excavate (ref. Means)	$1.06/cy		
Load (ref. Means)	$0.16		
Place (ref. Means)	1.55		
	$2.77/cy	=$ 6,703/ac	
Hauling		5,469	
Vegetation		1,290	
		$ 13,462/ac	$ 13,462/ac

Site Reviews

Report: Estimate	40 hr X $50=	$2,000	
Materials: Estimate		530	
Field Time: Estimate	16 hr X $50 =	800	
		$3,330	$3,330

COST CALCULATION SUMMARY
RECLAMATION/PARTIAL RECLAMATION ALTERNATIVES

PURPOSE: Determine the cost to implement the reclamation alternative. Calculated cost per acre.

RECLAMATION DESCRIPTION:

- Reclamation cost based on the March 18, 1998 memorandum from the MSU Reclamation Unit to EPA and on haul distance estimates based upon preliminary results of the ARWW&S OU Borrow Source investigation conducted in 1998 by MSU for the Montana DEQ.

DATE: Initial: December 1996; last revision: September 1998

Mobilization/Demobilization:		
Engineering Estimate		$100/acre
Site Preparation:		
Clearing and Grading (ref. Means)		$800/acre
Vegetation:		
Land Reclamation Level I ($945 to $1,290)		$1,290 or
Land Reclamation Level II ($2,435 to $3,495)		$3,495 or
Land Reclamation Level IIIA($9,595 to $11,180)		$11,180 or
Land Reclamation Level IIIB ($5,600 to $8,000)		$8,000 or
Land Reclamation Level IIIC Opportunity Ponds ($4,530 to $16,610)		$16,610 or
Land Reclamation Level IIIC Anaconda Ponds ($8,550 to $21,160)		$21,160
Stormwater Drainage Ditches:		
100 lf/acre, "v" ditch, 4.06/cy (ref. Means)		$90/acre
Dust Control:		
Water Truck, rented (ref. Means)	$3,225/mo	
Crew (ref. Means)	3,200	
	$6,425/mo	
Production = 150 ac/yr (use as average value for all alternatives)		
Dust for half the construction time, 4.5 mo		
Cost/acre = $6,425/mo x 4.5 mo x 1 yr/150 ac =		$200/acre
Stormwater:		
Variable costs for constructing stormwater diversions and O&M.		
Air Monitoring:		
Air Monitoring Station (ref. Kleinfelder 1996)	$2,700	
Monitoring during construction (ref. Kleinfelder 1996)	650	
		$3,350/station
Quarterly Inspection:		
Inspection, 1day/100ac x 8 hr/day x $50/hr = $4/ac		
Maximum = 2 wks/site = $4,000		
Minimum = 1 day/site = $400		
Report = $2,500		
Total = $4/ac+$2,500,		max = $6,500, min = $2,900
Vegetation Repair:		
Level I Reclamation		$1,290/ac
Fencing (Partial Reclamation Only)		
Ref Means		$10/lf

Site Reviews		
Report: Estimate	40 hr X $50= $2,000	
Materials: Estimate	530	
Field Time: Estimate	16 hr X $50 = 800	
		$3,330

COST CALCULATION SUMMARY
ROCK AMENDMENT

PURPOSE: Determine the cost to implement the rock amendment alternative. Calculated cost per acre.

ROCK AMENDMENT DESCRIPTION:

- Place 4" of pea gravel on tailings pond areas.

DATE: Initial: December 1996; last revision: September 1998

Mobilization/Demobilization:		
Engineering Estimate		$100/acre
Site Preparation:		
Clearing and Grading (ref. Means)		$800/acre
Surface Grading (ref. Means)		$ 2,275/acre
Rock Amendments (4" pea gravel):		
Pea gravel (ref. Means)	$17/cy	
Hauling, 40 miles (ref. Means)	11	
Placement (ref. Means)	2.34	
	$30.34/cy	$16,316/acre
Stormwater Drainage Ditches:		
100 lf/acre, “v” ditch, 4.06/cy (ref. Means)		$90/acre
Roads - Temporary		
100 lf/acre, 10 ft wide		
Gravel fill road, 8 inch gravel (ref. Means) $4.23/cy		$470/acre
Dust Control:		
Water Truck, rented (ref. Means)	$3,225/mo	
Crew (ref. Means)	3,200	
		$6,425/mo

Production = 150 ac/yr (use as average value for all alternatives)
Dust for half the construction time, 4.5 mo
Cost/acre = $6,425/mo x 4.5 mo x 1 yr/150 ac = $200/acre

Air Monitoring:

Air Monitoring Station (ref. Kleinfelder 1996)	$2,700	
Monitoring during construction (ref. Kleinfelder 1996)	650	
	$3,350	$3,350/station

Quarterly Inspection:
Inspection, 1day/100ac x 8 hr/day x $50/hr = $4/ac
Maximum = 2 wks/site = $4,000
Minimum = 1 day/site = $400
Report = $2,500
Total = $4/ac+$2,500, max = $6,500, min = $2,900

Repair - Same unit cost as rock amendment

Site Reviews

Report: Estimate	40 hr X $50= $2,000	
Materials: Estimate	530	
Field Time: Estimate	16 hr X $50 = 800	
		$3,330

COST CALCULATION
REMOVAL AND PARTIAL REMOVAL ALTERNATIVES

PURPOSE: Determine the cost to implement the removal alternative. Calculated cost per cubic yard (cy).

REMOVAL DESCRIPTION:

Depending on the situation for each site, the removal costs were based on one of the four scenarios described in the Titan Report (*Anaconda Smelter NPL Site, ARWW&S OU, Preliminary Remedial Action Objections/General Response Actions/Technology and Process Option Scoping/Waste Removal Evaluation. Prepared by Titan Environmental Corp for ARCO. March 1996*). The costs in the Titan Report were 1993 costs; a 3% interest rate was used to change the cost to 1996 dollars. Additional miscellaneous costs were used to complete the cost estimate.

ARCO's Cost Scenario No. 1 (Transport by Railroad)

Excavation = $2 - 0.303 (2/4.90)(decon) = $1.88 (1993 dollars) = $2.05/cy (1996 dollars)
Disposal = $1.80 - 0.303 (1.8/4.90) = $1.69 = $1.85
Load/Unload = $1.10 - 0.303(1.10/4.90) = $1.03 = $1.13

Transport by RR = $2.81/ton x 1.5 ton/cy - 0.607(roads) = $3.61 = $3.95
Other (Decon, Roads) = $0.303 + $0.607 = $0.91 = $0.99

ARCO's Cost Scenario No. 2 (Transport by 55 ton Truck)

Excavate/Load/Unload = $3.00 (1993 dollars) = $3.28 (1996 dollars)
Haul (55 ton truck) = $2.75 = $3.00
Other (flag, decon, support) = $2.00 = $2.19

ARCO's Cost Scenario No. 3 (from Streamside Tails Demo 2)

Excavation = $3.65 (1993 dollars) = $3.99 (1996 dollars)
Roads = $1.07 = $1.17
Clear/Grub & Erosion Control = $0.07 + 0.09 = $0.16 = $0.18
Haul (excavate by dozer and haul with 12 cy trucks) = $7.24 - $4.88 (excavation and roads) = $2.36 = $2.58
Haul (excavate by trackhoe and haul with 12 cy trucks) = $9.03 - $4.88 = $4.15 = $4.54
For extra long distances (beyond 6 miles rt) add $2.00
Other (H&S, Surveying, office, security, etc.) = $1.49 = $1.63
Mob/Demob = $0.07 = $0.08
Decon = $0.04 = $0.05

ARCO's Cost Scenario No. 4 (from Streamside Tailings Demo Project and Mill-Willow By Pass Project)

Excavate/Load/Haul/Unload/Disposal = $5.04 (1993 dollars) = $5.51 (1996 dollars)
Clear/Grub & Erosion Control = $0.07 + 0.09 = $0.16 = $0.18
Roads = $1.07 = $1.17
Mob/Demob = $0.09 = $0.10
Decon = $0.04 = $0.05
Other (H&S, Surveying, office, security, etc.) = $1.48 = $1.62

Miscellaneous Costs

Rough Grading for Seeding (reference Means 1996) = $0.13/sf
Air Monitoring:

Air Monitoring Station (ref. Kleinfelder 1996)	$2,700	
Monitoring during construction (ref. Kleinfelder 1996)	650	
		$3,350/station

Railroad Spur (reference ECHOS)
= $6,000 (turnout to new track) + ($59.70/lf + 54.44/lf) x 300 lf (track) + $3,000 (heavy duty RR car bumpers) = $43,242, use $45,000
Railroad Restoration (reference Means [1] and ECHOS [2])
= $33.98/lf (track - ref 2) + $83.50 (wood ties - ref 1) + $36.02 (ballast - ref 2)
= $153.5/lf, use $170/lf
RR Subgrade Construction (Means) = 1.67 bcy/lf x $34/cy = $56.78, use $60/lf
Remove RR Tracks (reference Means) = $16.25

Dispose of wood ties = $14/ton (engineer's estimate)
Bridge (reference Means 1996), precast, prestressed concrete box girder
= $10,400 + $4,600 (misc.) = $15,000
Reconstruct Ditch, "v" ditch, 3' deep x 4' wide (reference Means, for excavating trench)
= $4.06/cy
Excavate Backfill Material (ref. Means) = $2.77/cy
Haul Backfill Material
Off Highway, 40 cy, 2 miles round trip, $2.26/cy (ref. Means)
Off Highway, 40 cy, 4 miles round trip, $3.51/cy (ref. Means)
Vegetation, Phase I reclamation = $1,290/acre
Revegetation - riparian (reference ARCO) = $710/acre
Stream Bank Erosion Control (reference ARCO) = $4,493/acre

Mob/Demob = engineer's estimate
Dust control = engineer's estimate
Rebuild RR (Blue Lagoon) = $200/lf (engineer's estimate)
Compensation to RR Company for downtime = $20,000 (engineer's estimate)
Culvert under RR = $200/lf (engineer's estimate)
Soil cover for RR = engineer's estimate
Infrastructure - Sewer, Water, and Power = $20,000 ea (engineer's estimate)
Dewatering = engineer's estimate
East Anaconda Yard Waste Area of Concern, Excavate/Load/Unload and Haul unit costs includes 50% increase due to existing utilities at the site.

End of cost calculation sheets.

Capital and Operation & Maintenance Cost Spreadsheets

TABLE E-1
NORTH OPPORTUNITY SUBAREA
HIGH ARSENIC SOILS AREA OF CONCERN
Alternative - No Further Action (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Institutional Controls *	LS	0	0.00	$0	1	$0
Subtotal				$0		$0
2. Indirect Costs						
Field Indirect (0%)				$0		$0
Supervision, Inspection, & Overhead (4%)				$0		$0
Contractor Profit (10%)				$0		$0
Contractor Bonds (5%)				$0		$0
Design (0%)				$0		$0
Resident Engineering (0%)				$0		$0
Contingency (20%)				$0		$0
TOTAL CAPITAL COSTS				$0		$0

B. O & M COSTS

1. Direct Costs						
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Subtotal				$666		$7,642
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$27		$306
Contractor Bonds (5%)				$33		$382
Contractor Profit (10%)				$67		$764
Contingency (20%)				$133		$1,528
TOTAL O&M COSTS				$900		$10,600
TOTAL ALTERNATIVE COSTS						$11,000

* Already established through Superfund Overlay District and covenants on Ueland property.

TABLE E-3
NORTH OPPORTUNITY SUBAREA
HIGH ARSENIC SOILS AREA OF CONCERN
Alternative - Land Reclamation (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
			Min	Max	Min	Max		Min	Max
Mobilization/Demobilization	AC	162	$100		$16,200		1	$16,200	$16,200
Site Preparation	AC	162	$800		$129,600		1	$129,600	$129,600
Level I Reclamation	AC	32	$945	$1,290	$30,240	$41,280	1	$30,240	$41,280
Level II Reclamation	AC	130	$2,435	$3,495	$316,550	$454,350	1	$316,550	$454,350
Level III A Reclamation	AC	0	$9,505		$0		1	$0	$0
Level III B Reclamation	AC	0	$5,600		$0		1	$0	$0
Level II C Reclamation	AC	0	$4,530		$0		1	$0	$0
Dust Control	AC	162	$200		$32,400		1	$32,400	$32,400
Stormwater Drainage (100 LF/AC)	AC	162	$90		$14,580		1	$14,580	$14,580
Air Monitoring	EA	6	$3,350		$20,100		1	$20,100	$20,100
Subtotal					$559,670	$708,510		$559,670	$708,510
2. Indirect Costs									
Field Indirect (2%)					$11,193	$14,170		$11,193	$14,170
Supervision, Inspection, & Overhead (4%)					$22,387	$28,340		$22,387	$28,340
Contractor Profit (10%)					$55,967	$70,851		$55,967	$70,851
Contractor Bonds (5%)					$27,984	$35,426		$27,984	$35,426
Design (6%)					$33,580	$42,511		$33,580	$42,511
Resident Engineering (3%)					$16,790	$21,255		$16,790	$21,255
Contingency (20%)					$111,934	$141,702		$111,934	$141,702
TOTAL CAPITAL COSTS					$840,000	$1,063,000		$840,000	$1,063,000
B. O & M COSTS									
1. Direct Costs									
Quarterly Inspection	EA	4	$2,900		$11,600		2 thru 30	$133,098	
Vegetation Repair	AC	1.62	$1,290		$2,090		2 thru 30	$23,978	
Site Review	EA/5 yr	0.20	$3,330		$666		2 thru 30	$7,642	
Subtotal					$14,356			$164,718	
2. Indirect Costs									
Supervision, Inspection, & Overhead (4%)					$574			$6,589	
Contractor Bonds (5%)					$718			$8,236	
Contractor Profit (10%)					$1,436			$16,472	
Contingency (20%)					$2,871			$32,944	
TOTAL O&M COSTS					$20,000			$229,000	
TOTAL ALTERNATIVE COSTS								$1,069,000	$1,292,000

TABLE E-4
NORTH OPPORTUNITY SUBAREA
HIGH ARSENIC SOILS AREA OF CONCERN
Alternative - Partial Land Reclamation (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
			Min	Max	Min	Max		Min	Max
Mobilization/Demobilization	AC	59	$100		$5,900		1	$5,900	$5,900
Site Preparation	AC	59	$800		$47,200		1	$47,200	$47,200
Level I Reclamation - Highway Corridor	AC	59	$945	$1,290.0	$55,755	$76,110	1	$55,755	$76,110
Dust Control	AC	59	$200		$11,800		1	$11,800	$11,800
Stormwater Drainage (100 LF/AC)	AC	59	$90		$5,310		1	$5,310	$5,310
Fencing	LF	40,000	$10		$400,000		1	$400,000	$400,000
Air Monitoring	EA	6	$3,350		$20,100		1	$20,100	$20,100
Route Stormwater to Opportunity Ponds	LS	1	$856,000		$856,000		1	$856,000	$856,000
Subtotal					$1,402,065	$1,422,420		$1,402,065	$1,422,420
2. Indirect Costs									
Field Indirect (2%)					$28,041	$28,448		$28,041	$28,448
Supervision, Inspection, & Overhead (4%)					$56,083	$56,897		$56,083	$56,897
Contractor Profit (10%)					$140,207	$142,242		$140,207	$142,242
Contractor Bonds (5%)					$70,103	$71,121		$70,103	$71,121
Design (6%)					$84,124	$85,345		$84,124	$85,345
Resident Engineering (3%)					$42,062	$42,673		$42,062	$42,673
Contingency (20%)					$280,413	$284,484		$280,413	$284,484
TOTAL CAPITAL COSTS					$2,103,000	$2,134,000		$2,103,000	$2,134,000

B. O & M COSTS

1. Direct Costs							
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098	
Vegetation Repair	AC	0.51	$1,290	$658	2 thru 30	$7,549	
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642	
Stormwater Management	LS	1	$63,000	$63,000	2 thru 30	$722,862	
Subtotal				$75,924		$871,151	
2. Indirect Costs							
Supervision, Inspection, & Overhead (4%)				$3,037		$34,846	
Contractor Bonds (5%)				$3,796		$43,558	
Contractor Profit (10%)				$7,592		$87,115	
Contingency (20%)				$15,185		$174,230	
TOTAL O&M COSTS				$105,500		$1,210,900	
TOTAL ALTERNATIVE COSTS						$3,314,000	$3,345,000

TABLE E-5
NORTH OPPORTUNITY SUBAREA
SPARSELY VEGETATED SOILS AREA OF CONCERN
Alternative - No Further Action (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Institutional Controls *	LS	0	0.00	$0	1	$0
Subtotal				$0		$0
2. Indirect Costs						
Field Indirect (0%)				$0		$0
Supervision, Inspection, & Overhead (4%)				$0		$0
Contractor Profit (10%)				$0		$0
Contractor Bonds (5%)				$0		$0
Design (0%)				$0		$0
Resident Engineering (0%)				$0		$0
Contingency (20%)				$0		$0
TOTAL CAPITAL COSTS				$0		$0

B. O & M COSTS

1. Direct Costs						
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Subtotal				$666		$7,642
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$27		$306
Contractor Bonds (5%)				$33		$382
Contractor Profit (10%)				$67		$764
Contingency (20%)				$133		$1,528
TOTAL O&M COSTS				$900		$10,600
TOTAL ALTERNATIVE COSTS						$11,000

* Already established through Superfund Overlay District and covenants on Ueland property.

TABLE E-6
NORTH OPPORTUNITY SUBAREA
SPARSELY VEGETATED SOILS AREA OF CONCERN
Alternative - Land Reclamation (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
			Min	Max	Min	Max		Min	Max
Mobilization/Demobilization	AC	870	$100		$87,000		1 thru 2	$78,648	$78,648
Site Preparation	AC	870	$800		$696,000		1 thru 2	$629,184	$629,184
Level I Reclamation	AC	800	$945	$1,290	$756,000	$1,032,000	1 thru 2	$683,424	$932,928
Level II Reclamation	AC	70	$2,435	$3,495	$170,450	$244,650	1 thru 2	$154,087	$221,164
Level III A Reclamation	AC	0	$9,505		$0		1 thru 2	$0	$0
Level III B Reclamation	AC	0	$5,600		$0		1 thru 2	$0	$0
Level III C Reclamation	AC	0	$4,530		$0		1 thru 2	$0	$0
Dust Control	AC	870	$200		$174,000		1 thru 2	$157,296	$157,296
Stormwater Drainage (100 LF/AC)	AC	870	$90		$78,300		1 thru 2	$70,783	$70,783
Air Monitoring	AC	12	$3,350		$40,200		1 thru 2	$36,341	$36,341
Route Stormwater to W. Springs Pond #3	LS	1	$3,100,000		$3,100,000		1 thru 2	$2,802,400	$2,802,400
Subtotal					$5,101,950	$5,452,150		$4,612,163	$4,928,744
2. Indirect Costs									
Field Indirect (2%)					$102,039	$109,043		$92,243	$98,575
Supervision, Inspection, & Overhead (4%)					$204,078	$218,086		$184,487	$197,150
Contractor Profit (10%)					$510,195	$545,215		$461,216	$492,874
Contractor Bonds (5%)					$255,098	$272,608		$230,608	$246,437
Design (4%)					$204,078	$218,086		$184,487	$197,150
Resident Engineering (3%)					$153,059	$163,565		$138,365	$147,862
Contingency (20%)					$1,020,390	$1,090,430		$922,433	$985,749
TOTAL CAPITAL COSTS					$7,551,000	$8,069,000		$6,826,000	$7,295,000

B. O & M COSTS

1. Direct Costs						
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098
Vegetation Repair	AC	8.70	$1,290	$11,223	2 thru 30	$128,773
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Stormwater Management	LS	1	$118,500	$118,500	2 thru 30	$1,359,669
Subtotal				$141,989		$1,629,182
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$5,680		$65,167
Contractor Bonds (5%)				$7,099		$81,459
Contractor Profit (10%)				$14,199		$162,918
Contingency (20%)				$28,398		$325,836
TOTAL O&M COSTS				$197,400		$2,264,600

TOTAL ALTERNATIVE COSTS		Min	Max
TOTAL ALTERNATIVE COSTS		$9,091,000	$9,560,000

TABLE E-7
NORTH OPPORTUNITY SUBAREA
SPARSELY VEGETATED SOILS AREA OF CONCERN
Alternative - Partial Land Reclamation (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
			Min	Max	Min	Max		Min	Max
Mobilization/Demobilization	AC	425	$100		$42,500		1	$42,500	$42,500
Site Preparation	AC	425	$800		$340,000		1	$340,000	$340,000
Level I Reclamation	AC	0	$945		$0		1	$0	$0
Level II Reclamation	AC	425	$2,435	$3,495	$1,034,875	$1,485,375	1	$1,034,875	$1,485,375
Level III A Reclamation	AC	0	$9,505		$0		1	$0	$0
Level III B Reclamation	AC	0	$5,600		$0		1	$0	$0
Level III C Reclamation	AC	0	$4,350		$0		1	$0	$0
Dust Control	AC	425	$200		$85,000		1	$85,000	$85,000
Stormwater Drainage (100 LF/AC)	AC	425	$90		$38,250		1	$38,250	$38,250
Air Monitoring	EA	6	$3,350		$20,100		1	$20,100	$20,100
Route Stormwater to Opportunity Ponds	LS	1	$980,000		$980,000		1	$980,000	$980,000
Subtotal					$2,540,725	$2,991,225		$2,540,725	$2,991,225
2. Indirect Costs									
Field Indirect (2%)					$50,815	$59,825		$50,815	$59,825
Supervision, Inspection, & Overhead (4%)					$101,629	$119,649		$101,629	$119,649
Contractor Profit (10%)					$254,073	$299,123		$254,073	$299,123
Contractor Bonds (5%)					$127,036	$149,561		$127,036	$149,561
Design (4%)					$101,629	$119,649		$101,629	$119,649
Resident Engineering (3%)					$76,222	$89,737		$76,222	$89,737
Contingency (20%)					$508,145	$598,245		$508,145	$598,245
TOTAL CAPITAL COSTS					$3,760,000	$4,427,000		$3,760,000	$4,427,000

B. O & M COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098
Vegetation Repair	AC	4.25	$1,290	$5,483	2 thru 30	$62,906
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Stormwater Management	LS	1	$63,000	$63,000	2 thru 30	$722,862
Subtotal				$80,749		$926,508
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$3,230		$37,060
Contractor Bonds (5%)				$4,037		$46,325
Contractor Profit (10%)				$8,075		$92,651
Contingency (20%)				$16,150		$185,302
TOTAL O&M COSTS				$112,200		$1,287,800

TOTAL ALTERNATIVE COSTS	Present Worth Min	Present Worth Max
	$5,048,000	$5,715,000

TABLE E-8
NORTH OPPORTUNITY SUBAREA
WARM SPRINGS CREEK SST AREA OF CONCERN
Alternative - No Further Action (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Institutional Controls *	LS	0	0.00	$0	1	$0
Subtotal				$0		$0
2. Indirect Costs						
Field Indirect (0%)				$0		$0
Supervision, Inspection, & Overhead (4%)				$0		$0
Contractor Profit (10%)				$0		$0
Contractor Bonds (5%)				$0		$0
Design (0%)				$0		$0
Resident Engineering (0%)				$0		$0
Contingency (20%)				$0		$0
TOTAL CAPITAL COSTS				$0		$0
B. O & M COSTS						
1. Direct Costs						
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Subtotal				$666		$7,642
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$27		$306
Contractor Bonds (5%)				$33		$382
Contractor Profit (10%)				$67		$764
Contingency (20%)				$133		$1,528
TOTAL O&M COSTS				$900		$10,600
TOTAL ALTERNATIVE COSTS						$11,000

* Already established through Superfund Overlay District

TABLE E-9
NORTH OPPORTUNITY SUBAREA
WARM SPRINGS CREEK SST AREA OF CONCERN
Alternative - Capping (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Mobilization/Demobilization	AC	1	$100	$100	1	$100
Site Preparation (clearing and grading)	AC	1	$2,850	$2,850	1	$2,850
Foundation Layer (ripping and compacting)	AC	1	$8,100	$8,100	1	$8,100
Geosynthetic Clay Liner	AC	1	$22,500	$22,500	1	$22,500
Protective Soil Cover (18")	AC	1	$6,703	$6,703	1	$6,703
Vegetation	AC	1	$1,290	$1,290	1	$1,290
Haul (2 miles)	AC	1	$5,469	$5,469	1	$5,469
Stormwater Drainage Ditches (100 LF/AC)	AC	1	$90	$90	1	$90
Roads - Temporary	AC	1	$470	$470	1	$470
Dust Control	AC	1	$200	$200	1	$200
Air Monitoring	EA	4	$3,350	$13,400	1	$13,400
Consolidation	CY	100	$5.37	$537	1	$537
New Bridge	LS	1	$15,000	$15,000	1	$15,000
Stream Bank Erosion Control	AC	1	$4,493	$4,493	1	$4,493
Revegetation - riparian	AC	1	$710	$710	1	$710
Subtotal				$81,912		$81,912
2. Indirect Costs						
Field Indirect (2%)				$1,638		$1,638
Supervision, Inspection, & Overhead (4%)				$3,276		$3,276
Contractor Profit (10%)				$8,191		$8,191
Contractor Bonds (5%)				$4,096		$4,096
Design (6%)				$4,915		$4,915
Resident Engineering (3%)				$2,457		$2,457
Contingency (20%)				$16,382		$16,382
TOTAL CAPITAL COSTS				$123,000		$123,000

B. O & M COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098
Cap Repair / Vegetation	AC	0.01	$13,462	$135	2 thru 30	$1,545
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Subtotal				$12,401		$142,285
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$496		$5,691
Contractor Bonds (5%)				$620		$7,114
Contractor Profit (10%)				$1,240		$14,228
Contingency (20%)				$2,480		$28,457
TOTAL O&M COSTS				$17,200		$197,800
TOTAL ALTERNATIVE COSTS						$321,000

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TABLE E-10
NORTH OPPORTUNITY SUBAREA
WARM SPRINGS CREEK SST AREA OF CONCERN
Alternative - Land Reclamation (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
			Min	Max	Min	Max		Min	Max
Mobilization/Demobilization	AC	1	$100		$100		1	$100	$100
Site Preparation	AC	1	$800		$800		1	$800	$800
Level I Reclamation	AC	0	$945		$0		1	$0	$0
Level II Reclamation	AC	0	$2,435		$0		1	$0	$0
Level III A Reclamation	AC	0	$9,505		$0		1	$0	$0
Level III B Reclamation	AC	0	$5,600		$0		1	$0	$0
Level III C Reclamation	AC	1	$4,530	$16,610	$4,530	$16,610	1	$4,530	$16,610
Dust Control	AC	1	$200		$200		1	$200	$200
New Bridge	LS	1	$15,000		$15,000		1	$15,000	$15,000
Roads	LS	1	$1,638		$1,638		1	$1,638	$1,638
Stormwater Drainage (100 LF/AC)	AC	1	$90		$90		1	$90	$90
Stream Bank Erosion Control	AC	1	$4,493		$4,493		1	$4,493	$4,493
Revegetation - riparian	AC	1	$710		$710		1	$710	$710
Air Monitoring	EA	4	$3,350		$13,400		1	$13,400	$13,400
Subtotal					$40,961	$53,041		$40,961	$53,041
2. Indirect Costs									
Field Indirect (2%)					$819	$1,061		$819	$1,061
Supervision, Inspection, & Overhead (4%)					$1,638	$2,122		$1,638	$2,122
Contractor Profit (10%)					$4,096	$5,304		$4,096	$5,304
Contractor Bonds (5%)					$2,048	$2,652		$2,048	$2,652
Design (6%)					$2,458	$3,182		$2,458	$3,182
Resident Engineering (3%)					$1,229	$1,591		$1,229	$1,591
Contingency (20%)					$8,192	$10,608		$8,192	$10,608
TOTAL CAPITAL COSTS					$61,000	$80,000		$61,000	$80,000

B. O & M COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
Quarterly Inspection	EA	4	$2,900		$11,600		2 thru 30	$133,098	
Vegetation Repair	AC	0.01	$1,290		$13		2 thru 30	$148	
Site Review	EA/5 yr	0.20	$3,330		$666		2 thru 30	$7,642	
Subtotal					$12,279			$140,888	
2. Indirect Costs									
Supervision, Inspection, & Overhead (4%)					$491			$5,636	
Contractor Bonds (5%)					$614			$7,044	
Contractor Profit (10%)					$1,228			$14,089	
Contingency (20%)					$2,456			$28,178	
TOTAL O&M COSTS					$17,100			$195,800	
TOTAL ALTERNATIVE COSTS								$257,000	$276,000

TABLE E-11
NORTH OPPORTUNITY SUBAREA
WARM SPRINGS CREEK SST AREA OF CONCERN
Alternative - Removal (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
New Bridge	LS	1	$15,000	$15,000	1	$15,000
Excavation	CY	1,400	$1.50	$2,100	1	$2,100
Haul	CY	1,400	$6.54	$9,156	1	$9,156
Roads	CY	1,400	$1.17	$1,638	1	$1,638
Erosion	CY	1,400	$1.00	$1,400	1	$1,400
Mob/Demob	LS	1	$1,000	$1,000	1	$1,000
Other (H&S, Survey, Office, Security, etc)	CY	1,400	$1.63	$2,282	1	$2,282
Decon	CY	1,400	$0.05	$70	1	$70
Dust Control	CY	1,400	$0.22	$308	1	$308
Air Monitoring	EA	4	$3,350	$13,400	1	$13,400
Excavate Backfill Mat'l and placement	CY	500	$2.77	$1,385	1	$1,385
Haul Backfill Mat'l, 1 mile rt	CY	500	$1.91	$955	1	$955
Grading	SY	10,000	$0.13	$1,300	1	$1,300
Vegetation	AC	1	$1,290	$1,290	1	$1,290
Stream Bank Erosion Control	AC	1	$4,493	$4,493	1	$4,493
Revegetation - riparian	AC	1	$710	$710	1	$710
Subtotal				$56,487		$56,487
2. Indirect Costs						
Field Indirect (2%)				$1,130		$1,130
Supervision, Inspection, & Overhead (4%)				$2,259		$2,259
Contractor Profit (10%)				$5,649		$5,649
Contractor Bonds (5%)				$2,824		$2,824
Design (6%)				$3,389		$3,389
Resident Engineering (3%)				$1,695		$1,695
Contingency (20%)				$11,297		$11,297
TOTAL CAPITAL COSTS				$85,000		$85,000
TOTAL ALTERNATIVE COSTS						$85,000

TABLE E-12
OPPORTUNITY PONDS SUBAREA
HIGH ARSENIC SOILS AREA OF CONCERN
Alternative - No Further Action (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Institutional Controls *	LS	0	0.00	$0	1	$0
Subtotal				$0		$0
2. Indirect Costs						
Field Indirect (0%)				$0		$0
Supervision, Inspection, & Overhead (4%)				$0		$0
Contractor Profit (10%)				$0		$0
Contractor Bonds (5%)				$0		$0
Design (0%)				$0		$0
Resident Engineering (0%)				$0		$0
Contingency (20%)				$0		$0
TOTAL CAPITAL COSTS				$0		$0

B. O & M COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Subtotal				$666		$7,642
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$27		$306
Contractor Bonds (5%)				$33		$382
Contractor Profit (10%)				$67		$764
Contingency (20%)				$133		$1,528
TOTAL O&M COSTS				$900		$10,600
TOTAL ALTERNATIVE COSTS						$11,000

* Already established through Superfund Overlay District.

TABLE E-13
OPPORTUNITY PONDS SUBAREA
HIGH ARSENIC SOILS AREA OF CONCERN
Alternative - Soil Cover (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Mobilization/Demobilization	AC	356	$100	$35,600	1 thru 2	$32,182
Site Preparation (clearing and grading)	AC	356	$800	$284,800	1 thru 2	$257,459
Soil Cover (18")	AC	356	$6,703	$2,386,268	1 thru 2	$2,157,186
Vegetation	AC	356	$1,290	$459,240	1 thru 2	$415,153
Haul (2 miles)	AC	356	$5,469	$1,946,964	1 thru 2	$1,760,055
Stormwater Drainage Ditches (100 Lf/AC)	AC	356	$90	$32,040	1 thru 2	$28,964
Roads - Temporary	AC	356	$470	$167,320	1 thru 2	$151,257
Dust Control	AC	356	$200	$71,200	1 thru 2	$64,365
Air Monitoring	EA	24	$3,350	$80,400	1 thru 2	$72,682
Subtotal				$5,463,832		$4,939,304
2. Indirect Costs						
Field Indirect (2%)				$109,277		$98,786
Supervision, Inspection, & Overhead (4%)				$218,553		$197,572
Contractor Profit (10%)				$546,383		$493,930
Contractor Bonds (5%)				$273,192		$246,965
Design (4%)				$218,553		$197,572
Resident Engineering (3%)				$163,915		$148,179
Contingency (20%)				$1,092,766		$987,861
TOTAL CAPITAL COSTS				$8,086,000		$7,310,000

B. O & M COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098
Cover Repair / Vegetation	AC	3.56	$13,462	$47,925	2 thru 30	$549,888
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Subtotal				$60,191		$690,628
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$2,408		$27,625
Contractor Bonds (5%)				$3,010		$34,531
Contractor Profit (10%)				$6,019		$69,063
Contingency (20%)				$12,038		$138,126
TOTAL O&M COSTS				$83,700		$960,000
TOTAL ALTERNATIVE COSTS						$8,270,000

TABLE E-14
OPPORTUNITY PONDS SUBAREA
HIGH ARSENIC SOILS AREA OF CONCERN
Alternative - Land Reclamation (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
			Min	Max	Min	Max		Min	Max
Mobilization/Demobilization	AC	356	$100		$35,600		1	$35,600	$35,600
Site Preparation	AC	356	$800		$284,800		1	$284,800	$284,800
Level I Reclamation	AC	142	$945	$1,290	$134,190	$183,180	1	$134,190	$183,180
Level II Reclamation	AC	214	$2,435	$3,495	$521,090	$747,930	1	$521,090	$747,930
Level III A Reclamation	AC	0	$9,505		$0		1	$0	$0
Level III B Reclamation	AC	0	$5,600		$0		1	$0	$0
Level III C Reclamation	AC	0	$4,530		$0		1	$0	$0
Dust Control	AC	356	$200		$71,200		1	$71,200	$71,200
Stormwater Drainage (100 LF/AC)	AC	356	$90		$32,040		1	$32,040	$32,040
Air Monitoring	EA	6	$3,350		$20,100		1	$20,100	$20,100
Subtotal					$1,099,020	$1,374,850		$1,099,020	$1,374,850
2. Indirect Costs									
Field Indirect (2%)					$21,980	$27,497		$21,980	$27,497
Supervision, Inspection, & Overhead (4%)					$43,961	$54,994		$43,961	$54,994
Contractor Profit (10%)					$109,902	$137,485		$109,902	$137,485
Contractor Bonds (5%)					$54,951	$68,743		$54,951	$68,743
Design (4%)					$43,961	$54,994		$43,961	$54,994
Resident Engineering (3%)					$32,971	$41,246		$32,971	$41,246
Contingency (20%)					$219,804	$274,970		$219,804	$274,970
TOTAL CAPITAL COSTS					$1,627,000	$2,035,000		$1,627,000	$2,035,000

B. O & M COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth	
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098	
Vegetation Repair	AC	3.56	$1,290	$4,592	2 thru 30	$52,693	
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642	
Subtotal				$16,858		$193,433	
2. Indirect Costs							
Supervision, Inspection, & Overhead (4%)				$674		$7,737	
Contractor Bonds (5%)				$843		$9,672	
Contractor Profit (10%)				$1,686		$19,343	
Contingency (20%)				$3,372		$38,687	
TOTAL O&M COSTS				$23,400		$268,900	
TOTAL ALTERNATIVE COSTS						$1,896,000	$2,304,000

TABLE E-15
OPPORTUNITY PONDS SUBAREA
HIGH ARSENIC SOILS AREA OF CONCERN
Alternative - Partial Land Reclamation (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
			Min	Max	Min	Max		Min	Max
Mobilization/Demobilization	AC	45	$100		$4,500		1	$4,500	$4,500
Site Preparation	AC	45	$800		$36,000		1	$36,000	$36,000
Level I Reclamation - Highway Corridor	AC	45	$945	$1,290	$42,525	$58,050	1	$42,525	$58,050
Dust Control	AC	45	$200		$9,000		1	$9,000	$9,000
Stormwater Drainage (100 LF/AC)	AC	45	$90		$4,050		1	$4,050	$4,050
Fencing	LF	25,000	$10		$250,000		1	$250,000	$250,000
Air Monitoring	EA	4	$3,350		$13,400		1	$13,400	$13,400
Route Stormwater to Opportunity Ponds	LS	1	$1,000		$1,000		1	$1,000	$1,000
Subtotal					$360,475	$376,000		$360,475	$376,000
2. Indirect Costs									
Field Indirect (2%)					$7,210	$7,520		$7,210	$7,520
Supervision, Inspection, & Overhead (4%)					$14,419	$15,040		$14,419	$15,040
Contractor Profit (10%)					$36,048	$37,600		$36,048	$37,600
Contractor Bonds (5%)					$18,024	$18,800		$18,024	$18,800
Design (6%)					$21,629	$22,560		$21,629	$22,560
Resident Engineering (3%)					$10,814	$11,280		$10,814	$11,280
Contingency (20%)					$72,095	$75,200		$72,095	$75,200
TOTAL CAPITAL COSTS					$541,000	$564,000		$541,000	$564,000

B. O & M COSTS

1. Direct Costs						
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098
Vegetation Repair	AC	0.45	$1,290	$581	2 thru 30	$6,661
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Stormwater Management	LS	1	$100	$100	2 thru 30	$1,147
Subtotal				$12,947		$148,548
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$518		$5,942
Contractor Bonds (5%)				$647		$7,427
Contractor Profit (10%)				$1,295		$14,855
Contingency (20%)				$2,589		$29,710
TOTAL O&M COSTS				$18,000		$206,500

TOTAL ALTERNATIVE COSTS	Present Worth Min	Present Worth Max
	$748,000	$771,000

TABLE E-16
OPPORTUNITY PONDS SUBAREA
SPARSELY VEGETATED SOILS AREA OF CONCERN
Alternative - No Further Action (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Institutional Controls *	LS	0	0.00	$0	1	$0
Subtotal				$0		$0
2. Indirect Costs						
Field Indirect (0%)				$0		$0
Supervision, Inspection, & Overhead (4%)				$0		$0
Contractor Profit (10%)				$0		$0
Contractor Bonds (5%)				$0		$0
Design (0%)				$0		$0
Resident Engineering (0%)				$0		$0
Contingency (20%)				$0		$0
TOTAL CAPITAL COSTS				$0		$0

B. O & M COSTS

1. Direct Costs						
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Inspections	EA	1	$500	$500	2 thru 30	$5,737
Repair/Maint. of Prev. Reclaimed Area	AC	0.10	$1,290	$123	2 thru 30	$1,406
Subtotal				$1,289		$14,785
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$52		$591
Contractor Bonds (5%)				$64		$739
Contractor Profit (10%)				$129		$1,478
Contingency (20%)				$258		$2,957
TOTAL O&M COSTS				$1,800		$20,600
TOTAL ALTERNATIVE COSTS						$21,000

* Already established through Superfund Overlay District

TABLE E-17
OPPORTUNITY PONDS SUBAREA
SPARSELY VEGETATED SOILS AREA OF CONCERN
Alternative - Land Reclamation (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
			Min	Max	Min	Max		Min	Max
Mobilization/Demobilization	AC	491	$100		$49,100		1	$49,100	$49,100
Site Preparation	AC	491	$800		$392,800		1	$392,800	$392,800
Level I Reclamation	AC	300	$945	$1,290	$283,500	$387,000	1	$283,500	$387,000
Level II Reclamation	AC	191	$2,435	$3,495	$465,085	$667,545	1	$465,085	$667,545
Level III A Reclamation	AC	0	$9,505		$0		1	$0	$0
Level III B Reclamation	AC	0	$5,600		$0		1	$0	$0
Level III C Reclamation	AC	0	$4,530		$0		1	$0	$0
Dust Control	AC	491	$200		$98,200		1	$98,200	$98,200
Stormwater Drainage (100 LF/AC)	AC	491	$90		$44,190		1	$44,190	$44,190
Air Monitoring	EA	6	$3,350		$20,100		1	$20,100	$20,100
Subtotal					$1,352,975	$1,658,935		$1,352,975	$1,658,935
2. Indirect Costs									
Field Indirect (2%)					$27,060	$33,179		$27,060	$33,179
Supervision, Inspection, & Overhead (4%)					$54,119	$66,357		$54,119	$66,357
Contractor Profit (10%)					$135,298	$165,894		$135,298	$165,894
Contractor Bonds (5%)					$67,649	$82,947		$67,649	$82,947
Design (4%)					$54,119	$66,357		$54,119	$66,357
Resident Engineering (3%)					$40,589	$49,768		$40,589	$49,768
Contingency (20%)					$270,595	$331,787		$270,595	$331,787
TOTAL CAPITAL COSTS					$2,002,000	$2,455,000		$2,002,000	$2,455,000

B. O & M COSTS

1. Direct Costs							
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098	
Vegetation Repair	AC	4.90	$1,290	$6,321	2 thru 30	$72,527	
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642	
Subtotal				$18,587		$213,267	
2. Indirect Costs							
Supervision, Inspection, & Overhead (4%)				$743		$8,531	
Contractor Bonds (5%)				$929		$10,663	
Contractor Profit (10%)				$1,859		$21,327	
Contingency (20%)				$3,717		$42,653	
TOTAL O&M COSTS				$25,800		$296,400	
TOTAL ALTERNATIVE COSTS						$2,298,000	$2,751,000

TABLE E-18
OPPORTUNITY PONDS SUBAREA
SPARSELY VEGETATED SOILS AREA OF CONCERN
Alternative - Partial Land Reclamation (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
			Min	Max	Min	Max		Min	Max
Mobilization/Demobilization	AC	475	$100		$47,500		1	$47,500	$47,500
Site Preparation	AC	475	$800		$380,000		1	$380,000	$380,000
Level I Reclamation	AC	0	$945		$0		1	$0	$0
Level II Reclamation	AC	475	$2,435	$3,495	$1,156,625	$1,660,125	1	$1,156,625	$1,660,125
Level III A Reclamation	AC	0	$9,505		$0		1	$0	$0
Level III B Reclamation	AC	0	$5,600		$0		1	$0	$0
Level III C Reclamation	AC	0	$4,530		$0		1	$0	$0
Dust Control	AC	475	$200		$95,000		1	$95,000	$95,000
Stormwater Drainage (100 LF/AC)	AC	475	$90		$42,750		1	$42,750	$42,750
Air Monitoring	EA	6	$3,350		$20,100		1	$20,100	$20,100
Route Stormwater to Opportunity Ponds	LS	1	$60,000		$60,000		1	$60,000	$60,000
Subtotal					$1,801,975	$2,305,475		$1,801,975	$2,305,475
2. Indirect Costs									
Field Indirect (2%)					$36,040	$46,110		$36,040	$46,110
Supervision, Inspection, & Overhead (4%)					$72,079	$92,219		$72,079	$92,219
Contractor Profit (10%)					$180,198	$230,548		$180,198	$230,548
Contractor Bonds (5%)					$90,099	$115,274		$90,099	$115,274
Design (6%)					$108,119	$138,329		$108,119	$138,329
Resident Engineering (3%)					$54,059	$69,164		$54,059	$69,164
Contingency (20%)					$360,395	$461,095		$360,395	$461,095
TOTAL CAPITAL COSTS					$2,703,000	$3,458,000		$2,703,000	$3,458,000
B. O & M COSTS									
1. Direct Costs									
Quarterly Inspection	EA	4	$2,900		$11,600		2 thru 30	$133,098	
Vegetation Repair	AC	4.75	$1,290		$6,128		2 thru 30	$70,307	
Site Review	EA/5 yr	0.20	$3,330		$666		2 thru 30	$7,642	
Stormwater Management	LS	1	$8,000		$8,000		2 thru 30	$91,792	
Subtotal					$26,394			$302,839	
2. Indirect Costs									
Supervision, Inspection, & Overhead (4%)					$1,056			$12,114	
Contractor Bonds (5%)					$1,320			$15,142	
Contractor Profit (10%)					$2,639			$30,284	
Contingency (20%)					$5,279			$60,568	
TOTAL O&M COSTS					$36,700			$420,900	
TOTAL ALTERNATIVE COSTS								$3,124,000	$3,879,000

TABLE E-19
OPPORTUNITY PONDS SUBAREA
OPPORTUNITY PONDS AREA OF CONCERN
Alternative - No Further Action (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Institutional Controls *	LS	0	0.00	$0	1	$0
Subtotal				$0		$0
2. Indirect Costs						
Field Indirect (0%)				$0		$0
Supervision, Inspection, & Overhead (4%)				$0		$0
Contractor Profit (10%)				$0		$0
Contractor Bonds (5%)				$0		$0
Design (0%)				$0		$0
Resident Engineering (0%)				$0		$0
Contingency (20%)				$0		$0
TOTAL CAPITAL COSTS				$0		$0
B. O & M COSTS						
1. Direct Costs						
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Inspections	EA	1	$500	$500	2 thru 30	$5,737
Repair/Maint. of Prev. Reclaimed Area	AC	0.21	$1,290	$271	2 thru 30	$3,108
Subtotal				$1,437		$16,487
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$57		$659
Contractor Bonds (5%)				$72		$824
Contractor Profit (10%)				$144		$1,649
Contingency (20%)				$287		$3,297
TOTAL O&M COSTS				$2,000		$22,900
TOTAL ALTERNATIVE COSTS						$23,000

* Already established through Waste Management Development District and Superfund Overlay District

TABLE E-20
OPPORTUNITY PONDS SUBAREA
OPPORTUNITY PONDS AREA OF CONCERN
Alternative - Soil Cover (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Mobilization/Demobilization	AC	2,508	$100	$250,800	1 thru 10	$176,162
Site Preparation (clearing and grading)	AC	2,508	$800	$2,006,400	1 thru 10	$1,409,295
Soil Cover (18")	AC	2,508	$6,703	$16,811,124	1 thru 10	$11,808,133
Vegetation	AC	2,508	$1,290	$3,235,320	1 thru 10	$2,272,489
Haul (2 miles)	AC	2,508	$5,469	$13,716,252	1 thru 10	$9,634,295
Stormwater Drainage Ditches (100 Lf/AC)	AC	2,508	$90	$225,720	1 thru 10	$158,546
Roads - Temporary	AC	2,508	$470	$1,178,760	1 thru 10	$827,961
Consolidation	CY	74,100	$5.37	$397,917	1 thru 10	$279,497
Dust Control	AC	2,508	$200	$501,600	1 thru 10	$352,324
Air Monitoring	EA	156	$3,350	$522,600	1 thru 10	$367,074
Subtotal				$38,846,493		$27,285,777
2. Indirect Costs						
Field Indirect (2%)				$776,930		$545,716
Supervision, Inspection, & Overhead (4%)				$1,553,860		$1,091,431
Contractor Profit (10%)				$3,884,649		$2,728,578
Contractor Bonds (5%)				$1,942,325		$1,364,289
Design (2%)				$776,930		$545,716
Resident Engineering (2%)				$776,930		$545,716
Contingency (20%)				$7,769,299		$5,457,155
TOTAL CAPITAL COSTS				$56,327,000		$39,564,000

B. O & M COSTS

1. Direct Costs						
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098
Cover Repair / Vegetation	AC	25.08	$13,462	$337,627	2 thru 30	$3,873,932
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Subtotal				$349,893		$4,014,672
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$13,996		$160,587
Contractor Bonds (5%)				$17,495		$200,734
Contractor Profit (10%)				$34,989		$401,467
Contingency (20%)				$69,979		$802,934
TOTAL O&M COSTS				$486,400		$5,580,400
TOTAL ALTERNATIVE COSTS						$45,144,000

TABLE E-21
OPPORTUNITY PONDS SUBAREA
OPPORTUNITY PONDS AREA OF CONCERN
Alternative - Land Reclamation (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
			Min	Max	Min	Max		Min	Max
Mobilization/Demobilization	AC	2,508	$100		$250,800		1 thru 5	$205,656	$205,656
Site Preparation	AC	2,508	$800		$2,006,400		1 thru 5	$1,645,248	$1,645,248
Level I Reclamation	AC	0	$945		$0		1 thru 5	$0	$0
Level II Reclamation	AC	0	$2,435		$0		1 thru 5	$0	$0
Level III A Reclamation	AC	0	$9,505		$0		1 thru 5	$0	$0
Level III B Reclamation	AC	0	$5,600		$0		1 thru 5	$0	$0
Level III C Reclamation	AC	2,508	$4,530	$16,610	$11,361,240	$41,657,880	1 thru 5	$9,316,217	$34,159,462
Dust Control	AC	2,508	$200		$501,600		1 thru 5	$411,312	$411,312
Consolidation of Toe Area	CY	74,100	$5.37		$397,917		1 thru 5	$326,292	$326,292
Stormwater Drainage (100 LF/AC)	AC	2,508	$90		$225,720		1 thru 5	$185,090	$185,090
Air Monitoring	EA	30	$3,350		$100,500		1 thru 5	$82,410	$82,410
Subtotal					$14,844,177	$45,140,817		$12,172,225	$37,015,470
2. Indirect Costs									
Field Indirect (2%)					$296,884	$902,816		$243,445	$740,309
Supervision, Inspection, & Overhead (4%)					$593,767	$1,805,633		$486,889	$1,480,619
Contractor Profit (10%)					$1,484,418	$4,514,082		$1,217,223	$3,701,547
Contractor Bonds (5%)					$742,209	$2,257,041		$608,611	$1,850,773
Design (2%)					$296,884	$902,816		$243,445	$740,309
Resident Engineering (2%)					$296,884	$902,816		$243,445	$740,309
Contingency (20%)					$2,968,835	$9,028,163		$2,434,445	$7,403,094
TOTAL CAPITAL COSTS					$21,524,000	$65,454,000		$17,650,000	$53,672,000

B. O & M COSTS

1. Direct Costs							
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098	
Vegetation Repair	AC	25.08	$1,290	$32,353	2 thru 30	$371,221	
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642	
Subtotal				$44,619		$511,961	
2. Indirect Costs							
Supervision, Inspection, & Overhead (4%)				$1,785		$20,478	
Contractor Bonds (5%)				$2,231		$25,598	
Contractor Profit (10%)				$4,462		$51,196	
Contingency (20%)				$8,924		$102,392	
TOTAL O&M COSTS				$62,000		$711,600	
TOTAL ALTERNATIVE COSTS						$18,362,000	$54,384,000

TABLE E-22
OPPORTUNITY PONDS SUBAREA
OPPORTUNITY PONDS AREA OF CONCERN
Alternative - Partial Land Reclamation (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
			Min	Max	Min	Max		Min	Max
Mobilization/Demobilization	AC	2,508	$100		$250,800		1 thru 6	$199,261	$199,261
Site Preparation	AC	2,508	$800		$2,006,400		1 thru 6	$1,594,085	$1,594,085
Level I Reclamation - wind/wild life corroidor	AC	362	$945	$1,290	$342,090	$466,980	1 thru 6	$271,791	$371,016
Surface Grading	AC	2,146	$2,275		$4,882,150		1 thru 6	$3,878,868	$3,878,868
Rock Amendments (4" of pea gravel)	AC	2,146	$16,316		$35,014,136		1 thru 6	$27,818,731	$27,818,731
Air Monitoring	EA	36	$3,350		$120,600		1 thru 6	$95,817	$95,817
Dust Control	AC	2,508	$200		$501,600		1 thru 6	$398,521	$398,521
Consolidation of Toe Area	CY	74,100	$5.37		$397,917		1 thru 6	$316,145	$316,145
Stormwater Drainage (100 LF/AC)	AC	2,508	$90		$225,720		1 thru 6	$179,335	$179,335
Subtotal					$43,741,413	$43,866,303		$34,752,553	$34,851,778
2. Indirect Costs									
Field Indirect (2%)					$874,828	$877,326		$695,051	$697,036
Supervision, Inspection, & Overhead (4%)					$1,749,657	$1,754,652		$1,390,102	$1,394,071
Contractor Profit (10%)					$4,374,141	$4,386,630		$3,475,255	$3,485,178
Contractor Bonds (5%)					$2,187,071	$2,193,315		$1,737,628	$1,742,589
Design (2%)					$874,828	$877,326		$695,051	$697,036
Resident Engineering (2%)					$874,828	$877,326		$695,051	$697,036
Contingency (20%)					$8,748,283	$8,773,261		$6,950,511	$6,970,356
TOTAL CAPITAL COSTS					$63,425,000	$63,606,000		$50,391,000	$50,535,000

B. O & M COSTS

1. Direct Costs						
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098
Vegetation Repair	AC	25.08	$1,290	$32,353	2 thru 30	$371,221
Rock Repair	AC	11	$16,316	$175,071	2 thru 30	$2,008,761
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Subtotal				$219,690		$2,520,722
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$8,788		$100,829
Contractor Bonds (5%)				$10,984		$126,036
Contractor Profit (10%)				$21,969		$252,072
Contingency (20%)				$43,938		$504,144
TOTAL O&M COSTS				$305,400		$3,503,800

TOTAL ALTERNATIVE COSTS		Min	Max
TOTAL ALTERNATIVE COSTS		$53,895,000	$54,039,000

TABLE E-23
OPPORTUNITY PONDS SUBAREA
OPPORTUNITY PONDS AREA OF CONCERN
Alternative - Land Reclamation/Soil Cover (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
			Min	Max	Min	Max		Min	Max
Mobilization/Demobilization	AC	2,508	$100		$250,800		1 thru 6	$199,261	$199,261
Site Preparation	AC	2,508	$800		$2,006,400		1 thru 6	$1,594,085	$1,594,085
Level III C Reclamation - adjusted	AC	2,508	$4,530	$16,610	$11,361,240	$41,657,880	1 thru 6	$9,026,505	$33,097,186
Soil Cover (6")	AC	2,508	$2,234		$5,602,872		1 thru 6	$4,451,482	$4,451,482
Haul (2 miles)	AC	2,508	$5,469		$13,716,252		1 thru 6	$10,897,562	$10,897,562
Vegetation	AC	2,508	$1,290		$3,235,320		1 thru 6	$2,570,462	$2,570,462
Dust Control	AC	2,508	$200		$501,600		1 thru 6	$398,521	$398,521
Consolidation of Toe Area	CY	74,100	$5.37		$397,917		1 thru 6	$316,145	$316,145
Stormwater Drainage (100 LF/AC)	AC	2,508	$90		$225,720		1 thru 6	$179,335	$179,335
Air Monitoring	EA	36	$3,350		$120,600		1 thru 6	$95,817	$95,817
Subtotal					$37,418,721	$67,715,361		$29,729,174	$53,799,854
2. Indirect Costs									
Field Indirect (2%)					$748,374	$1,354,307		$594,583	$1,075,997
Supervision, Inspection, & Overhead (4%)					$1,496,749	$2,708,614		$1,189,167	$2,151,994
Contractor Profit (10%)					$3,741,872	$6,771,536		$2,972,917	$5,379,985
Contractor Bonds (5%)					$1,870,936	$3,385,768		$1,486,459	$2,689,993
Design (2%)					$748,374	$1,354,307		$594,583	$1,075,997
Resident Engineering (2%)					$748,374	$1,354,307		$594,583	$1,075,997
Contingency (20%)					$7,483,744	$13,543,072		$5,945,835	$10,759,971
TOTAL CAPITAL COSTS					$54,257,000	$98,187,000		$43,107,000	$78,010,000

B. O & M COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth	
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098	
Vegetation Repair	AC	25.08	$1,290	$32,353	2 thru 30	$371,221	
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642	
Subtotal				$44,619		$511,961	
2. Indirect Costs							
Supervision, Inspection, & Overhead (4%)				$1,785		$20,478	
Contractor Bonds (5%)				$2,231		$25,598	
Contractor Profit (10%)				$4,462		$51,196	
Contingency (20%)				$8,924		$102,392	
TOTAL O&M COSTS				$62,000		$711,600	
TOTAL ALTERNATIVE COSTS						$43,819,000	$78,722,000

TABLE E-24
OPPORTUNITY PONDS SUBAREA
OPPORTUNITY PONDS AREA OF CONCERN
Alternative - Rock Amendment (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Mobilization/Demobilization	AC	2,508	$100	$250,800	1 thru 6	$199,261
Site Preparation	AC	2,508	$800	$2,006,400	1 thru 6	$1,594,085
Surface Grading	AC	2,508	$2,275	$5,705,700	1 thru 6	$4,533,179
Rock Amendments (4" of pea gravel)	AC	2,508	$16,316	$40,920,528	1 thru 6	$32,511,359
Consolidation of Toe Area	CY	74,100	$5.37	$397,917	1 thru 6	$316,145
Roads	AC	2,508	$470	$1,178,760	1 thru 6	$936,525
Air Monitoring	EA	36	$3,350	$120,600	1 thru 6	$95,817
Dust Control During Construction	AC	2,508	$200	$501,600	1 thru 6	$398,521
Stormwater Drainage (100 LF/AC)	AC	2,508	$90	$225,720	1 thru 6	$179,335
Subtotal				$51,308,025		$40,764,226
2. Indirect Costs						
Field Indirect (2%)				$1,026,161		$815,285
Supervision, Inspection, & Overhead (4%)				$2,052,321		$1,630,569
Contractor Profit (10%)				$5,130,803		$4,076,423
Contractor Bonds (5%)				$2,565,401		$2,038,211
Design (2%)				$1,026,161		$815,285
Resident Engineering (2%)				$1,026,161		$815,285
Contingency (20%)				$10,261,605		$8,152,845
TOTAL CAPITAL COSTS				$74,397,000		$59,108,000
B. O & M COSTS						
1. Direct Costs						
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098
Repair	AC	25.08	$16,316	$409,205	2 thru 30	$4,695,221
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Subtotal				$421,471		$4,835,961
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$16,859		$193,438
Contractor Bonds (5%)				$21,074		$241,798
Contractor Profit (10%)				$42,147		$483,596
Contingency (20%)				$84,294		$967,192
TOTAL O&M COSTS				$585,800		$6,722,000
TOTAL ALTERNATIVE COSTS						$65,830,000

TABLE E-25
OPPORTUNITY PONDS SUBAREA
CELL A AREA OF CONCERN
Alternative - No Further Action (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Institutional Controls *	LS	0	0.00	$0	1	$0
Subtotal				$0		$0
2. Indirect Costs						
Field Indirect (0%)				$0		$0
Supervision, Inspection, & Overhead (4%)				$0		$0
Contractor Profit (10%)				$0		$0
Contractor Bonds (5%)				$0		$0
Design (0%)				$0		$0
Resident Engineering (0%)				$0		$0
Contingency (20%)				$0		$0
TOTAL CAPITAL COSTS				$0		$0

B. O & M COSTS

1. Direct Costs						
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Subtotal				$666		$7,642
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$27		$306
Contractor Bonds (5%)				$33		$382
Contractor Profit (10%)				$67		$764
Contingency (20%)				$133		$1,528
TOTAL O&M COSTS				$900		$10,600
TOTAL ALTERNATIVE COSTS						$11,000

* Already established through Waste Management Development District and Superfund Overlay District

OPPORTUNITY PONDS SUBAREA
CELL A AREA OF CONCERN
Alternative - Soil Cover

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Mobilization/Demobilization	AC	198	100	$19,800	1	$19,800
Site Preparation (clearing and grading)	AC	198	800	$158,400	1	$158,400
Soil Cover (18")	AC	198	6,703	$1,327,194	1	$1,327,194
Haul (2 miles)	AC	198	5,469	$1,082,862	1	$1,082,862
Vegetation	AC	198	1,290	$255,420	1	$255,420
Stormwater Drainage Ditches (100 LF/AC)	AC	198	90	$17,820	1	$17,820
Roads - Temporary	AC	198	470	$93,060	1	$93,060
Dust Control	AC	198	200	$39,600	1	$39,600
Air Monitoring	EA	6	3,350	$20,100	1	$20,100
Subtotal				$3,014,256		$3,014,256
2. Indirect Costs						
Field Indirect (2%)				$60,285		$60,285
Supervision, Inspection, & Overhead (4%)				$120,570		$120,570
Contractor Profit (10%)				$301,426		$301,426
Contractor Bonds (5%)				$150,713		$150,713
Design (6%)				$180,855		$180,855
Resident Engineering (3%)				$90,428		$90,428
Contingency (20%)				$602,851		$602,851
TOTAL CAPITAL COSTS				$4,521,000		$4,521,000

B. O & M COSTS

1. Direct Costs						
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098
Cover Repair / Vegetation	AC	1.98	$13,462	$26,655	2 thru 30	$305,837
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Subtotal				$38,921		$446,577
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$1,557		$17,863
Contractor Bonds (5%)				$1,946		$22,329
Contractor Profit (10%)				$3,892		$44,658
Contingency (20%)				$7,784		$89,315
TOTAL O&M COSTS				$54,100		$620,700
TOTAL ALTERNATIVE COSTS						$5,142,000

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OPPORTUNITY PONDS SUBAREA
CELL A AREA OF CONCERN
Alternative - Land Reclamation

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
			Min	Max	Min	Max		Min	Max
Mobilization/Demobilization	AC	198	$100		$19,800		1	$19,800	$19,800
Site Preparation	AC	198	$800		$158,400		1	$158,400	$158,400
Level I Reclamation	AC	0	$945		$0		1	$0	$0
Level II Reclamation	AC	0	$2,435		$0		1	$0	$0
Level III A Reclamation	AC	0	$9,505		$0		1	$0	$0
Level III B Reclamation	AC	0	$5,600		$0		1	$0	$0
Level III C Reclamation	AC	198	$4,530	$16,610	$896,940	$3,288,780	1	$896,940	$3,288,780
Dust Control	AC	198	$200		$39,600		1	$39,600	$39,600
Stormwater Drainage (100 LF/AC)	AC	198	$90		$17,820		1	$17,820	$17,820
Air Monitoring	EA	6	$3,350		$20,100		1	$20,100	$20,100
Subtotal					$1,152,660	$1,152,660		$1,152,660	$3,544,500
2. Indirect Costs									
Field Indirect (2%)					$23,053	$23,053		$23,053	$70,890
Supervision, Inspection, & Overhead (4%)					$46,106	$46,106		$46,106	$141,780
Contractor Profit (10%)					$115,266	$115,266		$115,266	$354,450
Contractor Bonds (5%)					$57,633	$57,633		$57,633	$177,225
Design (6%)					$69,160	$69,160		$69,160	$212,670
Resident Engineering (3%)					$34,580	$34,580		$34,580	$106,335
Contingency (20%)					$230,532	$230,532		$230,532	$708,900
TOTAL CAPITAL COSTS					$1,729,000	$1,729,000		$1,729,000	$5,317,000

B. O & M COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
Quarterly Inspection	EA	4	$2,900		$11,600		2 thru 30	$133,098	
Vegetation Repair	AC	1.98	$1,290		$2,554		2 thru 30	$29,307	
Site Review	EA/5 yr	0.20	$3,330		$666		2 thru 30	$7,642	
Subtotal					$14,820			$170,047	
2. Indirect Costs									
Supervision, Inspection, & Overhead (4%)					$593			$6,802	
Contractor Bonds (5%)					$741			$8,502	
Contractor Profit (10%)					$1,482			$17,005	
Contingency (20%)					$2,964			$34,009	
TOTAL O&M COSTS					$20,600			$236,400	
TOTAL ALTERNATIVE COSTS								$1,965,000	$5,553,000

TABLE E-26
OPPORTUNITY PONDS SUBAREA
CELL A AREA OF CONCERN
Alternative - Rock Amendment (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Mobilization/Demobilization	AC	198	$100	$19,800	1	$19,800
Site Preparation	AC	198	$800	$158,400	1	$158,400
Surface Grading	AC	198	$2,275	$450,450	1	$450,450
Rock Amendments (4" of pea gravel)	AC	198	$16,316	$3,230,568	1	$3,230,568
Roads	AC	198	$470	$93,060	1	$93,060
Air Monitoring	EA	6	$3,350	$20,100	1	$20,100
Dust Control During Construction	AC	198	$200	$39,600	1	$39,600
Stormwater Drainage (100 LF/AC)	AC	198	$90	$17,820	1	$17,820
Subtotal				$4,029,798		$4,029,798
2. Indirect Costs						
Field Indirect (2%)				$80,596		$80,596
Supervision, Inspection, & Overhead (4%)				$161,192		$161,192
Contractor Profit (10%)				$402,980		$402,980
Contractor Bonds (5%)				$201,490		$201,490
Design (6%)				$241,788		$241,788
Resident Engineering (3%)				$120,894		$120,894
Contingency (20%)				$805,960		$805,960
TOTAL CAPITAL COSTS				$6,045,000		$6,045,000

B. O & M COSTS

1. Direct Costs						
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098
Repair	AC	1.98	$16,316	$32,306	2 thru 30	$370,675
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Subtotal				$44,572		$511,415
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$1,783		$20,457
Contractor Bonds (5%)				$2,229		$25,571
Contractor Profit (10%)				$4,457		$51,142
Contingency (20%)				$8,914		$102,283
TOTAL O&M COSTS				$62,000		$710,900
TOTAL ALTERNATIVE COSTS						$6,756,000

TABLE E-27
OPPORTUNITY PONDS SUBAREA
SOUTH LIME DITCH AREA OF CONCERN
Alternative - No Further Action (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Institutional Controls *	LS	0	0.00	$0	1	$0
Subtotal				$0		$0
2. Indirect Costs						
Field Indirect (0%)				$0		$0
Supervision, Inspection, & Overhead (4%)				$0		$0
Contractor Profit (10%)				$0		$0
Contractor Bonds (5%)				$0		$0
Design (0%)				$0		$0
Resident Engineering (0%)				$0		$0
Contingency (20%)				$0		$0
TOTAL CAPITAL COSTS				$0		$0
B. O & M COSTS						
1. Direct Costs						
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Subtotal				$666		$7,642
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$27		$306
Contractor Bonds (5%)				$33		$382
Contractor Profit (10%)				$67		$764
Contingency (20%)				$133		$1,528
TOTAL O&M COSTS				$900		$10,600
TOTAL ALTERNATIVE COSTS						$11,000

* Already established through Superfund Overlay District

TABLE E-28
OPPORTUNITY PONDS SUBAREA
SOUTH LIME DITCH AREA OF CONCERN
Alternative - Capping (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Mobilization/Demobilization	AC	196	$100	$19,600	1	$19,600
Site Preparation (clearing and grading)	AC	196	$2,850	$558,600	1	$558,600
Foundation Layer (ripping and compacting)	AC	196	$8,100	$1,587,600	1	$1,587,600
Geosynthetic Clay Liner	AC	196	$22,500	$4,410,000	1	$4,410,000
Protective Soil Cover (18")	AC	196	$6,703	$1,313,788	1	$1,313,788
Vegetation	AC	196	$1,290	$252,840	1	$252,840
Haul (2 miles)	AC	196	$5,469	$1,071,924	1	$1,071,924
Stormwater Drainage Ditches (100 LF/AC)	AC	196	$90	$17,640	1	$17,640
Roads - Temporary	AC	196	$470	$92,120	1	$92,120
Dust Control	AC	196	$200	$39,200	1	$39,200
Air Monitoring	EA	12	$3,350	$40,200	1	$40,200
Subtotal				$9,403,512		$9,403,512
2. Indirect Costs						
Field Indirect (2%)				$188,070		$188,070
Supervision, Inspection, & Overhead (4%)				$376,140		$376,140
Contractor Profit (10%)				$940,351		$940,351
Contractor Bonds (5%)				$470,176		$470,176
Design (4%)				$376,140		$376,140
Resident Engineering (3%)				$282,105		$282,105
Contingency (20%)				$1,880,702		$1,880,702
TOTAL CAPITAL COSTS				$13,917,000		$13,917,000

B. O & M COSTS

1. Direct Costs						
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098
Cap Repair / Vegetation	AC	1.96	$13,462	$26,386	2 thru 30	$302,747
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Subtotal				$38,652		$443,488
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$1,546		$17,740
Contractor Bonds (5%)				$1,933		$22,174
Contractor Profit (10%)				$3,865		$44,349
Contingency (20%)				$7,730		$88,698
TOTAL O&M COSTS				$53,700		$616,400
TOTAL ALTERNATIVE COSTS						$14,533,000

TABLE E-29
OPPORTUNITY PONDS SUBAREA
SOUTH LIME DITCH AREA OF CONCERN
Alternative - Soil Cover (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Mobilization/Demobilization	AC	196	$100	$19,600	1 thru 2	$17,718
Site Preparation (clearing and grading)	AC	196	$800	$156,800	1 thru 2	$141,747
Soil Cover (18")	AC	196	$6,703	$1,313,788	1 thru 2	$1,187,664
Vegetation	AC	196	$1,290	$252,840	1 thru 2	$228,567
Haul (1 mile)	AC	196	$4,066	$796,936	1 thru 2	$720,430
Stormwater Drainage Ditches (100 Lf/AC)	AC	196	$90	$17,640	1 thru 2	$15,947
Roads - Temporary	AC	196	$470	$92,120	1 thru 2	$83,276
Dust Control	AC	196	$200	$39,200	1 thru 2	$35,437
Air Monitoring	EA	12	$3,350	$40,200	1 thru 2	$36,341
Subtotal				$2,729,124		$2,467,128
2. Indirect Costs						
Field Indirect (2%)				$54,582		$49,343
Supervision, Inspection, & Overhead (4%)				$109,165		$98,685
Contractor Profit (10%)				$272,912		$246,713
Contractor Bonds (5%)				$136,456		$123,356
Design (6%)				$163,747		$148,028
Resident Engineering (4%)				$109,165		$98,685
Contingency (20%)				$545,825		$493,426
TOTAL CAPITAL COSTS				$4,121,000		$3,725,000

B. O & M COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098
Cover Repair / Vegetation	AC	1.96	$13,462	$26,386	2 thru 30	$302,747
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Subtotal				$38,652		$443,488
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$1,546		$17,740
Contractor Bonds (5%)				$1,933		$22,174
Contractor Profit (10%)				$3,865		$44,349
Contingency (20%)				$7,730		$88,698
TOTAL O&M COSTS				$53,700		$616,400
TOTAL ALTERNATIVE COSTS						$4,341,000

TABLE E-30
OPPORTUNITY PONDS SUBAREA
SOUTH LIME DITCH AREA OF CONCERN
Alternative - Land Reclamation (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
			Min	Max	Min	Max		Min	Max
Mobilization/Demobilization	AC	196	$100		$19,600		1	$19,600	$19,600
Site Preparation	AC	196	$800		$156,800		1	$156,800	$156,800
Level I Reclamation	AC	0	$945		$0		1	$0	$0
Level II Reclamation	AC	0	$2,435		$0		1	$0	$0
Level III A Reclamation	AC	0	$9,505		$0		1	$0	$0
Level III B Reclamation	AC	0	$5,600		$0		1	$0	$0
Level III C Reclamation	AC	196	$4,530	$16,610	$887,880	$3,255,560	1	$887,880	$3,255,560
Dust Control	AC	196	$200		$39,200		1	$39,200	$39,200
Stormwater Drainage (100 LF/AC)	AC	196	$90		$17,640		1	$17,640	$17,640
Air Monitoring	EA	6	$3,350		$20,100		1	$20,100	$20,100
Subtotal					$1,141,220	$3,508,900		$1,141,220	$3,508,900
2. Indirect Costs									
Field Indirect (2%)					$22,824	$70,178		$22,824	$70,178
Supervision, Inspection, & Overhead (4%)					$45,649	$140,356		$45,649	$140,356
Contractor Profit (10%)					$114,122	$350,890		$114,122	$350,890
Contractor Bonds (5%)					$57,061	$175,445		$57,061	$175,445
Design (6%)					$68,473	$210,534		$68,473	$210,534
Resident Engineering (3%)					$34,237	$105,267		$34,237	$105,267
Contingency (20%)					$228,244	$701,780		$228,244	$701,780
TOTAL CAPITAL COSTS					$1,712,000	$5,263,000		$1,712,000	$5,263,000

B. O & M COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
Quarterly Inspection	EA	4	$2,900		$11,600		2 thru 30	$133,098	
Vegetation Repair	AC	1.96	$1,290		$2,528		2 thru 30	$29,011	
Site Review	EA/5 yr	0.20	$3,330		$666		2 thru 30	$7,642	
Subtotal					$14,794			$169,751	
2. Indirect Costs									
Supervision, Inspection, & Overhead (4%)					$592			$6,790	
Contractor Bonds (5%)					$740			$8,488	
Contractor Profit (10%)					$1,479			$16,975	
Contingency (20%)					$2,959			$33,950	
TOTAL O&M COSTS					$20,600			$236,000	
TOTAL ALTERNATIVE COSTS								$1,948,000	$5,499,000

TABLE E-31
OPPORTUNITY PONDS SUBAREA
SOUTH LIME DITCH AREA OF CONCERN
Alternative - Removal (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Excavate/Load/Haul/Unload/Disposal	CY	1,900,000	$5.51	$10,469,000	1 thru 6	$8,317,621
Clear/Grub and Erosion	CY	1,900,000	$0.18	$342,000	1 thru 6	$271,719
Roads	CY	1,900,000	$1.17	$2,223,000	1 thru 6	$1,766,174
Mob/Demob	CY	1,900,000	$0.10	$190,000	1 thru 6	$150,955
Other (H&S, Survey, Office, Security, etc)	CY	1,900,000	$1.62	$3,078,000	1 thru 6	$2,445,471
Decon	CY	1,900,000	$0.05	$95,000	1 thru 6	$75,478
Dust Control	CY	1,900,000	$0.03	$57,000	1 thru 6	$45,287
Air Monitoring	EA	36	$3,350	$120,600	1 thru 6	$95,817
Excavate Backfill Mat'l and placement	CY	530,000	$2.77	$1,468,100	1 thru 6	$1,166,405
Haul Backfill Mat'l, 1 mile rt	CY	530,000	$1.91	$1,012,300	1 thru 6	$804,272
Grading	SY	2,370,000	$0.13	$308,100	1 thru 6	$244,785
Vegetation	AC	490	$1,290	$632,100	1 thru 6	$502,203
Subtotal				$19,995,200		$15,886,186
2. Indirect Costs						
Field Indirect (2%)				$399,904		$317,724
Supervision, Inspection, & Overhead (4%)				$799,808		$635,447
Contractor Profit (10%)				$1,999,520		$1,588,619
Contractor Bonds (5%)				$999,760		$794,309
Design (2%)				$399,904		$317,724
Resident Engineering (1%)				$199,952		$158,862
Contingency (20%)				$3,999,040		$3,177,237
TOTAL CAPITAL COSTS				$28,793,000		$22,876,000
TOTAL ALTERNATIVE COSTS						$22,876,000

TABLE E-32
OPPORTUNITY PONDS SUBAREA
SOUTH LIME DITCH AREA OF CONCERN
Alternative - Partial Removal (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Excavate/Load/Haul/Unload/Disposal	CY	423,000	$5.51	$2,330,730	1 thru 3	$2,038,612
Clear/Grub and Erosion	CY	423,000	$0.18	$76,140	1 thru 3	$66,597
Roads	CY	423,000	$1.17	$494,910	1 thru 3	$432,881
Mob/Demob	CY	423,000	$0.10	$42,300	1 thru 3	$36,998
Other (H&S, Survey, Office, Security, etc)	CY	423,000	$1.62	$685,260	1 thru 3	$599,374
Decon	CY	423,000	$0.05	$21,150	1 thru 3	$18,499
Dust Control	CY	423,000	$0.03	$12,690	1 thru 3	$11,100
Air Monitoring	EA	18	$3,350	$60,300	1 thru 3	$52,742
Excavate Backfill Mat'l and placement	CY	211,500	$2.77	$585,855	1 thru 3	$512,428
Haul Backfill Mat'l, 1 mile rt	CY	211,500	$1.91	$403,965	1 thru 3	$353,335
Grading	SY	540,000	$0.13	$70,200	1 thru 3	$61,402
Vegetation	AC	112	$1,290	$144,480	1 thru 3	$126,372
Subtotal				$4,927,980		$4,310,340
2. Indirect Costs						
Field Indirect (2%)				$98,560		$86,207
Supervision, Inspection, & Overhead (4%)				$197,119		$172,414
Contractor Profit (10%)				$492,798		$431,034
Contractor Bonds (5%)				$246,399		$215,517
Design (2%)				$98,560		$86,207
Resident Engineering (1%)				$49,280		$43,103
Contingency (20%)				$985,596		$862,068
TOTAL CAPITAL COSTS				$7,096,000		$6,207,000
TOTAL ALTERNATIVE COSTS				$7,096,000		$6,207,000

TABLE E-33
OPPORTUNITY PONDS SUBAREA
TRIANGLE WASTE AREA OF CONCERN
Alternative - No Further Action (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Institutional Controls *	LS	0	0.00	$0	1	$0
Subtotal				$0		$0
2. Indirect Costs						
Field Indirect (0%)				$0		$0
Supervision, Inspection, & Overhead (4%)				$0		$0
Contractor Profit (10%)				$0		$0
Contractor Bonds (5%)				$0		$0
Design (0%)				$0		$0
Resident Engineering (0%)				$0		$0
Contingency (20%)				$0		$0
TOTAL CAPITAL COSTS				$0		$0
B. O & M COSTS						
1. Direct Costs						
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Inspections	EA	1	$500	$500	2 thru 30	$5,737
Repair/Maint. of Prev. Reclaimed Area	AC	0.07	$1,290	$84	2 thru 30	$962
Subtotal				$1,250		$14,341
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$50		$574
Contractor Bonds (5%)				$62		$717
Contractor Profit (10%)				$125		$1,434
Contingency (20%)				$250		$2,868
TOTAL O&M COSTS				$1,700		$19,900
TOTAL ALTERNATIVE COSTS						$20,000

* Already established through Superfund Overlay District

TABLE E-34
OPPORTUNITY PONDS SUBAREA
TRIANGLE WASTE AREA OF CONCERN
Alternative - Soil Cover (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Mobilization/Demobilization	AC	300	$100	$30,000	1 thru 2	$27,120
Site Preparation (clearing and grading)	AC	300	$800	$240,000	1 thru 2	$216,960
Soil Cover (18")	AC	300	$6,703	$2,010,900	1 thru 2	$1,817,854
Vegetation	AC	300	$1,290	$387,000	1 thru 2	$349,848
Haul (1 mile)	AC	300	$4,066	$1,219,800	1 thru 2	$1,102,699
Stormwater Drainage Ditches (100 Lf/AC)	AC	300	$90	$27,000	1 thru 2	$24,408
Roads - Temporary	AC	300	$470	$141,000	1 thru 2	$127,464
Dust Control	AC	300	$200	$60,000	1 thru 2	$54,240
Air Monitoring	EA	18	$3,350	$60,300	1 thru 2	$54,511
Subtotal				$4,176,000		$3,775,104
2. Indirect Costs						
Field Indirect (2%)				$83,520		$75,502
Supervision, Inspection, & Overhead (4%)				$167,040		$151,004
Contractor Profit (10%)				$417,600		$377,510
Contractor Bonds (5%)				$208,800		$188,755
Design (4%)				$167,040		$151,004
Resident Engineering (3%)				$125,280		$113,253
Contingency (20%)				$835,200		$755,021
TOTAL CAPITAL COSTS				$6,180,000		$5,587,000

B. O & M COSTS

1. Direct Costs						
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098
Cover Repair / Vegetation	AC	3.00	$13,462	$40,386	2 thru 30	$463,389
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Subtotal				$52,652		$604,129
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$2,106		$24,165
Contractor Bonds (5%)				$2,633		$30,206
Contractor Profit (10%)				$5,265		$60,413
Contingency (20%)				$10,530		$120,826
TOTAL O&M COSTS				$73,200		$839,700
TOTAL ALTERNATIVE COSTS						$6,427,000

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TABLE E-35
OPPORTUNITY PONDS SUBAREA
TRIANGLE WASTE AREA OF CONCERN
Alternative - Land Reclamation (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
			Min	Max	Min	Max		Min	Max
Mobilization/Demobilization	AC	300	$100		$30,000		1	$30,000	$30,000
Site Preparation	AC	300	$800		$240,000		1	$240,000	$240,000
Level I Reclamation	AC	0	$945		$0		1	$0	$0
Level II Reclamation	AC	0	$2,435		$0		1	$0	$0
Level III A Reclamation	AC	75	$9,505	$11,180	$712,875	$838,500	1	$712,875	$838,500
Level III B Reclamation	AC	0	$5,600		$0		1	$0	$0
Level III C Reclamation	AC	225	$4,530	$16,610	$1,019,250	$3,737,250	1	$1,019,250	$3,737,250
Dust Control	AC	300	$200		$60,000		1	$60,000	$60,000
Stormwater Drainage (100 LF/AC)	AC	300	$90		$27,000		1	$27,000	$27,000
Air Monitoring	EA	6	$3,350		$20,100		1	$20,100	$20,100
Subtotal					$2,109,225	$4,952,850		$2,109,225	$4,952,850
2. Indirect Costs									
Field Indirect (2%)					$42,185	$99,057		$42,185	$99,057
Supervision, Inspection, & Overhead (4%)					$84,369	$198,114		$84,369	$198,114
Contractor Profit (10%)					$210,923	$495,285		$210,923	$495,285
Contractor Bonds (5%)					$105,461	$247,643		$105,461	$247,643
Design (4%)					$84,369	$198,114		$84,369	$198,114
Resident Engineering (3%)					$63,277	$148,586		$63,277	$148,586
Contingency (20%)					$421,845	$990,570		$421,845	$990,570
TOTAL CAPITAL COSTS					$3,122,000	$7,330,000		$3,122,000	$7,330,000

B. O & M COSTS

1. Direct Costs									
Quarterly Inspection	EA	4	$2,900		$11,600		2 thru 30	$133,098	
Vegetation Repair	AC	3.00	$1,290		$3,870		2 thru 30	$44,404	
Site Review	EA/5 yr	0.20	$3,330		$666		2 thru 30	$7,642	
Subtotal					$16,136			$185,144	
2. Indirect Costs									
Supervision, Inspection, & Overhead (4%)					$645			$7,406	
Contractor Bonds (5%)					$807			$9,257	
Contractor Profit (10%)					$1,614			$18,514	
Contingency (20%)					$3,227			$37,029	
TOTAL O&M COSTS					$22,400			$257,400	
TOTAL ALTERNATIVE COSTS								$3,379,000	$7,587,000

TABLE E-36
OPPORTUNITY PONDS SUBAREA
TRIANGLE WASTE AREA OF CONCERN
Alternative - Partial Land Reclamation (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
			Min	Max	Min	Max		Min	Max
Mobilization/Demobilization	AC	86	$100		$8,600		1	$8,600	$8,600
Site Preparation	AC	86	$800		$68,800		1	$68,800	$68,800
Level I Reclamation - wind/wild life corridor	AC	86	$945	$1,290	$81,270	$110,940	1	$81,270	$110,940
Dust Control	AC	86	$200		$17,200		1	$17,200	$17,200
Stormwater Drainage (100 LF/AC)	AC	86	$90		$7,740		1	$7,740	$7,740
Air Monitoring	EA	6	$3,350		$20,100		1	$20,100	$20,100
Route Stormwater to Opportunity Ponds	LS	1	$0		$0		1	$0	$0
Subtotal					$203,710	$233,380		$203,710	$233,380
2. Indirect Costs									
Field Indirect (2%)					$4,074	$4,668		$4,074	$4,668
Supervision, Inspection, & Overhead (4%)					$8,148	$9,335		$8,148	$9,335
Contractor Profit (10%)					$20,371	$23,338		$20,371	$23,338
Contractor Bonds (5%)					$10,186	$11,669		$10,186	$11,669
Design (6%)					$12,223	$14,003		$12,223	$14,003
Resident Engineering (3%)					$6,111	$7,001		$6,111	$7,001
Contingency (20%)					$40,742	$46,676		$40,742	$46,676
TOTAL CAPITAL COSTS					$306,000	$350,000		$306,000	$350,000

B. O & M COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098
Vegetation Repair	AC	0.86	$1,290	$1,109	2 thru 30	$12,729
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Stormwater Management	LS	1	$500	$500	2 thru 30	$5,737
Subtotal				$13,875		$159,206
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$555		$6,368
Contractor Bonds (5%)				$694		$7,960
Contractor Profit (10%)				$1,388		$15,921
Contingency (20%)				$2,775		$31,841
TOTAL O&M COSTS				$19,300		$221,300

TOTAL ALTERNATIVE COSTS	Present Worth Min	Present Worth Max
	$527,000	$571,000

TABLE E-37
OPPORTUNITY PONDS SUBAREA
TRIANGLE WASTE AREA OF CONCERN
Alternative - Removal (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Excavate/Load/Haul/Unload/Disposal	CY	1,600,000	$5.51	$8,816,000	1 thru 10	$6,192,358
Clear/Grub and Erosion	CY	1,600,000	$0.18	$288,000	1 thru 10	$202,291
Roads	CY	1,600,000	$1.17	$1,872,000	1 thru 10	$1,314,893
Mob/Demob	CY	1,600,000	$0.10	$160,000	1 thru 10	$112,384
Other (H&S, Survey, Office, Security, etc)	CY	1,600,000	$1.62	$2,592,000	1 thru 10	$1,820,621
Decon	CY	1,600,000	$0.05	$80,000	1 thru 10	$56,192
Dust Control	CY	1,600,000	$0.24	$384,000	1 thru 10	$269,722
Air Monitoring	EA	60	$3,340	$200,400	1 thru 10	$140,761
Excavate Backfill Mat'l and placement	CY	485,000	$2.77	$1,343,450	1 thru 10	$943,639
Haul Backfill Mat'l, 2 mile rt	CY	485,000	$2.26	$1,096,100	1 thru 10	$769,901
Grading	SY	1,452,000	$0.13	$188,760	1 thru 10	$132,585
Vegetation	AC	300	$1,290	$387,000	1 thru 10	$271,829
Subtotal				$17,407,710		$12,227,176
2. Indirect Costs						
Field Indirect (2%)				$348,154		$244,544
Supervision, Inspection, & Overhead (4%)				$696,308		$489,087
Contractor Profit (10%)				$1,740,771		$1,222,718
Contractor Bonds (5%)				$870,386		$611,359
Design (2%)				$348,154		$244,544
Resident Engineering (1%)				$174,077		$122,272
Contingency (20%)				$3,481,542		$2,445,435
TOTAL CAPITAL COSTS				$25,067,000		$17,607,000
TOTAL ALTERNATIVE COSTS						$17,607,000

TABLE E-38
OLD WORKS/STUCKY RIDGE SUBAREA
HIGH ARSENIC SOILS AREA OF CONCERN
Alternative - No Further Action (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Institutional Controls *	LS	0	0.00	$0	1	$0
Subtotal				$0		$0
2. Indirect Costs						
Field Indirect (0%)				$0		$0
Supervision, Inspection, & Overhead (4%)				$0		$0
Contractor Profit (10%)				$0		$0
Contractor Bonds (5%)				$0		$0
Design (0%)				$0		$0
Resident Engineering (0%)				$0		$0
Contingency (20%)				$0		$0
TOTAL CAPITAL COSTS				$0		$0

B. O & M COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Inspections	EA	1	$500	$500	2 thru 30	$5,737
Repair/Maint. of Prev. Reclaimed Area	AC	0.23	$1,290	$290	2 thru 30	$3,330
Subtotal				$1,456		$16,709
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$58		$668
Contractor Bonds (5%)				$73		$835
Contractor Profit (10%)				$146		$1,671
Contingency (20%)				$291		$3,342
TOTAL O&M COSTS				$2,000		$23,200
TOTAL ALTERNATIVE COSTS						$23,000

* Already established through Superfund Overlay District

TABLE E-39
OLD WORKS/STUCKY RIDGE SUBAREA
HIGH ARSENIC SOILS AREA OF CONCERN
Alternative - Soil Cover (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Mobilization/Demobilization	AC	80	$100	$8,000	1	$8,000
Site Preparation (clearing and grading)	AC	80	$800	$64,000	1	$64,000
Soil Cover (18")	AC	80	$6,703	$536,240	1	$536,240
Vegetation	AC	80	$1,290	$103,200	1	$103,200
Haul (2 miles)	AC	80	$5,469	$437,520	1	$437,520
Stormwater Drainage Ditches (100 LF/AC)	AC	80	$90	$7,200	1	$7,200
Dozer Basins	AC	12	$500	$6,000	1	$6,000
Roads - Temporary	AC	80	$470	$37,600	1	$37,600
Dust Control	AC	80	$200	$16,000	1	$16,000
Air Monitoring	EA	6	$3,350	$20,100	1	$20,100
Subtotal				$1,235,860		$1,235,860
2. Indirect Costs						
Field Indirect (2%)				$24,717		$24,717
Supervision, Inspection, & Overhead (4%)				$49,434		$49,434
Contractor Profit (10%)				$123,586		$123,586
Contractor Bonds (5%)				$61,793		$61,793
Design (6%)				$74,152		$74,152
Resident Engineering (3%)				$37,076		$37,076
Contingency (20%)				$247,172		$247,172
TOTAL CAPITAL COSTS				$1,854,000		$1,854,000
B. O & M COSTS						
1. Direct Costs						
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098
Cover Repair / Vegetation	AC	0.80	$13,462	$10,770	2 thru 30	$123,570
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Subtotal				$23,036		$264,310
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$921		$10,572
Contractor Bonds (5%)				$1,152		$13,216
Contractor Profit (10%)				$2,304		$26,431
Contingency (20%)				$4,607		$52,862
TOTAL O&M COSTS				$32,000		$367,400
TOTAL ALTERNATIVE COSTS						$2,221,000

TABLE E-40
OLD WORKS / STUCKY RIDGE SUBAREA
HIGH ARSENIC SOILS AREA OF CONCERN
Alternative - Land Reclamation (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
			Min	Max	Min	Max		Min	Max
Mobilization/Demobilization	AC	80	$100		$8,000		1	$8,000	$8,000
Site Preparation	AC	80	$800		$64,000		1	$64,000	$64,000
Level I Reclamation	AC	0	$945		$0		1	$0	$0
Level II Reclamation	AC	65	$2,435	$3,495	$158,275	$227,175	1	$158,275	$227,175
Level III A Reclamation	AC	15	$9,505	$11,180	$142,575	$167,700	1	$142,575	$167,700
Level III B Reclamation	AC	0	$5,600		$0		1	$0	$0
Level III C Reclamation	AC	0	$4,530		$0		1	$0	$0
Dust Control	AC	80	$200		$16,000		1	$16,000	$16,000
Dozer Basins	AC	12	$500		$6,000		1	$6,000	$6,000
Stormwater Drainage (100 LF/AC)	AC	80	$90		$7,200		1	$7,200	$7,200
Air Monitoring	EA	6	$3,350		$20,100		1	$20,100	$20,100
Subtotal					$422,150	$516,175		$422,150	$516,175
2. Indirect Costs									
Field Indirect (2%)					$8,443	$10,324		$8,443	$10,324
Supervision, Inspection, & Overhead (4%)					$16,886	$20,647		$16,886	$20,647
Contractor Profit (10%)					$42,215	$51,618		$42,215	$51,618
Contractor Bonds (5%)					$21,108	$25,809		$21,108	$25,809
Design (6%)					$25,329	$30,971		$25,329	$30,971
Resident Engineering (3%)					$12,665	$15,485		$12,665	$15,485
Contingency (20%)					$84,430	$103,235		$84,430	$103,235
TOTAL CAPITAL COSTS					$633,000	$774,000		$633,000	$774,000

B. O & M COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth	
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098	
Vegetation Repair	AC	0.80	$1,290	$1,032	2 thru 30	$11,841	
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642	
Subtotal				$13,298		$152,581	
2. Indirect Costs							
Supervision, Inspection, & Overhead (4%)				$532		$6,103	
Contractor Bonds (5%)				$665		$7,629	
Contractor Profit (10%)				$1,330		$15,258	
Contingency (20%)				$2,660		$30,516	
TOTAL O&M COSTS				$18,500		$212,100	
TOTAL ALTERNATIVE COSTS						$845,000	$986,000

TABLE E-41
OLD WORKS / STUCKY RIDGE SUBAREA
HIGH ARSENIC SOILS AREA OF CONCERN
Alternative - Partial Land Reclamation (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
			Min	Max	Min	Max		Min	Max
Mobilization/Demobilization	AC	24	$100		$2,400		1	$2,400	$2,400
Site Preparation	AC	24	$800		$19,200		1	$19,200	$19,200
Level I Reclamation - Highway Corridor	AC	24	$945	$1,290	$22,680	$30,960	1	$22,680	$30,960
Dust Control	AC	24	$200		$4,800		1	$4,800	$4,800
Dozer Basins	AC	2	$500		$1,000		1	$1,000	$1,000
Stormwater Drainage (100 LF/AC)	AC	24	$90		$2,160		1	$2,160	$2,160
Fencing	LF	6,600	$10		$66,000		1	$66,000	$66,000
Air Monitoring	EA	6	$3,350		$20,100		1	$20,100	$20,100
Route Stormwater to Opportunity Ponds	LS	1	$0		$0		1	$0	$0
Subtotal					$138,340	$146,620		$138,340	$146,620
2. Indirect Costs									
Field Indirect (2%)					$2,767	$2,932		$2,767	$2,932
Supervision, Inspection, & Overhead (4%)					$5,534	$5,865		$5,534	$5,865
Contractor Profit (10%)					$13,834	$14,662		$13,834	$14,662
Contractor Bonds (5%)					$6,917	$7,331		$6,917	$7,331
Design (6%)					$8,300	$8,797		$8,300	$8,797
Resident Engineering (3%)					$4,150	$4,399		$4,150	$4,399
Contingency (20%)					$27,668	$29,324		$27,668	$29,324
TOTAL CAPITAL COSTS					$208,000	$220,000		$208,000	$220,000

B. O & M COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth	
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098	
Vegetation Repair	AC	0.24	$1,290	$310	2 thru 30	$3,552	
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642	
Stormwater Management	LS	1	$9,000	$9,000	2 thru 30	$103,266	
Subtotal				$21,576		$247,558	
2. Indirect Costs							
Supervision, Inspection, & Overhead (4%)				$863		$9,902	
Contractor Bonds (5%)				$1,079		$12,378	
Contractor Profit (10%)				$2,158		$24,756	
Contingency (20%)				$4,315		$49,512	
TOTAL O&M COSTS				$30,000		$344,100	
TOTAL ALTERNATIVE COSTS						$552,000	$564,000

TABLE E-42
OLD WORKS/STUCKY RIDGE SUBAREA
SPARSELY VEGETATED SOILS AREA OF CONCERN
Alternative - No Further Action (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Institutional Controls *	LS	0	0.00	$0	1	$0
Subtotal				$0		$0
2. Indirect Costs						
Field Indirect (0%)				$0		$0
Supervision, Inspection, & Overhead (4%)				$0		$0
Contractor Profit (10%)				$0		$0
Contractor Bonds (5%)				$0		$0
Design (0%)				$0		$0
Resident Engineering (0%)				$0		$0
Contingency (20%)				$0		$0
TOTAL CAPITAL COSTS				$0		$0
B. O & M COSTS						
1. Direct Costs						
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Inspections	EA	1	$500	$500	2 thru 30	$5,737
Repair/Maint. of Prev. Reclaimed Area	AC	1.39	$1,290	$1,793	2 thru 30	$20,574
Subtotal				$2,959		$33,953
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$118		$1,358
Contractor Bonds (5%)				$148		$1,698
Contractor Profit (10%)				$296		$3,395
Contingency (20%)				$592		$6,791
TOTAL O&M COSTS				$4,100		$47,200
TOTAL ALTERNATIVE COSTS						$47,000

* Already established through Superfund Overlay District, covenant restrictions on Ueland property, and development restrictions on Old Works Trail System parcel, Golf Course parcel, Ballfields/Industrial Park parcel, Stucky Ridge parcel, and Sewage Lagoon parcel.

TABLE E-43
OLD WORKS / STUCKY RIDGE SUBREA
SPARSELY VEGETATED SOILS AREA OF CONCERN
Alternative - Land Reclamation (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
			Min	Max	Min	Max		Min	Max
Mobilization/Demobilization	AC	4,949	$100		$494,900		1 thru 10	$347,618	$347,618
Site Preparation	AC	4,949	$800		$3,959,200		1 thru 10	$2,780,942	$2,780,942
Level I Reclamation	AC	1,900	$945	$1,290	$1,795,500	$2,451,000	1 thru 10	$1,261,159	$1,721,582
Level II Reclamation	AC	3,049	$2,435	$3,495	$7,424,315	$10,656,255	1 thru 10	$5,214,839	$7,484,954
Level III A Reclamation	AC	0	$9,505		$0		1 thru 10	$0	$0
Level III B Reclamation	AC	0	$5,600		$0		1 thru 10	$0	$0
Level III C Reclamation	AC	0	$4,530		$0		1 thru 10	$0	$0
Dust Control	AC	4,949	$200		$989,800		1 thru 10	$695,236	$695,236
Dozer Basins	AC	3,959	$500		$1,979,500		1 thru 10	$1,390,401	$1,390,401
Stormwater Drainage (100 LF/AC)	AC	4,949	$90		$445,410		1 thru 10	$312,856	$312,856
Air Monitoring	EA	60	$3,350		$201,000		1 thru 10	$141,182	$141,182
Subtotal					$17,289,625	$21,177,065		$12,144,233	$14,874,770
2. Indirect Costs									
Field Indirect (2%)					$345,793	$423,541		$242,885	$297,495
Supervision, Inspection, & Overhead (4%)					$691,585	$847,083		$485,769	$594,991
Contractor Profit (10%)					$1,728,963	$2,117,707		$1,214,423	$1,487,477
Contractor Bonds (5%)					$864,481	$1,058,853		$607,212	$743,739
Design (2%)					$345,793	$423,541		$242,885	$297,495
Resident Engineering (2%)					$345,793	$423,541		$242,885	$297,495
Contingency (20%)					$3,457,925	$4,235,413		$2,428,847	$2,974,954
TOTAL CAPITAL COSTS					$25,070,000	$30,707,000		$17,609,000	$21,568,000

B. O & M COSTS

1. Direct Costs									
Quarterly Inspection	EA	4	$2,900		$11,600		2 thru 30	$133,098	
Vegetation Repair	AC	49.49	$1,290		$63,842		2 thru 30	$732,524	
Site Review	EA/5 yr	0.20	$3,330		$666		2 thru 30	$7,642	
Subtotal					$76,108			$873,264	
2. Indirect Costs									
Supervision, Inspection, & Overhead (4%)					$3,044			$34,931	
Contractor Bonds (5%)					$3,805			$43,663	
Contractor Profit (10%)					$7,611			$87,326	
Contingency (20%)					$15,222			$174,653	
TOTAL O&M COSTS					$105,800			$1,213,800	
TOTAL ALTERNATIVE COSTS								$18,823,000	$22,782,000

TABLE E-44
OLD WORKS / STUCKY RIDGE SUBREA
SPARSELY VEGETATED SOILS AREA OF CONCERN
Alternative - Partial Land Reclamation (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
			Min	Max	Min	Max		Min	Max
Mobilization/Demobilization	AC	1,270	$100		$127,000		1 thru 3	$111,083	$111,083
Site Preparation	AC	1,270	$800		$1,016,000		1 thru 3	$888,661	$888,661
Level I Reclamation	AC	0	$945		$0		1 thru 3	$0	$0
Level II Reclamation	AC	1,270	$2,435	$3,495	$3,092,450	$4,438,650	1 thru 3	$2,704,863	$3,882,339
Level III A Reclamation	AC	0	$9,505		$0		1 thru 3	$0	$0
Level III B Reclamation	AC	0	$5,600		$0		1 thru 3	$0	$0
Level III C Reclamation	AC	0	$4,530		$0		1 thru 3	$0	$0
Dust Control	AC	1,270	$200		$254,000		1 thru 3	$222,165	$222,165
Dozer Basins	AC	1,270	$500		$635,000		1 thru 3	$555,413	$555,413
Stormwater Drainage (100 LF/AC)	AC	1,270	$90		$114,300		1 thru 3	$99,974	$99,974
Air Monitoring	EA	18	$3,350		$60,300		1 thru 3	$52,742	$52,742
Route Stormwater to Opportunity Ponds	LS	1	$890,000		$890,000		1 thru 3	$778,453	$778,453
Subtotal					$6,189,050	$7,535,250		$5,413,356	$6,590,832
2. Indirect Costs									
Field Indirect (2%)					$123,781	$150,705		$108,267	$131,817
Supervision, Inspection, & Overhead (4%)					$247,562	$301,410		$216,534	$263,633
Contractor Profit (10%)					$618,905	$753,525		$541,336	$659,083
Contractor Bonds (5%)					$309,453	$376,763		$270,668	$329,542
Design (2%)					$123,781	$150,705		$108,267	$131,817
Resident Engineering (2%)					$123,781	$150,705		$108,267	$131,817
Contingency (20%)					$1,237,810	$1,507;050		$1,082,671	$1,318,166
TOTAL CAPITAL COSTS					$8,974,000	$10,926,000		$7,849,000	$9,557,000
B. O & M COSTS									
1. Direct Costs									
Quarterly Inspection	EA	4	$2,900		$11,600		2 thru 30	$133,098	
Vegetation Repair	AC	12.70	$1,290		$16,383		2 thru 30	$187,979	
Site Review	EA/5 yr	0.20	$3,330		$666		2 thru 30	$7,642	
Stormwater Management	LS	1	$130,000		$130,000		2 thru 30	$1,491,620	
Subtotal					$158,649			$1,820,339	
2. Indirect Costs									
Supervision, Inspection, & Overhead (4%)					$6,346			$72,814	
Contractor Bonds (5%)					$7,932			$91,017	
Contractor Profit (10%)					$15,865			$182,034	
Contingency (20%)					$31,730			$364,068	
TOTAL O&M COSTS					$220,500			$2,530,300	
TOTAL ALTERNATIVE COSTS								$10,379,000	$12,087,000

TABLE E-45
SMELTER HILL SUBAREA
HIGH ARSENIC SOILS AREA OF CONCERN
Alternative - No Further Action (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Institutional Controls *	LS	0	0.00	$0	1	$0
Subtotal				$0		$0
2. Indirect Costs						
Field Indirect (0%)				$0		$0
Supervision, Inspection, & Overhead (4%)				$0		$0
Contractor Profit (10%)				$0		$0
Contractor Bonds (5%)				$0		$0
Design (0%)				$0		$0
Resident Engineering (0%)				$0		$0
Contingency (20%)				$0		$0
TOTAL CAPITAL COSTS				$0		$0

B. O & M COSTS

1. Direct Costs						
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Subtotal				$666		$7,642
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$27		$306
Contractor Bonds (5%)				$33		$382
Contractor Profit (10%)				$67		$764
Contingency (20%)				$133		$1,528
TOTAL O&M COSTS				$900		$10,600
TOTAL ALTERNATIVE COSTS						$11,000

* Already established through Superfund Overlay District

TABLE E-46
SMELTER HILL SUBAREA
HIGH ARSENIC SOILS AREA OF CONCERN
Alternative - Soil Cover (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Mobilization/Demobilization	AC	520	$100	$52,000	1 thru 2	$47,008
Site Preparation (clearing and grading)	AC	520	$800	$416,000	1 thru 2	$376,064
Soil Cover (18")	AC	520	$6,703	$3,485,560	1 thru 2	$3,150,946
Vegetation	AC	520	$1,290	$670,800	1 thru 2	$606,403
Haul (2 miles)	AC	520	$5,469	$2,843,880	1 thru 2	$2,570,868
Stormwater Drainage Ditches (100 LF/AC)	AC	520	$90	$46,800	1 thru 2	$42,307
Dozer Basins	AC	468	$500	$234,000	1 thru 2	$211,536
Roads - Temporary	AC	520	$470	$244,400	1 thru 2	$220,938
Dust Control	AC	520	$200	$104,000	1 thru 2	$94,016
Air Monitoring	EA	36	$3,350	$120,600	1 thru 2	$109,022
Subtotal				$8,218,040		$7,429,108
2. Indirect Costs						
Field Indirect (2%)				$164,361		$148,582
Supervision, Inspection, & Overhead (4%)				$328,722		$297,164
Contractor Profit (10%)				$821,804		$742,911
Contractor Bonds (5%)				$410,902		$371,455
Design (4%)				$328,722		$297,164
Resident Engineering (3%)				$246,541		$222,873
Contingency (20%)				$1,643,608		$1,485,822
TOTAL CAPITAL COSTS				$12,163,000		$10,995,000

B. O & M COSTS

1. Direct Costs						
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098
Cover Repair / Vegetation	AC	5.20	$13,462	$70,002	2 thru 30	$803,208
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$4
Subtotal				$82,268		$936,310
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$3,291		$37,452
Contractor Bonds (5%)				$4,113		$46,815
Contractor Profit (10%)				$8,227		$93,631
Contingency (20%)				$16,454		$187,262
TOTAL O&M COSTS				$114,400		$1,301,500
TOTAL ALTERNATIVE COSTS						$12,297,000

TABLE E-47
SMELTER HILL SUBAREA
HIGH ARSENIC SOILS AREA OF CONCERN
Alternative - Land Reclamation (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
			Min	Max	Min	Max		Min	Max
Mobilization/Demobilization	AC	520	$100		$52,000		1 thru 2	$47,008	$47,008
Site Preparation	AC	520	$800		$416,000		1 thru 2	$376,064	$376,064
Level I Reclamation	AC	260	$945	$1,290	$245,700	$335,400	1 thru 2	$222,113	$303,202
Level II Reclamation	AC	260	$2,435	$3,495	$633,100	$908,700	1 thru 2	$572,322	$821,465
Level III A Reclamation	AC	0	$9,505		$0		1 thru 2	$0	$0
Level III B Reclamation	AC	0	$5,600		$0		1 thru 2	$0	$0
Level III C Reclamation	AC	0	$4,530		$0		1 thru 2	$0	$0
Dust Control	AC	520	$200		$104,000		1 thru 2	$94,016	$94,016
Dozer Basins	AC	468	$500		$234,000		1 thru 2	$211,536	$211,536
Stormwater Drainage (100 LF/AC)	AC	520	$90		$46,800		1 thru 2	$42,307	$42,307
Air Monitoring	EA	12	$3,350		$40,200		1 thru 2	$36,341	$36,341
Subtotal					$1,771,800	$2,137,100		$1,601,707	$1,931,938
2. Indirect Costs									
Field Indirect (2%)					$35,436	$42,742		$32,034	$38,639
Supervision, Inspection, & Overhead (4%)					$70,872	$85,484		$64,068	$77,278
Contractor Profit (10%)					$177,180	$213,710		$160,171	$193,194
Contractor Bonds (5%)					$88,590	$106,855		$80,085	$96,597
Design (4%)					$70,872	$85,484		$64,068	$77,278
Resident Engineering (3%)					$53,154	$64,113		$48,051	$57,958
Contingency (20%)					$354,360	$427,420		$320,341	$386,388
TOTAL CAPITAL COSTS					$2,622,000	$3,163,000		$2,371,000	$2,859,000

B. O & M COSTS

1. Direct Costs							
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098	
Vegetation Repair	AC	5.20	$1,290	$6,708	2 thru 30	$76,968	
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642	
Subtotal				$18,974		$217,708	
2. Indirect Costs							
Supervision, Inspection, & Overhead (4%)				$759		$8,708	
Contractor Bonds (5%)				$949		$10,885	
Contractor Profit (10%)				$1,897		$21,771	
Contingency (20%)				$3,795		$43,542	
TOTAL O&M COSTS				$26,400		$302,600	
TOTAL ALTERNATIVE COSTS						$2,674,000	$3,162,000

TABLE E-48
SMELTER HILL SUBAREA
HIGH ARSENIC SOILS AREA OF CONCERN
Alternative - Partial Land Reclamation (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
			Min	Max	Min	Max		Min	Max
Mobilization/Demobilization	AC	20	$100		$2,000		1	$2,000	$2,000
Site Preparation	AC	20	$800		$16,000		1	$16,000	$16,000
Level I Reclamation - Highway Corridor	AC	20	$945	$1,290	$18,900	$25,800	1	$18,900	$25,800
Dust Control	AC	20	$200		$4,000		1	$4,000	$4,000
Dozer Basins	AC	20	$22		$440		1	$440	$440
Stormwater Drainage (100 LF/AC)	AC	20	$90		$1,800		1	$1,800	$1,800
Fencing	LF	56,000	$10		$560,000		1	$560,000	$560,000
Air Monitoring	EA	6	$3,350		$20,100		1	$20,100	$20,100
Route Stormwater to Opportunity Ponds	LS	1	$422,000		$422,000		1	$422,000	$422,000
Subtotal					$1,045,240	$1,052,140		$1,045,240	$1,052,140
2. Indirect Costs									
Field Indirect (2%)					$20,905	$21,043		$20,905	$21,043
Supervision, Inspection, & Overhead (4%)					$41,810	$42,086		$41,810	$42,086
Contractor Profit (10%)					$104,524	$105,214		$104,524	$105,214
Contractor Bonds (5%)					$52,262	$52,607		$52,262	$52,607
Design (6%)					$62,714	$63,128		$62,714	$63,128
Resident Engineering (3%)					$31,357	$31,564		$31,357	$31,564
Contingency (20%)					$209,048	$210,428		$209,048	$210,428
TOTAL CAPITAL COSTS					$1,568,000	$1,578,000		$1,568,000	$1,578,000
B. O & M COSTS									
1. Direct Costs									
Quarterly Inspection	EA	4	$2,900		$11,600		2 thru 30	$133,098	
Vegetation Repair	AC	0.20	$1,290		$258		2 thru 30	$2,960	
Site Review	EA/5 yr	0.20	$3,330		$666		2 thru 30	$7,642	
Stormwater Management	LS	1	$70,000		$70,000		2 thru 30	$803,180	
Subtotal					$82,524			$946,880	
2. Indirect Costs									
Supervision, Inspection, & Overhead (4%)					$3,301			$37,875	
Contractor Bonds (5%)					$4,126			$47,344	
Contractor Profit (10%)					$8,252			$94,688	
Contingency (20%)					$16,505			$189,376	
TOTAL O&M COSTS					$114,700			$1,316,200	
TOTAL ALTERNATIVE COSTS								$2,884,000	$2,894,000

TABLE E-49
SMELTER HILL SUBAREA
SPARSELY VEGETATED SOILS AREA OF CONCERN
Alternative - No Further Action (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Institutional Controls *	LS	0	0.00	$0	1	$0
Subtotal				$0		$0
2. Indirect Costs						
Field Indirect (0%)				$0		$0
Supervision, Inspection, & Overhead (4%)				$0		$0
Contractor Profit (10%)				$0		$0
Contractor Bonds (5%)				$0		$0
Design (0%)				$0		$0
Resident Engineering (0%)				$0		$0
Contingency (20%)				$0		$0
TOTAL CAPITAL COSTS				$0		$0

B. O & M COSTS

1. Direct Costs						
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Subtotal				$666		$7,642
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$27		$306
Contractor Bonds (5%)				$33		$382
Contractor Profit (10%)				$67		$764
Contingency (20%)				$133		$1,528
TOTAL O&M COSTS				$900		$10,600
TOTAL ALTERNATIVE COSTS						$11,000

* Already established through Superfund Overlay District, conservation easements on WH Ranch Company property, and covenants on the Willow Glen Property.

TABLE E-50
SMELTER HILL SUBAREA
SPARSELY VEGETATED SOILS AREA OF CONCERN
Alternative - Land Reclamation (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
			Min	Max	Min	Max		Min	Max
Mobilization/Demobilization	AC	2,466	$100		$246,600		1 thru 5	$202,212	$202,212
Site Preparation	AC	2,466	$800		$1,972,800		1 thru 5	$1,617,696	$1,617,696
Level I Reclamation	AC	1,233	$945	$1,290	$1,165,185	$1,590,570	1 thru 5	$955,452	$1,304,267
Level II Reclamation	AC	1,233	$2,435	$3,495	$3,002,355	$4,309,335	1 thru 5	$2,461,931	$3,533,655
Level III A Reclamation	AC	0	$9,505		$0		1 thru 5	$0	$0
Level III B Reclamation	AC	0	$5,600		$0		1 thru 5	$0	$0
Level III C Reclamation	AC	0	$4,530		$0		1 thru 5	$0	$0
Dust Control	AC	2,466	$200		$493,200		1 thru 5	$404,424	$404,424
Dozer Basins	AC	2,220	$500		$1,110,000		1 thru 5	$910,200	$910,200
Stormwater Drainage (100 LF/AC)	AC	2,466	$90		$221,940		1 thru 5	$181,991	$181,991
Air Monitoring	EA	30	$3,350		$100,500		1 thru 5	$82,410	$82,410
Subtotal					$8,312,580	$10,044,945		$6,816,316	$8,236,855
2. Indirect Costs									
Field Indirect (2%)					$166,252	$200,899		$136,326	$164,737
Supervision, Inspection, & Overhead (4%)					$332,503	$401,798		$272,653	$329,474
Contractor Profit (10%)					$831,258	$1,004,495		$681,632	$823,685
Contractor Bonds (5%)					$415,629	$502,247		$340,816	$411,843
Design (2%)					$166,252	$200,899		$136,326	$164,737
Resident Engineering (2%)					$166,252	$200,899		$136,326	$164,737
Contingency (20%)					$1,662,516	$2,008,989		$1,363,263	$1,647,371
TOTAL CAPITAL COSTS					$12,053,000	$14,565,000		$9,884,000	$11,943,000

B. O & M COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
Quarterly Inspection	EA	4	$2,900		$11,600		2 thru 30	$133,098	
Vegetation Repair	AC	24.66	$1,290		$31,811		2 thru 30	$365,004	
Site Review	EA/5 yr	0.20	$3,330		$666		2 thru 30	$7,642	
Subtotal					$44,077			$505,744	
2. Indirect Costs									
Supervision, Inspection, & Overhead (4%)					$1,763			$20,230	
Contractor Bonds (5%)					$2,204			$25,287	
Contractor Profit (10%)					$4,408			$50,574	
Contingency (20%)					$8,815			$101,149	
TOTAL O&M COSTS					$61,300			$703,000	
TOTAL ALTERNATIVE COSTS								$10,587,000	$12,646,000

TABLE E-51
SMELTER HILL SUBAREA
SPARSELY VEGETATED SOILS AREA OF CONCERN
Alternative - Partial Land Reclamation (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
			Min	Max	Min	Max		Min	Max
Mobilization/Demobilization	AC	1,470	$100		$147,000		1 thru 3	$128,576	$128,576
Site Preparation	AC	1,470	$800		$1,176,000		1 thru 3	$1,028,608	$1,028,608
Level I Reclamation	AC	0	$945		$0		1 thru 3	$0	$0
Level II Reclamation	AC	1,470	$2,435	$3,495	$3,579,450	$5,137,650	1 thru 3	$3,130,826	$4,493,731
Level III A Reclamation	AC	0	$9,505		$0		1 thru 3	$0	$0
Level III B Reclamation	AC	0	$5,600		$0		1 thru 3	$0	$0
Level III C Reclamation	AC	0	$4,530		$0		1 thru 3	$0	$0
Dust Control	AC	1,470	$200		$294,000		1 thru 3	$257,152	$257,152
Dozer Basins	AC	1,470	$500		$735,000		1 thru 3	$642,880	$642,880
Stormwater Drainage (100 LF/AC)	AC	1,470	$90		$132,300		1 thru 3	$115,718	$115,718
Air Monitoring	EA	18	$3,350		$60,300		1 thru 3	$52,742	$52,742
Route Stormwater to Opportunity Ponds	LS	1	$110,000		$110,000		1 thru 3	$96,213	$96,213
Subtotal					$6,234,050	$7,792,250		$5,452,716	$6,815,621
2. Indirect Costs									
Field Indirect (2%)					$124,681	$155,845		$109,054	$136,312
Supervision, Inspection, & Overhead (4%)					$249,362	$311,690		$218,109	$272,625
Contractor Profit (10%)					$623,405	$779,225		$545,272	$681,562
Contractor Bonds (5%)					$311,703	$389,613		$272,636	$340,781
Design (2%)					$124,681	$155,845		$109,054	$136,312
Resident Engineering (2%)					$124,681	$155,845		$109,054	$136,312
Contingency (20%)					$1,246,810	$1,558,450		$1,090,543	$1,363,124
TOTAL CAPITAL COSTS					$9,039,000	$11,299,000		$7,906,000	$9,883,000

B. O & M COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth	
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098	
Vegetation Repair	AC	1.47	$1,290	$1,896	2 thru 30	$21,758	
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642	
Stormwater Management	LS	1	$50,000	$50,000	2 thru 30	$573,700	
Subtotal				$64,162		$736,198	
2. Indirect Costs							
Supervision, Inspection, & Overhead (4%)				$2,566		$29,448	
Contractor Bonds (5%)				$3,208		$36,810	
Contractor Profit (10%)				$6,416		$73,620	
Contingency (20%)				$12,832		$147,240	
TOTAL O&M COSTS				$89,200		$1,023,300	
TOTAL ALTERNATIVE COSTS						$8,929,000	$10,906,000

TABLE E-52
SMELTER HILL SUBAREA
ANACONDA PONDS AREA OF CONCERN
Alternative - No Further Action (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Institutional Controls *	LS	0	0.00	$0	1	$0
Subtotal				$0		$0
2. Indirect Costs						
Field Indirect (0%)				$0		$0
Supervision, Inspection, & Overhead (4%)				$0		$0
Contractor Profit (10%)				$0		$0
Contractor Bonds (5%)				$0		$0
Design (0%)				$0		$0
Resident Engineering (0%)				$0		$0
Contingency (20%)				$0		$0
TOTAL CAPITAL COSTS				$0		$0

B. O & M COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Inspections	EA	1	$500	$500	2 thru 30	$5,737
Repair/Maint. of Prev. Reclaimed Area	AC	0.71	$1,290	$909	2 thru 30	$10,435
Subtotal				$2,075		$23,814
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$83		$953
Contractor Bonds (5%)				$104		$1,191
Contractor Profit (10%)				$208		$2,381
Contingency (20%)				$415		$4,763
TOTAL O&M COSTS				$2,900		$33,100
TOTAL ALTERNATIVE COSTS						$33,000

* Already established through Waste Management Development District and Superfund Overlay District

TABLE E-53
SMELTER HILL SUBAREA
ANACONDA PONDS AREA OF CONCERN
Alternative - Soil Cover (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Mobilization/Demobilization	AC	449	$100	$44,900	1 thru 3	$39,273
Site Preparation (clearing)	AC	449	$800	$359,200	1 thru 3	$314,180
Soil Cover (18")	AC	449	$6,703	$3,009,647	1 thru 3	$2,632,438
Additional Soil Amendment - manure	AC	449	$2,252	$1,011,148	1 thru 3	$884,417
Vegetation	AC	449	$1,290	$579,210	1 thru 3	$506,616
Haul (2 miles)	AC	449	$5,469	$2,455,581	1 thru 3	$2,147,815
Stormwater Drainage Ditches (100 Lf/AC)	AC	449	$90	$40,410	1 thru 3	$35,345
Roads - Temporary	AC	449	$470	$211,030	1 thru 3	$184,581
Roads - borrow area (2,000 lf)	LS	1	$9,400	$9,400	1 thru 3	$8,222
Dust Control	AC	449	$200	$89,800	1 thru 3	$78,545
Air Monitoring	EA	30	$3,350	$100,500	1 thru 3	$87,904
Subtotal				$7,910,826		$6,919,336
2. Indirect Costs						
Field Indirect (2%)				$158,217		$138,387
Supervision, Inspection, & Overhead (4%)				$316,433		$276,773
Contractor Profit (10%)				$791,083		$691,934
Contractor Bonds (5%)				$395,541		$345,967
Design (4%)				$316,433		$276,773
Resident Engineering (3%)				$237,325		$207,580
Contingency (20%)				$1,582,165		$1,383,867
TOTAL CAPITAL COSTS				$11,708,000		$10,241,000

B. O & M COSTS

1. Direct Costs						
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098
Cover Repair / Vegetation	AC	4.49	$13,462	$60,444	2 thru 30	$693,539
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Subtotal				$72,710		$834,279
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$2,908		$33,371
Contractor Bonds (5%)				$3,636		$41,714
Contractor Profit (10%)				$7,271		$83,428
Contingency (20%)				$14,542		$166,856
TOTAL O&M COSTS				$101,100		$1,159,600
TOTAL ALTERNATIVE COSTS						$11,401,000

TABLE E-54
SMELTER HILL SUBAREA
ANACONDA PONDS AREA OF CONCERN
Alternative - Land Reclamation (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
			Min	Max	Min	Max		Min	Max
Mobilization/Demobilization	AC	449	$100		$44,900		1	$44,900	$44,900
Site Preparation	AC	449	$800		$359,200		1	$359,200	$359,200
Level I Reclamation	AC	0	$945		$0		1	$0	$0
Level II Reclamation	AC	0	$2,435		$0		1	$0	$0
Level III A Reclamation	AC	0	$9,505		$0		1	$0	$0
Level III B Reclamation	AC	0	$5,600		$0		1	$0	$0
Level III C Reclamation	AC	449	$8,550	$21,160	$3,838,950	$9,500,840	1	$3,838,950	$9,500,840
Dust Control	AC	449	$200		$89,800		1	$89,800	$89,800
Stormwater Drainage (100 LF/AC)	AC	449	$90		$40,410		1	$40,410	$40,410
Air Monitoring	EA	6	$3,350		$20,100		1	$20,100	$20,100
Subtotal					$4,393,360	$10,055,250		$4,393,360	$10,055,250
2. Indirect Costs									
Field Indirect (2%)					$87,867	$201,105		$87,867	$201,105
Supervision, Inspection, & Overhead (4%)					$175,734	$402,210		$175,734	$402,210
Contractor Profit (10%)					$439,336	$1,005,525		$439,336	$1,005,525
Contractor Bonds (5%)					$219,668	$502,763		$219,668	$502,763
Design (4%)					$175,734	$402,210		$175,734	$402,210
Resident Engineering (3%)					$131,801	$301,658		$131,801	$301,658
Contingency (20%)					$878,672	$2,011,050		$878,672	$2,011,050
TOTAL CAPITAL COSTS					$6,502,000	$14,882,000		$6,502,000	$14,882,000

B. O & M COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
Quarterly Inspection	EA	4	$2,900		$11,600		2 thru 30	$133,098	
Vegetation Repair	AC	4.49	$1,290		$5,792		2 thru 30	$66,459	
Site Review	EA/5 yr	0.20	$3,330		$666		2 thru 30	$7,642	
Subtotal					$18,058			$207,199	
2. Indirect Costs									
Supervision, Inspection, & Overhead (4%)					$722			$8,288	
Contractor Bonds (5%)					$903			$10,360	
Contractor Profit (10%)					$1,806			$20,720	
Contingency (20%)					$3,612			$41,440	
TOTAL O&M COSTS					$25,100			$288,000	
TOTAL ALTERNATIVE COSTS								$6,790,000	$15,170,000

TABLE E-55
SMELTER HILL SUBAREA
ANACONDA PONDS AREA OF CONCERN
Alternative - Partial Land Reclamation (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
			Min	Max	Min	Max		Min	Max
Mobilization/Demobilization	AC	176	$100		$17,600		1	$17,600	$17,600
Site Preparation	AC	176	$800		$140,800		1	$140,800	$140,800
Level I Reclamation - wind/wild life corridor	AC	176	$945	$1,290	$166,320	$227,040	1	$166,320	$227,040
Dust Control	AC	176	$200		$35,200		1	$35,200	$35,200
Stormwater Drainage (100 LF/AC)	AC	176	$90		$15,840		1	$15,840	$15,840
Air Monitoring	EA	6	$3,350		$20,100		1	$20,100	$20,100
Route Stormwater to Opportunity Ponds	LS	1	$0		$0		1	$0	$0
Subtotal					$395,860	$456,580		$395,860	$456,580
2. Indirect Costs									
Field Indirect (2%)					$7,917	$9,132		$7,917	$9,132
Supervision, Inspection, & Overhead (4%)					$15,834	$18,263		$15,834	$18,263
Contractor Profit (10%)					$39,586	$45,658		$39,586	$45,658
Contractor Bonds (5%)					$19,793	$22,829		$19,793	$22,829
Design (6%)					$23,752	$27,395		$23,752	$27,395
Resident Engineering (3%)					$11,876	$13,697		$11,876	$13,697
Contingency (20%)					$79,172	$91,316		$79,172	$91,316
TOTAL CAPITAL COSTS					$594,000	$685,000		$594,000	$685,000

B. O & M COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth	
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098	
Vegetation Repair	AC	1.79	$1,290	$2,309	2 thru 30	$26,495	
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642	
Stormwater Management	LS	1	$15,000	$15,000	2 thru 30	$172,110	
Subtotal				$29,575		$339,345	
2. Indirect Costs							
Supervision, Inspection, & Overhead (4%)				$1,183		$13,574	
Contractor Bonds (5%)				$1,479		$16,967	
Contractor Profit (10%)				$2,958		$33,934	
Contingency (20%)				$5,915		$67,869	
TOTAL O&M COSTS				$41,100		$471,700	
TOTAL ALTERNATIVE COSTS						$1,066,000	$1,157,000

SHAPPRCL.XLS9/24/98

TABLE E-56
SMELTER HILL SUBAREA
ANACONDA PONDS AREA OF CONCERN
Alternative - Land Reclamation/Soil Cover (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
			Min	Max	Min	Max		Min	Max
Mobilization/Demobilization	AC	449	$100		$44,900		1	$44,900	$44,900
Site Preparation	AC	449	$800		$359,200		1	$359,200	$359,200
Level III C Reclamation - adjusted	AC	449	$8,550	$21,160	$3,838,950	$9,500,840	1	$3,838,950	$9,500,840
Soil Cover (6")	AC	449	$2,234		$1,003,066		1	$1,003,066	$1,003,066
Vegetation	AC	449	$1,290		$579,210		1	$579,210	$579,210
Haul (2 miles)	AC	449	$5,469		$2,455,581		1	$2,455,581	$2,455,581
Dust Control	AC	449	$200		$89,800		1	$89,800	$89,800
Stormwater Drainage (100 LF/AC)	AC	449	$90		$40,410		1	$40,410	$40,410
Air Monitoring	EA	6	$3,350		$20,100		1	$20,100	$20,100
Subtotal					$8,431,217	$14,093,107		$8,431,217	$14,093,107
2. Indirect Costs									
Field Indirect (2%)					$168,624	$281,862		$168,624	$281,862
Supervision, Inspection, & Overhead (4%)					$337,249	$563,724		$337,249	$563,724
Contractor Profit (10%)					$843,122	$1,409,311		$843,122	$1,409,311
Contractor Bonds (5%)					$421,561	$704,655		$421,561	$704,655
Design (4%)					$337,249	$563,724		$337,249	$563,724
Resident Engineering (3%)					$252,937	$422,793		$252,937	$422,793
Contingency (20%)					$1,686,243	$2,818,621		$1,686,243	$2,818,621
TOTAL CAPITAL COSTS					$12,478,000	$20,858,000		$12,478,000	$20,858,000

B. O & M COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth	
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098	
Vegetation Repair	AC	4.49	$1,290	$5,792	2 thru 30	$66,459	
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642	
Subtotal				$18,058		$207,199	
2. Indirect Costs							
Supervision, Inspection, & Overhead (4%)				$722		$8,288	
Contractor Bonds (5%)				$903		$10,360	
Contractor Profit (10%)				$1,806		$20,720	
Contingency (20%)				$3,612		$41,440	
TOTAL O&M COSTS				$25,100		$288,000	
TOTAL ALTERNATIVE COSTS						$12,766,000	$21,146,000

TABLE E-57
SMELTER HILL SUBAREA
ANACONDA PONDS AREA OF CONCERN
Alternative - Rock Amendment (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Mobilization/Demobilization	AC	449	$100	$44,900	1 thru 2	$40,590
Site Preparation	AC	449	$800	$359,200	1 thru 2	$324,717
Surface Grading	AC	449	$2,275	$1,021,475	1 thru 2	$923,413
Rock Amendments (4" of pea gravel)	AC	449	$16,316	$7,325,884	1 thru 2	$6,622,599
Roads	AC	449	$470	$211,030	1 thru 2	$190,771
Air Monitoring	EA	12	$3,350	$40,200	1 thru 2	$36,341
Dust Control During Construction	AC	449	$200	$89,800	1 thru 2	$81,179
Stormwater Drainage (200 LF/AC)	AC	449	$90	$40,410	1 thru 2	$36,531
Route Stormwater to Opportunity Ponds	LS	1	$0	$0	1 thru 2	$0
Subtotal				$9,132,899		$8,256,141
2. Indirect Costs						
Field Indirect (2%)				$182,658		$165,123
Supervision, Inspection, & Overhead (4%)				$365,316		$330,246
Contractor Profit (10%)				$913,290		$825,614
Contractor Bonds (5%)				$456,645		$412,807
Design (4%)				$365,316		$330,246
Resident Engineering (3%)				$273,987		$247,684
Contingency (20%)				$1,826,580		$1,651,228
TOTAL CAPITAL COSTS				$13,517,000		$12,219,000

B. O & M COSTS

1. Direct Costs						
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098
Repair	AC	4.49	$16,316	$73,259	2 thru 30	$840,572
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Stormwater Management	LS	1	$15,000	$15,000	2 thru 30	$172,110
Subtotal				$100,525		$1,153,422
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$4,021		$46,137
Contractor Bonds (5%)				$5,026		$57,671
Contractor Profit (10%)				$10,052		$115,342
Contingency (20%)				$20,105		$230,684
TOTAL O&M COSTS				$139,700		$1,603,300
TOTAL ALTERNATIVE COSTS						$13,822,000

TABLE E-58
SMELTER HILL SUBAREA
DISTURBED AREA AREA OF CONCERN
Alternative - No Further Action (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Institutional Controls *	LS	0	0.00	$0	1	$0
Subtotal				$0		$0
2. Indirect Costs						
Field Indirect (0%)				$0		$0
Supervision, Inspection, & Overhead (4%)				$0		$0
Contractor Profit (10%)				$0		$0
Contractor Bonds (5%)				$0		$0
Design (0%)				$0		$0
Resident Engineering (0%)				$0		$0
Contingency (20%)				$0		$0
TOTAL CAPITAL COSTS				$0		$0

B. O & M COSTS

1. Direct Costs						
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Inspections	EA	1	$500	$500	2 thru 30	$5,737
Repair/Maint. of Prev. Reclaimed Area	AC	0.79	$1,290	$1,019	2 thru 30	$11,693
Subtotal				$2,185		$25,072
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$87		$1,003
Contractor Bonds (5%)				$109		$1,254
Contractor Profit (10%)				$219		$2,507
Contingency (20%)				$437		$5,014
TOTAL O&M COSTS				$3,000		$34,800
TOTAL ALTERNATIVE COSTS						$35,000

* Already established through Superfund Overlay District

TABLE E-59
SMELTER HILL SUBAREA
DISTURBED AREA AREA OF CONCERN
Alternative - Soil Cover (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Mobilization/Demobilization	AC	522	$100	$52,200	1 thru 2	$47,189
Site Preparation (clearing and grading)	AC	522	$800	$417,600	1 thru 2	$377,510
Soil Cover (18")	AC	522	$6,703	$3,498,966	1 thru 2	$3,163,065
Vegetation	AC	522	$1,290	$673,380	1 thru 2	$608,736
Haul (2 miles)	AC	522	$5,469	$2,854,818	1 thru 2	$2,580,755
Stormwater Drainage Ditches (100 Lf/AC)	AC	522	$90	$46,980	1 thru 2	$42,470
Dozer Basins	AC	418	$500	$209,000	1 thru 2	$188,936
Roads - Temporary	AC	522	$470	$245,340	1 thru 2	$221,787
Dust Control	AC	522	$200	$104,400	1 thru 2	$94,378
Air Monitoring	EA	36	$3,350	$120,600	1 thru 2	$109,022
Subtotal				$8,223,284		$7,433,849
2. Indirect Costs						
Field Indirect (2%)				$164,466		$148,677
Supervision, Inspection, & Overhead (4%)				$328,931		$297,354
Contractor Profit (10%)				$822,328		$743,385
Contractor Bonds (5%)				$411,164		$371,692
Design (4%)				$328,931		$297,354
Resident Engineering (3%)				$246,699		$223,015
Contingency (20%)				$1,644,657		$1,486,770
TOTAL CAPITAL COSTS				$12,170,000		$11,002,000

B. O & M COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098
Cover Repair / Vegetation	AC	5.22	$13,462	$70,272	2 thru 30	$806,297
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Subtotal				$82,538		$947,037
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$3,302		$37,881
Contractor Bonds (5%)				$4,127		$47,352
Contractor Profit (10%)				$8,254		$94,704
Contingency (20%)				$16,508		$189,407
TOTAL O&M COSTS				$114,700		$1,316,400
TOTAL ALTERNATIVE COSTS						$12,318,000

TABLE E-60
SMELTER HILL SUBAREA
DISTURBED AREA AREA OF CONCERN
Alternative - Land Reclamation (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
			Min	Max	Min	Max		Min	Max
Mobilization/Demobilization	AC	522	$100		$52,200		1 thru 2	$47,189	$47,189
Site Preparation	AC	522	$800		$417,600		1 thru 2	$377,510	$377,510
Level I Reclamation	AC	40	$945		$37,800		1 thru 2	$34,171	$34,171
Level II Reclamation	AC	250	$2,345	$3,495	$586,250	$873,750	1 thru 2	$529,970	$789,870
Level III A Reclamation	AC	0	$9,505		$0		1 thru 2	$0	$0
Level III B Reclamation	AC	232	$5,600	$8,000	$1,299,200	$1,856,000	1 thru 2	$1,174,477	$1,677,824
Level III C Reclamation	AC	0	$4,530		$0		1 thru 2	$0	$0
Dust Control	AC	522	$200		$104,400		1 thru 2	$94,378	$94,378
Dozer Basins	AC	418	$500		$209,000		1 thru 2	$188,936	$188,936
Stormwater Drainage (100 LF/AC)	AC	522	$90		$46,980		1 thru 2	$42,470	$42,470
Air Monitoring	EA	12	$3,350		$40,200		1 thru 2	$36,341	$36,341
Subtotal					$2,793,630	$3,637,930		$2,525,442	$3,288,689
2. Indirect Costs									
Field Indirect (2%)					$55,873	$72,759		$50,509	$65,774
Supervision, Inspection, & Overhead (4%)					$111,745	$145,517		$101,018	$131,548
Contractor Profit (10%)					$279,363	$363,793		$252,544	$328,869
Contractor Bonds (5%)					$139,682	$181,897		$126,272	$164,434
Design (4%)					$111,745	$145,517		$101,018	$131,548
Resident Engineering (3%)					$83,809	$109,138		$75,763	$98,661
Contingency (20%)					$558,726	$727,586		$505,088	$657,738
TOTAL CAPITAL COSTS					$4,135,000	$5,384,000		$3,738,000	$4,867,000
B. O & M COSTS									
1. Direct Costs									
Quarterly Inspection	EA	4	$2,900		$11,600		2 thru 30	$133,098	
Vegetation Repair	AC	5.22	$1,290		$6,734		2 thru 30	$77,264	
Site Review	EA/5 yr	0.20	$3,330		$666		2 thru 30	$7,642	
Subtotal					$19,000			$218,004	
2. Indirect Costs									
Supervision, Inspection, & Overhead (4%)					$760			$8,720	
Contractor Bonds (5%)					$950			$10,900	
Contractor Profit (10%)					$1,900			$21,800	
Contingency (20%)					$3,800			$43,601	
TOTAL O&M COSTS					$26,400			$303,000	
TOTAL ALTERNATIVE COSTS								$4,041,000	$5,170,000

TABLE E-61
SMELTER HILL SUBAREA
DISTURBED AREA AREA OF CONCERN
Alternative - Partial Land Reclamation (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
			Min	Max	Min	Max		Min	Max
Mobilization/Demobilization	AC	110	$100		$11,000		1	$11,000	$11,000
Site Preparation	AC	110	$800		$88,000		1	$88,000	$88,000
Level I Reclamation	AC	8	$945	$1,290	$7,560	$10,320	1	$7,560	$10,320
Level II Reclamation	AC	52	$2,435	$3,495	$126,620	$181,740	1	$126,620	$181,740
Level III A Reclamation	AC	0	$9,505		$0		1	$0	$0
Level III B Reclamation	AC	50	$5,600	$8,000	$280,000	$400,000	1	$280,000	$400,000
Level III C Reclamation	AC	0	$4,530		$0		1	$0	$0
Dust Control	AC	110	$200		$22,000		1	$22,000	$22,000
Dozer Basins	AC	88	$500		$44,000		1	$44,000	$44,000
Stormwater Drainage (100 LF/AC)	AC	110	$90		$9,900		1	$9,900	$9,900
Air Monitoring	EA	6	$3,350		$20,100		1	$20,100	$20,100
Route Stormwater to Opportunity Ponds	LS	1	$0		$0		1	$0	$0
Subtotal					$609,180	$787,060		$609,180	$787,060
2. Indirect Costs									
Field Indirect (2%)					$12,184	$15,741		$12,184	$15,741
Supervision, Inspection, & Overhead (4%)					$24,367	$31,482		$24,367	$31,482
Contractor Profit (10%)					$60,918	$78,706		$60,918	$78,706
Contractor Bonds (5%)					$30,459	$39,353		$30,459	$39,353
Design (6%)					$36,551	$47,224		$36,551	$47,224
Resident Engineering (3%)					$18,275	$23,612		$18,275	$23,612
Contingency (20%)					$121,836	$157,412		$121,836	$157,412
TOTAL CAPITAL COSTS					$914,000	$1,181,000		$914,000	$1,181,000
B. O & M COSTS									
1. Direct Costs									
Quarterly Inspection	EA	4	$2,900		$11,600		2 thru 30	$133,098	
Vegetation Repair	AC	1.00	$1,290		$1,290		2 thru 30	$14,801	
Site Review	EA/5 yr	1.10	$3,330		$3,663		2 thru 30	$42,029	
Stormwater Management	LS	1	$40,000		$40,000		2 thru 30	$458,960	
Subtotal					$56,553			$648,889	
2. Indirect Costs									
Supervision, Inspection, & Overhead (4%)					$2,262			$25,956	
Contractor Bonds (5%)					$2,828			$32,444	
Contractor Profit (10%)					$5,655			$64,889	
Contingency (20%)					$11,311			$129,778	
TOTAL O&M COSTS					$78,600			$902,000	
TOTAL ALTERNATIVE COSTS								$1,816,000	$2,083,000

TABLE E-62
SMELTER HILL SUBAREA
EAST ANACONDA YARD WASTES AREA OF CONCERN
Alternative - No Further Action (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Institutional Controls *	LS	0	0.00	$0	1	$0
Subtotal				$0		$0
2. Indirect Costs						
Field Indirect (0%)				$0		$0
Supervision, Inspection, & Overhead (4%)				$0		$0
Contractor Profit (10%)				$0		$0
Contractor Bonds (5%)				$0		$0
Design (0%)				$0		$0
Resident Engineering (0%)				$0		$0
Contingency (20%)				$0		$0
TOTAL CAPITAL COSTS				$0		$0

B. O & M COSTS

1. Direct Costs						
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Subtotal				$666		$7,642
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$27		$306
Contractor Bonds (5%)				$33		$382
Contractor Profit (10%)				$67		$764
Contingency (20%)				$133		$1,528
TOTAL O&M COSTS				$900		$10,600
TOTAL ALTERNATIVE COSTS						$11,000

* Already established through Superfund Overlay District and covenant restrictions on East Anaconda Yard Parcel.

TABLE E-63
SMELTER HILL SUBAREA
EAST ANACONDA YARD WASTE AREA OF CONCERN
Alternative - Capping (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Mobilization/Demobilization	AC	86	$100	$8,600	1	$8,600
Site Preparation (clearing and grading)	AC	86	$2,850	$245,100	1	$245,100
Foundation Layer (ripping and compacting)	AC	86	$8,100	$696,600	1	$696,600
Geosynthetic Clay Liner	AC	86	$22,500	$1,935,000	1	$1,935,000
Soil Cover (18")	AC	86	$6,703	$576,458	1	$576,458
Vegetation	AC	86	$1,290	$110,940	1	$110,940
Haul (4 miles)	AC	86	$8,494	$730,484	1	$730,484
Stormwater Drainage Ditches (100 Lf/AC)	AC	86	$90	$7,740	1	$7,740
Roads - Temporary	AC	86	$470	$40,420	1	$40,420
Dust Control	AC	86	$200	$17,200	1	$17,200
Air Monitoring	EA	4	$3,350	$13,400	1	$13,400
Subtotal				$4,381,942		$4,381,942
2. Indirect Costs						
Field Indirect (2%)				$87,639		$87,639
Supervision, Inspection, & Overhead (4%)				$175,278		$175,278
Contractor Profit (10%)				$438,194		$438,194
Contractor Bonds (5%)				$219,097		$219,097
Design (6%)				$262,917		$262,917
Resident Engineering (3%)				$131,458		$131,458
Contingency (20%)				$876,388		$876,388
TOTAL CAPITAL COSTS				$6,573,000		$6,573,000

B. O & M COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098
Cover Repair / Vegetation	AC	0.86	$13,462	$11,577	2 thru 30	$132,838
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Subtotal				$23,843		$273,578
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$954		$10,943
Contractor Bonds (5%)				$1,192		$13,679
Contractor Profit (10%)				$2,384		$27,358
Contingency (20%)				$4,769		$54,716
TOTAL O&M COSTS				$33,100		$380,300
TOTAL ALTERNATIVE COSTS						$6,953,000

TABLE E-64
SMELTER HILL SUBAREA
EAST ANACONDA YARD WASTE AREA OF CONCERN
Alternative - Soil Cover (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Mobilization/Demobilization	AC	8	$100	$800	1	$800
Site Preparation (clearing and grading)	AC	8	$800	$6,400	1	$6,400
Soil Cover (18") - Acid Plant Area Only	AC	8	$6,703	$53,624	1	$53,624
Vegetation	AC	8	$1,290	$10,320	1	$10,320
Haul (4 miles)	AC	8	$8,494	$67,952	1	$67,952
Stormwater Drainage Ditches (100 Lf/AC)	AC	8	$90	$720	1	$720
Roads - Temporary	AC	8	$470	$3,760	1	$3,760
Dust Control	AC	8	$200	$1,600	1	$1,600
Air Monitoring	EA	4	$3,350	$13,400	1	$13,400
Subtotal				$158,576		$158,576
2. Indirect Costs						
Field Indirect (2%)				$3,172		$3,172
Supervision, Inspection, & Overhead (4%)				$6,343		$6,343
Contractor Profit (10%)				$15,858		$15,858
Contractor Bonds (5%)				$7,929		$7,929
Design (6%)				$9,515		$9,515
Resident Engineering (3%)				$4,757		$4,757
Contingency (20%)				$31,715		$31,715
TOTAL CAPITAL COSTS				$238,000		$238,000

B. O & M COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098
Cover Repair / Vegetation	AC	0.08	$13,462	$1,077	2 thru 30	$12,357
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Subtotal				$13,343		$153,097
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$534		$6,124
Contractor Bonds (5%)				$667		$7,655
Contractor Profit (10%)				$1,334		$15,310
Contingency (20%)				$2,669		$30,619
TOTAL O&M COSTS				$18,500		$212,800
TOTAL ALTERNATIVE COSTS						$451,000

TABLE E-65
SMELTER HILL SUBAREA
EAST ANACONDA YARD WASTE AREA OF CONCERN
Alternative - Removal (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Excavate/Load/Haul/Unload - cover mat'l	CY	246,000	$5.51	$1,355,460	1 thru 6	$1,076,913
Remove RR Tracks and Ties	LF	40,300	$16.25	$654,875	1 thru 6	$520,298
Offsite Disposal of Ties	TON	6,100	$14.00	$85,400	1 thru 6	$67,850
Excavate/Load/Unload	CY	459,000	$4.92	$2,258,280	1 thru 6	$1,794,203
Haul	CY	459,000	$3.00	$1,377,000	1 thru 6	$1,094,027
Clear/Grub and Erosion	CY	704,800	$0.18	$126,864	1 thru 6	$100,793
Roads	CY	704,800	$1.17	$824,616	1 thru 6	$655,157
Mob/Demob	CY	704,800	$0.10	$70,480	1 thru 6	$55,996
Other (H&S, Survey, Office, Security, etc)	CY	704,800	$1.62	$1,141,776	1 thru 6	$907,141
Decon	CY	459,000	$0.05	$22,950	1 thru 6	$18,234
Dust Control	CY	950,000	$0.04	$38,000	1 thru 6	$30,191
Air Monitoring	EA	36	$3,350	$120,600	1 thru 6	$95,817
Backfill and Placement - onsite cover mat'l (1)	CY	246,000	$8.27	$2,034,420	1 thru 6	$1,616,347
Backfill and Placement - offsite borrow mat'l	CY	430,000	$3.00	$1,290,000	1 thru 6	$1,024,905
Haul Offsite Backfill mat'l - 4 miles rt	CY	430,000	$3.51	$1,509,300	1 thru 6	$1,199,139
Railroad Bed Subgrade w/ borrow mat'l	LF	14,400	$60	$864,000	1 thru 6	$686,448
Replace Railroad Lines (4 total)	LF	14,400	$170	$2,448,000	1 thru 6	$1,944,936
Infrastructure - Sewer	LS	1	$20,000	$20,000	1 thru 6	$15,890
Infrastructure - Water	LS	1	$20,000	$20,000	1 thru 6	$15,890
Infrastructure - Power	LS	1	$20,000	$20,000	1 thru 6	$15,890
Grading	SY	417,200	$0.13	$54,236	1 thru 6	$43,091
Vegetation	AC	86	$1,290	$111,198	1 thru 6	$88,347
Subtotal				$16,447,455		$13,067,503
2. Indirect Costs						
Field Indirect (2%)				$328,949		$261,350
Supervision, Inspection, & Overhead (4%)				$657,898		$522,700
Contractor Profit (10%)				$1,644,746		$1,306,750
Contractor Bonds (5%)				$822,373		$653,375
Design (6%)				$986,847		$784,050
Resident Engineering (3%)				$493,424		$392,025
Contingency (20%)				$3,289,491		$2,613,501
TOTAL CAPITAL COSTS				$24,671,000		$19,601,000
TOTAL ALTERNATIVE COSTS						$19,601,000

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TABLE E-66
SMELTER HILL SUBAREA
EAST ANACONDA YARD WASTE AREA OF CONCERN
Alternative - Partial Removal (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Excavate/Load/Unload	CY	103,500	$4.92	$509,220	1	$509,220
Haul	CY	103,500	$3.00	$310,500	1	$310,500
Clear/Grub and Erosion	CY	103,500	$0.18	$18,630	1	$18,630
Roads	CY	103,500	$1.17	$121,095	1	$121,095
Mob/Demob	CY	103,500	$0.10	$10,350	1	$10,350
Other (H&S, Survey, Office, Security, etc)	CY	103,500	$1.62	$167,670	1	$167,670
Decon	CY	103,500	$0.05	$5,175	1	$5,175
Dust Control	CY	103,500	$0.04	$4,140	1	$4,140
Air Monitoring	EA	6	$3,350	$20,100	1	$20,100
Excavate Backfill Mat'l and placement	CY	103,500	$2.77	$286,695	1	$286,695
Haul Backfill Mat'l, 4 mile rt	CY	103,500	$3.51	$363,285	1	$363,285
Grading	SY	37,700	$0.13	$4,901	1	$4,901
Vegetation	AC	8	$1,290	$10,320	1	$10,320
Subtotal				$1,832,081		$1,832,081
2. Indirect Costs						
Field Indirect (2%)				$36,642		$36,642
Supervision, Inspection, & Overhead (4%)				$73,283		$73,283
Contractor Profit (10%)				$183,208		$183,208
Contractor Bonds (5%)				$91,604		$91,604
Design (6%)				$109,925		$109,925
Resident Engineering (3%)				$54,962		$54,962
Contingency (20%)				$366,416		$366,416
TOTAL CAPITAL COSTS				$2,748,000		$2,748,000
TOTAL ALTERNATIVE COSTS						$2,748,000

TABLE E-67
SMELTER HILL SUBAREA
MAIN GRANULATED SLAG AREA OF CONCERN
Alternative - No Further Action (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Institutional Controls *	LS	0	0.00	$0	1	$0
Subtotal				$0		$0
2. Indirect Costs						
Field Indirect (0%)				$0		$0
Supervision, Inspection, & Overhead (4%)				$0		$0
Contractor Profit (10%)				$0		$0
Contractor Bonds (5%)				$0		$0
Design (0%)				$0		$0
Resident Engineering (0%)				$0		$0
Contingency (20%)				$0		$0
TOTAL CAPITAL COSTS				$0		$0
B. O & M COSTS						
1. Direct Costs						
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Subtotal				$666		$7,642
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$27		$306
Contractor Bonds (5%)				$33		$382
Contractor Profit (10%)				$67		$764
Contingency (20%)				$133		$1,528
TOTAL O&M COSTS				$900		$10,600
TOTAL ALTERNATIVE COSTS						$11,000

* Already established through Superfund Overlay District

TABLE E-68
SMELTER HILL SUBAREA
MAIN GRANULATED SLAG AREA OF CONCERN
Alternative - Rock Amendment (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Mobilization/Demobilization	AC	88	$100	$8,800	1	$8,800
Site Preparation	AC	88	$800	$70,400	1	$70,400
Surface Grading	AC	88	$2,275	$200,200	1	$200,200
Rock Amendments (4" of pea gravel)	AC	88	$16,316	$1,435,808	1	$1,435,808
Roads	AC	88	$470	$41,360	1	$41,360
Air Monitoring	EA	6	$3,350	$20,100	1	$20,100
Dust Control During Construction	AC	88	$200	$17,600	1	$17,600
Wind Fence (2' high)	LF	9,000	$2	$18,000	1	$18,000
Stormwater Drainage (100 LF/AC)	AC	88	$90	$7,920	1	$7,920
Subtotal				$1,820,188		$1,820,188
2. Indirect Costs						
Field Indirect (2%)				$36,404		$36,404
Supervision, Inspection, & Overhead (4%)				$72,808		$72,808
Contractor Profit (10%)				$182,019		$182,019
Contractor Bonds (5%)				$91,009		$91,009
Design (6%)				$109,211		$109,211
Resident Engineering (3%)				$54,606		$54,606
Contingency (20%)				$364,038		$364,038
TOTAL CAPITAL COSTS				$2,730,000		$2,730,000

B. O & M COSTS

1. Direct Costs						
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098
Repair	AC	0.88	$16,316	$14,358	2 thru 30	$164,745
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Subtotal				$26,624		$305,485
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$1,065		$12,219
Contractor Bonds (5%)				$1,331		$15,274
Contractor Profit (10%)				$2,662		$30,548
Contingency (20%)				$5,325		$61,097
TOTAL O&M COSTS				$37,000		$424,600
TOTAL ALTERNATIVE COSTS						$3,155,000

TABLE E-69
SOUTH OPPORTUNITY SUBAREA
SPARSELY VEGETATED SOILS AREA OF CONCERN
Alternative - No Further Action (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Institutional Controls *	LS	0	0.00	$0	1	$0
Subtotal				$0		$0
2. Indirect Costs						
Field Indirect (0%)				$0		$0
Supervision, Inspection, & Overhead (4%)				$0		$0
Contractor Profit (10%)				$0		$0
Contractor Bonds (5%)				$0		$0
Design (0%)				$0		$0
Resident Engineering (0%)				$0		$0
Contingency (20%)				$0		$0
TOTAL CAPITAL COSTS				$0		$0

B. O & M COSTS

1. Direct Costs						
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Subtotal				$666		$7,642
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$27		$306
Contractor Bonds (5%)				$33		$382
Contractor Profit (10%)				$67		$764
Contingency (20%)				$133		$1,528
TOTAL O&M COSTS				$900		$10,600
TOTAL ALTERNATIVE COSTS						$11,000

* Already established through Superfund Overlay District, Open Space Development Review District, conservation easements on WH Ranch Co, and covenant restrictions on Willow Glen property.

TABLE E-70
SOUTH OPPORTUNITY SUBAREA
SPARSELY VEGETATED SOILS AREA OF CONCERN
Alternative - Land Reclamation (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
			Min	Max	Min	Max		Min	Max
Mobilization/Demobilization	AC	342	$100		$34,200		1	$34,200	$34,200
Site Preparation	AC	342	$800		$273,600		1	$273,600	$273,600
Level I Reclamation	AC	171	$945	$1,290	$161,595	$220,590	1	$161,595	$220,590
Level II Reclamation	AC	171	$2,435	$3,495	$416,385	$597,645	1	$416,385	$597,645
Level III A Reclamation	AC	0	$9,505		$0		1	$0	$0
Level III B Reclamation	AC	0	$5,600		$0		1	$0	$0
Level III C Reclamation	AC	0	$4,530		$0		1	$0	$0
Dust Control	AC	342	$200		$68,400		1	$68,400	$68,400
Stormwater Drainage (100 LF/AC)	AC	342	$90		$30,780		1	$30,780	$30,780
Air Monitoring	EA	6	$3,350		$20,100		1	$20,100	$20,100
Subtotal					$1,005,060	$1,245,315		$1,005,060	$1,245,315
2. Indirect Costs									
Field Indirect (2%)					$20,101	$24,906		$20,101	$24,906
Supervision, Inspection, & Overhead (4%)					$40,202	$49,813		$40,202	$49,813
Contractor Profit (10%)					$100,506	$124,532		$100,506	$124,532
Contractor Bonds (5%)					$50,253	$62,266		$50,253	$62,266
Design (4%)					$40,202	$49,813		$40,202	$49,813
Resident Engineering (3%)					$30,152	$37,359		$30,152	$37,359
Contingency (20%)					$201,012	$249,063		$201,012	$249,063
TOTAL CAPITAL COSTS					$1,487,000	$1,843,000		$1,487,000	$1,843,000

B. O & M COSTS

1. Direct Costs						
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098
Vegetation Repair	AC	3.42	$1,290	$4,412	2 thru 30	$50,621
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Subtotal				$16,678		$191,361
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$667		$7,654
Contractor Bonds (5%)				$834		$9,568
Contractor Profit (10%)				$1,668		$19,136
Contingency (20%)				$3,336		$38,272
TOTAL O&M COSTS				$23,200		$266,000

TOTAL ALTERNATIVE COSTS		Min	Max
		$1,753,000	$2,109,000

TABLE E-71
SOUTH OPPORTUNITY SUBAREA
SPARSELY VEGETATED SOILS AREA OF CONCERN
Alternative - Partial Land Reclamation (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
			Min	Max	Min	Max		Min	Max
Mobilization/Demobilization	AC	200	$100		$20,000		1	$20,000	$20,000
Site Preparation	AC	200	$800		$160,000		1	$160,000	$160,000
Level I Reclamation	AC	200	$945	$1,290	$189,000	$258,000	1	$189,000	$258,000
Level II Reclamation	AC	0	$2,435		$0		1	$0	$0
Level III A Reclamation	AC	0	$9,505		$0		1	$0	$0
Level III B Reclamation	AC	0	$5,600		$0		1	$0	$0
Level III C Reclamation	AC	0	$4,530		$0		1	$0	$0
Dust Control	AC	200	$200		$40,000		1	$40,000	$40,000
Stormwater Drainage (100 LF/AC)	AC	200	$90		$18,000		1	$18,000	$18,000
Air Monitoring	EA	6	$3,350		$20,100		1	$20,100	$20,100
Route Stormwater to Opportunity Ponds	LS	1	$290,000		$290,000		1	$290,000	$290,000
Subtotal					$737,100	$806,100		$737,100	$806,100
2. Indirect Costs									
Field Indirect (2%)					$14,742	$16,122		$14,742	$16,122
Supervision, Inspection, & Overhead (4%)					$29,484	$32,244		$29,484	$32,244
Contractor Profit (10%)					$73,710	$80,610		$73,710	$80,610
Contractor Bonds (5%)					$36,855	$40,305		$36,855	$40,305
Design (4%)					$29,484	$32,244		$29,484	$32,244
Resident Engineering (3%)					$22,113	$24,183		$22,113	$24,183
Contingency (20%)					$147,420	$161,220		$147,420	$161,220
TOTAL CAPITAL COSTS					$1,091,000	$1,193,000		$1,091,000	$1,193,000

B. O & M COSTS

1. Direct Costs				Cost	Years	Present Worth
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098
Vegetation Repair	AC	2.00	$1,290	$2,580	2 thru 30	$29,603
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Stormwater Management	LS	1	$28,000	$28,000	2 thru 30	$321,272
Subtotal				$42,846		$491,615
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$1,714		$19,665
Contractor Bonds (5%)				$2,142		$24,581
Contractor Profit (10%)				$4,285		$49,162
Contingency (20%)				$8,569		$98,323
TOTAL O&M COSTS				$59,600		$683,300

TOTAL ALTERNATIVE COSTS	$1,774,000	$1,876,000

TABLE E-72
SOUTH OPPORTUNITY SUBAREA
BLUE LAGOON AREA OF CONCERN
Alternative - No Further Action (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Institutional Controls *	LS	0	0.00	$0	1	$0
Subtotal				$0		$0
2. Indirect Costs						
Field Indirect (0%)				$0		$0
Supervision, Inspection, & Overhead (4%)				$0		$0
Contractor Profit (10%)				$0		$0
Contractor Bonds (5%)				$0		$0
Design (0%)				$0		$0
Resident Engineering (0%)				$0		$0
Contingency (20%)				$0		$0
TOTAL CAPITAL COSTS				$0		$0

B. O & M COSTS

1. Direct Costs						
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Subtotal				$666		$7,642
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$27		$306
Contractor Bonds (5%)				$33		$382
Contractor Profit (10%)				$67		$764
Contingency (20%)				$133		$1,528
TOTAL O&M COSTS				$900		$10,600
TOTAL ALTERNATIVE COSTS						$11,000

* Already established through Superfund Overlay District and Open Space Development Review District.

TABLE E-73
SOUTH OPPORTUNITY SUBAREA
BLUE LAGOON AREA OF CONCERN
Alternative - Removal (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Excavation	CY	84,000	$3.99	$335,160	1 thru 2	$302,985
Dewatering	LS	1	$1,000	$1,000	1 thru 2	$904
Roads	CY	84,000	$1.17	$98,280	1 thru 2	$88,845
Erosion	CY	84,000	$0.10	$8,400	1 thru 2	$7,594
Haul	CY	84,000	$6.54	$549,360	1 thru 2	$496,621
Mob/Demob	CY	84,000	$0.08	$6,720	1 thru 2	$6,075
Other (H&S, Survey, Office, Security, etc)	CY	84,000	$1.63	$136,920	1 thru 2	$123,776
Decon	CY	84,000	$0.05	$4,200	1 thru 2	$3,797
Dust Control	CY	84,000	$0.23	$19,320	1 thru 2	$17,465
Air Monitoring	EA	4	$3,350	$13,400	1 thru 2	$12,114
Excavate Backfill Mat'l and placement	CY	5,000	$2.77	$13,850	1 thru 2	$12,520
Haul Backfill Mat'l, 6 mile rt (20 cy/truck)	CY	5,000	$6.17	$30,850	1 thru 2	$27,888
Grading - Blue Lagoon	SY	9,600	$0.13	$1,248	1 thru 2	$1,128
Vegetation - Blue Lagoon	AC	2	$1,290	$2,580	1 thru 2	$2,332
Backfilling - RR	CY	77,400	$17	$1,315,800	1 thru 2	$1,189,483
Rebuild RR	LF	500	$200	$100,000	1 thru 2	$90,400
Compensation for Down Time	MO	12	$20,000	$240,000	1 thru 2	$216,960
Subtotal				$2,877,088		$2,600,888
2. Indirect Costs						
Field Indirect (2%)				$57,542		$52,018
Supervision, Inspection, & Overhead (4%)				$115,084		$104,036
Contractor Profit (10%)				$287,709		$260,089
Contractor Bonds (5%)				$143,854		$130,044
Design (6%)				$172,625		$156,053
Resident Engineering (3%)				$86,313		$78,027
Contingency (20%)				$575,418		$520,178
TOTAL CAPITAL COSTS				$4,316,000		$3,901,000
TOTAL ALTERNATIVE COSTS						$3,901,000

TABLE E-74
SOUTH OPPORTUNITY SUBAREA
BLUE LAGOON AREA OF CONCERN
Alternative - Partial Removal (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Excavation - Blue Lagoon	CY	5,100	$3.99	$20,349	1	$20,349
Dewatering	LS	1	$1,000	$1,000	1	$1,000
Roads	CY	5,100	$1.17	$5,967	1	$5,967
Erosion	CY	5,100	$0.10	$510	1	$510
Haul	CY	5,100	$6.54	$33,354	1	$33,354
Mob/Demob	CY	5,100	$0.08	$408	1	$408
Other (H&S, Survey, Office, Security, etc)	CY	5,100	$1.63	$8,313	1	$8,313
Decon	CY	5,100	$0.05	$255	1	$255
Dust Control	CY	5,100	$0.23	$1,173	1	$1,173
Culvert Under RR	EA	1	$20,000	$20,000	1	$20,000
Air Monitoring	EA	4	$3,350	$13,400	1	$13,400
Excavate Backfill Mat'l and placement	CY	5,000	$2.77	$13,850	1	$13,850
Haul Backfill Mat'l, 6 mile rt (20 cy/truck)	CY	5,000	$6.17	$30,850	1	$30,850
Grading	SY	9,600	$0.13	$1,248	1	$1,248
Vegetation	AC	2	$1,290	$2,580	1	$2,580
Soil Cover for RR - Geocell	SF	72,500	$3	$217,500	1	$217,500
Soil Cover for RR - Topsoil - haul	CY	1,600	$17	$27,200	1	$27,200
Soil Cover for RR - Topsoil - place	CY	1,600	$10	$16,000	1	$16,000
Soil Cover for RR - Hydroseed	AC	2	$1,500	$3,000	1	$3,000
Subtotal				$416,957		$416,957
2. Indirect Costs						
Field Indirect (2%)				$8,339		$8,339
Supervision, Inspection, & Overhead (4%)				$16,678		$16,678
Contractor Profit (10%)				$41,696		$41,696
Contractor Bonds (5%)				$20,848		$20,848
Design (4%)				$8,339		$8,339
Resident Engineering (2%)				$4,170		$4,170
Contingency (20%)				$83,391		$83,391
TOTAL CAPITAL COSTS				$600,000		$600,000

B. O & M COSTS

1. Direct Costs						
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098
Cover Repair / Vegetation	AC	0.01	$27,000	$270	2 thru 30	$3,098
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Subtotal				$12,536		$143,838
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$501		$5,754
Contractor Bonds (5%)				$627		$7,192
Contractor Profit (10%)				$1,254		$14,384
Contingency (20%)				$2,507		$28,768
TOTAL O&M COSTS				$17,400		$199,900
TOTAL ALTERNATIVE COSTS						$800,000

TABLE E-75
SOUTH OPPORTUNITY SUBAREA
WILLOW CREEK SST AREA OF CONCERN
Alternative - No Further Action (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Institutional Controls *	LS	0	0.00	$0	1	$0
Subtotal				$0		$0
2. Indirect Costs						
Field Indirect (0%)				$0		$0
Supervision, Inspection, & Overhead (4%)				$0		$0
Contractor Profit (10%)				$0		$0
Contractor Bonds (5%)				$0		$0
Design (0%)				$0		$0
Resident Engineering (0%)				$0		$0
Contingency (20%)				$0		$0
TOTAL CAPITAL COSTS				$0		$0
B. O & M COSTS						
1. Direct Costs						
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Subtotal				$666		$7,642
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$27		$306
Contractor Bonds (5%)				$33		$382
Contractor Profit (10%)				$67		$764
Contingency (20%)				$133		$1,528
TOTAL O&M COSTS				$900		$10,600
TOTAL ALTERNATIVE COSTS						$11,000

- Already established through Superfund Overlay District and Open Space Development Review District.

TABLE E-76
SOUTH OPPORTUNITY SUBAREA
WILLOW CREEK SST AREA OF CONCERN
Alternative - Capping (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Mobilization/Demobilization	AC	49	$100	$4,900	1	$4,900
Site Preparation (clearing and grading)	AC	49	$2,850	$139,650	1	$139,650
Foundation Layer (ripping and compacting)	AC	49	$8,100	$396,900	1	$396,900
Geosynthetic Clay Liner	AC	49	$22,500	$1,102,500	1	$1,102,500
Protective Soil Cover (18')	AC	49	$6,703	$328,447	1	$328,447
Vegetation	AC	49	$1,290	$63,210	1	$63,210
Haul (4 miles)	AC	49	$8,494	$416,206	1	$416,206
Stormwater Drainage Ditches (100 LF/AC)	AC	49	$90	$4,410	1	$4,410
Roads - Temporary	AC	49	$470	$23,030	1	$23,030
Dust Control	AC	49	$200	$9,800	1	$9,800
Air Monitoring	EA	6	$3,350	$20,100	1	$20,100
Consolidation	CY	500	$5.37	$2,685	1	$2,685
Stream Bank Erosion Control	AC	15	$4,493	$67,395	1	$67,395
Revegetation - riparian	AC	15	$710	$10,650	1	$10,650
Subtotal				$2,589,883		$2,589,883
2. Indirect Costs						
Field Indirect (2%)				$51,798		$51,798
Supervision, Inspection, & Overhead (4%)				$103,595		$103,595
Contractor Profit (10%)				$258,988		$258,988
Contractor Bonds (5%)				$129,494		$129,494
Design (6%)				$155,393		$155,393
Resident Engineering (3%)				$77,696		$77,696
Contingency (20%)				$517,977		$517,977
TOTAL CAPITAL COSTS				$3,885,000		$3,885,000

B. O & M COSTS

1. Direct Costs						
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098
Cap Repair / Vegetation	AC	0.49	$13,462	$6,596	2 thru 30	$75,687
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Subtotal				$18,862		$216,427
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$754		$8,657
Contractor Bonds (5%)				$943		$10,821
Contractor Profit (10%)				$1,886		$21,643
Contingency (20%)				$3,772		$43,285
TOTAL O&M COSTS				$26,200		$300,800
TOTAL ALTERNATIVE COSTS						$4,186,000

TABLE E-77
SOUTH OPPORTUNITY SUBAREA
WILLOW CREEK SST AREA OF CONCERN
Alternative - Land Reclamation (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
			Min	Max	Min	Max		Min	Max
Mobilization/Demobilization	AC	65	$100		$6,500		1	$6,500	$6,500
Site Preparation	AC	65	$800		$52,000		1	$52,000	$52,000
Level I Reclamation	AC	0	$945		$0		1	$0	$0
Level II Reclamation	AC	0	$2,435		$0		1	$0	$0
Level III A Reclamation	AC	0	$9,505		$0		1	$0	$0
Level II B Reclamation	AC	0	$5,600		$0		1	$0	$0
Level III C Reclamation	AC	65	$4,530	$16,610	$294,450	$1,079,650	1	$294,450	$1,079,650
Dust Control	AC	65	$200		$13,000		1	$13,000	$13,000
Stormwater Drainage (100 LF/AC)	AC	65	$90		$5,850		1	$5,850	$5,850
Stream Bank Erosion Control	AC	15	$4,493		$67,395		1	$67,395	$67,395
Revegetation - riparian	AC	15	$710		$10,650		1	$10,650	$10,650
Air Monitoring	EA	6	$3,350		$20,100		1	$20,100	$20,100
Subtotal					$469,945	$1,255,145		$469,945	$1,255,145
2. Indirect Costs									
Field Indirect (2%)					$9,399	$25,103		$9,399	$25,103
Supervision, Inspection, & Overhead (4%)					$18,798	$50,206		$18,798	$50,206
Contractor Profit (10%)					$46,995	$125,515		$46,995	$125,515
Contractor Bonds (5%)					$23,497	$62,757		$23,497	$62,757
Design (6%)					$28,197	$75,309		$28,197	$75,309
Resident Engineering (3%)					$14,098	$37,654		$14,098	$37,654
Contingency (20%)					$93,989	$251,029		$93,989	$251,029
TOTAL CAPITAL COSTS					$705,000	$1,883,000		$705,000	$1,883,000

B. O & M COSTS

1. Direct Costs							
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098	
Vegetation Repair	AC	0.65	$1,290	$839	2 thru 30	$9,621	
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642	
Subtotal				$13,105		$150,361	
2. Indirect Costs							
Supervision, Inspection, & Overhead (4%)				$524		$6,014	
Contractor Bonds (5%)				$655		$7,518	
Contractor Profit (10%)				$1,310		$15,036	
Contingency (20%)				$2,621		$30,072	
TOTAL O&M COSTS				$18,200		$209,000	
TOTAL ALTERNATIVE COSTS						$914,000	$2,092,000

TABLE E-78
SOUTH OPPORTUNITY SUBAREA
WILLOW CREEK SST AREA OF CONCERN
Alternative - Removal (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Excavation	CY	185,500	$3.99	$740,145	1 thru 2	$669,091
Clear/Grub and Erosion	CY	185,500	$0.18	$33,390	1 thru 2	$30,185
Roads	CY	185,500	$1.17	$217,035	1 thru 2	$196,200
Haul	CY	185,500	$4.54	$842,170	1 thru 2	$761,322
Mob/Demob	CY	185,500	$0.08	$14,840	1 thru 2	$13,415
Other (H&S, Survey, Office, Security, etc)	CY	185,500	$1.63	$302,365	1 thru 2	$273,338
Decon	CY	185,500	$0.05	$9,275	1 thru 2	$8,385
Dust Control	CY	185,500	$0.14	$25,970	1 thru 2	$23,477
Air Monitoring	EA	12	$3,350	$40,200	1 thru 2	$36,341
Grading	SY	242,000	$0.13	$31,460	1 thru 2	$28,440
Vegetation	AC	50	$1,290	$64,500	1 thru 2	$58,308
Stream Bank Erosion Control	AC	15	$4,493	$67,395	1 thru 2	$60,925
Revegetation - riparian	AC	15	$710	$10,650	1 thru 2	$9,628
Subtotal				$2,399,395		$2,169,053
2. Indirect Costs						
Field Indirect (2%)				$47,988		$43,381
Supervision, Inspection, & Overhead (4%)				$95,976		$86,762
Contractor Profit (10%)				$239,940		$216,905
Contractor Bonds (5%)				$119,970		$108,453
Design (2%)				$47,988		$43,381
Resident Engineering (1%)				$23,994		$21,691
Contingency (20%)				$479,879		$433,811
TOTAL CAPITAL COSTS				$3,455,000		$3,123,000
TOTAL ALTERNATIVE COSTS						$3,123,000

TABLE E-79
SOUTH OPPORTUNITY SUBAREA
WILLOW CREEK SST AREA OF CONCERN
Alternative - Partial Removal (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Excavation (Acid Plant)	CY	96,200	$3.99	$383,838	1 thru 2	$346,990
Clear/Grub and Erosion	CY	96,200	$0.18	$17,316	1 thru 2	$15,654
Roads	CY	96,200	$1.17	$112,554	1 thru 2	$101,749
Haul	CY	96,200	$4.54	$436,748	1 thru 2	$394,820
Mob/Demob	CY	96,200	$0.08	$7,696	1 thru 2	$6,957
Other (H&S, Survey, Office, Security, etc)	CY	96,200	$1.63	$156,806	1 thru 2	$141,753
Decon	CY	96,200	$0.05	$4,810	1 thru 2	$4,348
Dust Control	CY	96,200	$0.14	$13,468	1 thru 2	$12,175
Air Monitoring	EA	12	$3,350	$40,200	1 thru 2	$36,341
Grading	SY	164,600	$0.13	$21,398	1 thru 2	$19,344
Vegetation	AC	34	$1,290	$43,860	1 thru 2	$39,649
Stream Bank Erosion Control	AC	2	$4,493	$8,986	1 thru 2	$8,123
Revegetation - riparian	AC	2	$710	$1,420	1 thru 2	$1,284
Subtotal				$1,249,100		$1,129,186
2. Indirect Costs						
Field Indirect (2%)				$24,982		$22,584
Supervision, Inspection, & Overhead (4%)				$49,964		$45,167
Contractor Profit (10%)				$124,910		$112,919
Contractor Bonds (5%)				$62,455		$56,459
Design (4%)				$49,964		$45,167
Resident Engineering (2%)				$24,982		$22,584
Contingency (20%)				$249,820		$225,837
TOTAL CAPITAL COSTS				$1,836,000		$1,660,000
TOTAL ALTERNATIVE COSTS						$1,660,000

TABLE E-80
SOUTH OPPORTUNITY SUBAREA
YELLOW DITCH AREA OF CONCERN
Alternative - No Further Action (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Institutional Controls *	LS	0	0.00	$0	1	$0
Subtotal				$0		$0
2. Indirect Costs						
Field Indirect (0%)				$0		$0
Supervision, Inspection, & Overhead (4%)				$0		$0
Contractor Profit (10%)				$0		$0
Contractor Bonds (5%)				$0		$0
Design (0%)				$0		$0
Resident Engineering (0%)				$0		$0
Contingency (20%)				$0		$0
TOTAL CAPITAL COSTS				$0		$0

B. O & M COSTS

1. Direct Costs						
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Subtotal				$666		$7,642
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$27		$306
Contractor Bonds (5%)				$33		$382
Contractor Profit (10%)				$67		$764
Contingency (20%)				$133		$1,528
TOTAL O&M COSTS				$900		$10,600
TOTAL ALTERNATIVE COSTS						$11,000

* Already established through Superfund Overlay District and Open Space Development Review District.

TABLE E-81
SOUTH OPPORTUNITY SUBAREA
YELLOW DITCH AREA OF CONCERN
Alternative - Capping (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Mobilization/Demobilization	AC	10	$100	$1,000	1	$1,000
Site Preparation (clearing and grading)	AC	10	$2,850	$28,500	1	$28,500
Foundation Layer (ripping and compacting)	AC	10	$8,100	$81,000	1	$81,000
Geosynthetic Clay Liner	AC	10	$22,500	$225,000	1	$225,000
Protective Soil Cover (18')	AC	10	$6,703	$67,030	1	$67,030
Vegetation	AC	10	$1,290	$12,900	1	$12,900
Haul (4 miles)	AC	10	$8,494	$84,940	1	$84,940
Stormwater Drainage Ditches (100 LF/AC)	AC	10	$90	$900	1	$900
Roads - Temporary	AC	10	$470	$4,700	1	$4,700
Dust Control	AC	10	$200	$2,000	1	$2,000
Air Monitoring	EA	4	$3,350	$13,400	1	$13,400
Subtotal				$521,370		$521,370
2. Indirect Costs						
Field Indirect (2%)				$10,427		$10,427
Supervision, Inspection, & Overhead (4%)				$20,855		$20,855
Contractor Profit (10%)				$52,137		$52,137
Contractor Bonds (5%)				$26,069		$26,069
Design (6%)				$31,282		$31,282
Resident Engineering (3%)				$15,641		$15,641
Contingency (20%)				$104,274		$104,274
TOTAL CAPITAL COSTS				$782,000		$782,000

B. O & M COSTS

1. Direct Costs						
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098
Cap Repair / Vegetation	AC	0.10	$13,462	$1,346	2 thru 30	$15,446
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Subtotal				$13,612		$156,186
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$544		$6,247
Contractor Bonds (5%)				$681		$7,809
Contractor Profit (10%)				$1,361		$15,619
Contingency (20%)				$2,722		$31,237
TOTAL O&M COSTS				$18,900		$217,100
TOTAL ALTERNATIVE COSTS						$999,000

TABLE E-82
SOUTH OPPORTUNITY SUBAREA
YELLOW DITCH AREA OF CONCERN
Alternative - Soil Cover (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Mobilization/Demobilization	AC	10	$100	$1,000	1	$1,000
Site Preparation (clearing and grading)	AC	10	$800	$8,000	1	$8,000
Soil Cover (18")	AC	10	$6,703	$67,030	1	$67,030
Vegetation	AC	10	$1,290	$12,900	1	$12,900
Haul (4 miles)	AC	10	$8,494	$84,940	1	$84,940
Stormwater Drainage Ditches (100 LF/AC)	AC	10	$90	$900	1	$900
Roads - Temporary	AC	10	$470	$4,700	1	$4,700
Dust Control	AC	10	$200	$2,000	1	$2,000
Air Monitoring	EA	4	$3,350	$13,400	1	$13,400
Subtotal				$194,870		$194,870
2. Indirect Costs						
Field Indirect (2%)				$3,897		$3,897
Supervision, Inspection, & Overhead (4%)				$7,795		$7,795
Contractor Profit (10%)				$19,487		$19,487
Contractor Bonds (5%)				$9,744		$9,744
Design (6%)				$11,692		$11,692
Resident Engineering (3%)				$5,846		$5,846
Contingency (20%)				$38,974		$38,974
TOTAL CAPITAL COSTS				$292,000		$292,000

B. O & M COSTS

1. Direct Costs						
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098
Cover Repair / Vegetation	AC	0.10	$13,462	$1,346	2 thru 30	$15,446
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642
Subtotal				$13,612		$156,186
2. Indirect Costs						
Supervision, Inspection, & Overhead (4%)				$544		$6,247
Contractor Bonds (5%)				$681		$7,809
Contractor Profit (10%)				$1,361		$15,619
Contingency (20%)				$2,722		$31,237
TOTAL O&M COSTS				$18,900		$217,100
TOTAL ALTERNATIVE COSTS						$509,000

TABLE E-83
SOUTH OPPORTUNITY SUBAREA
YELLOW DITCH AREA OF CONCERN
Alternative - Land Reclamation (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost		Cost		Years	Present Worth	
			Min	Max	Min	Max		Min	Max
Mobilization/Demobilization	AC	10	$100		$1,000		1	$1,000	$1,000
Site Preparation	AC	10	$800		$8,000		1	$8,000	$8,000
Level I Reclamation	AC	0	$945		$0		1	$0	$0
Level II Reclamation	AC	0	$2,435		$0		1	$0	$0
Level III A Reclamation	AC	0	$9,505		$0		1	$0	$0
Level III B Reclamation	AC	0	$5,600		$0		1	$0	$0
Level III C Reclamation	AC	10	$4,530	$16,610	$45,300	$166,100	1	$45,300	$166,100
Dust Control	AC	10	$200		$2,000		1	$2,000	$2,000
Stormwater Drainage (100 LF/AC)	AC	10	$90		$900		1	$900	$900
Air Monitoring	EA	4	$3,350		$13,400		1	$13,400	$13,400
Subtotal					$70,600	$191,400		$70,600	$191,400
2. Indirect Costs									
Field Indirect (2%)					$1,412	$3,828		$1,412	$3,828
Supervision, Inspection, & Overhead (4%)					$2,824	$7,656		$2,824	$7,656
Contractor Profit (10%)					$7,060	$19,140		$7,060	$19,140
Contractor Bonds (5%)					$3,530	$9,570		$3,530	$9,570
Design (6%)					$4,236	$11,484		$4,236	$11,484
Resident Engineering (3%)					$2,118	$5,742		$2,118	$5,742
Contingency (20%)					$14,120	$38,280		$14,120	$38,280
TOTAL CAPITAL COSTS					$106,000	$287,000		$106,000	$287,000

B. O & M COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth	
Quarterly Inspection	EA	4	$2,900	$11,600	2 thru 30	$133,098	
Vegetation Repair	AC	0.10	$1,290	$129	2 thru 30	$1,480	
Site Review	EA/5 yr	0.20	$3,330	$666	2 thru 30	$7,642	
Subtotal				$12,395		$142,220	
2. Indirect Costs							
Supervision, Inspection, & Overhead (4%)				$496		$5,689	
Contractor Bonds (5%)				$620		$7,111	
Contractor Profit (10%)				$1,240		$14,222	
Contingency (20%)				$2,479		$28,444	
TOTAL O&M COSTS				$17,200		$197,700	
TOTAL ALTERNATIVE COSTS						$304,000	$485,000

TABLE E-84
SOUTH OPPORTUNITY SUBAREA
YELLOW DITCH AREA OF CONCERN
Alternative - Removal (Revision 2)

A. CAPITAL COSTS

1. Direct Costs	Unit	Quantity	Unit Cost	Cost	Years	Present Worth
Excavation	CY	140,000	$3.99	$558,600	1 thru 2	$504,974
Clear/Grub and Erosion	CY	140,000	$0.18	$25,200	1 thru 2	$22,781
Roads	CY	140,000	$1.17	$163,800	1 thru 2	$148,075
Haul	CY	140,000	$6.54	$915,600	1 thru 2	$827,702
Mob/Demob	CY	140,000	$0.08	$11,200	1 thru 2	$10,125
Other (H&S, Survey, Office, Security, etc)	CY	140,000	$1.63	$228,200	1 thru 2	$206,293
Decon	CY	140,000	$0.05	$7,000	1 thru 2	$6,328
Dust Control	CY	140,000	$0.14	$19,600	1 thru 2	$17,718
Air Monitoring	EA	8	$3,350	$26,800	1 thru 2	$24,227
Excavate Backfill Mat'l and placement	CY	140,000	$2.77	$387,800	1 thru 2	$350,571
Haul Backfill Mat'l, 4 mile rt	CY	140,000	$3.51	$491,400	1 thru 2	$444,226
Grading	SY	44,444	$0.13	$5,778	1 thru 2	$5,223
Dtich Construction	CY	8,900	$4.06	$36,134	1 thru 2	$32,665
Subtotal				$2,877,112		$2,600,909
2. Indirect Costs						
Field Indirect (2%)				$57,542		$52,018
Supervision, Inspection, & Overhead (4%)				$115,084		$104,036
Contractor Profit (10%)				$287,711		$260,091
Contractor Bonds (5%)				$143,856		$130,045
Design (2%)				$57,542		$52,018
Resident Engineering (1%)				$28,771		$26,009
Contingency (20%)				$575,422		$520,182
TOTAL CAPITAL COSTS				$4,143,000		$3,745,000
TOTAL ALTERNATIVE COSTS						$3,745,000

RECORD OF DECISION

RESPONSIVENESS SUMMARY

ANACONDA REGIONAL WATER, WASTE, AND SOILS OPERABLE UNIT

Anaconda Smelter National Priorities List Site
Anaconda, Montana

SEPTEMBER 1998

U.S. Environmental Protection Agency
and
Montana Department of Environmental Quality

RECORD OF DECISION

ANACONDA REGIONAL WATER, WASTE, AND SOILS OPERABLE UNIT
ANACONDA SMELTER NPL SITE
ANACONDA, MONTANA

September 1998

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RESPONSIVENESS SUMMARY

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TABLES

APPENDICES

LIST OF ABBREVIATIONS AND ACRONYMS

ALDC	Anaconda-Deer Lodge County
AMC	Anaconda Minerals Company
ARAR	Applicable or Relevant and Appropriate Requirement
ARCO	Atlantic Richfield Company
ARTS	Anaconda Revegetation Treatability Studies
ARWW&S	Anaconda Regional Water, Waste, and Soils
AWQC	Ambient Water Quality Criteria
BAF	bioavailability factor
BERA	Baseline Ecological Risk Assessment
BOR	Bureau of Reclamation
CDM Federal	CDM Federal Programs Corporation
CEC	cation exchange capacity
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CIA	Citizens in Action
COC	contaminant of concern
CPSA	Comprehensive Plant Stress Analysis
EAC	Environmental Advisory Council
EC	effect concentration
ENSR	ENSR Toxicology
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
ERL	effects range - low
FS	Feasibility Study
HI	hazard index
HQ	hazard quotient
h.t.	habitat type
mg/kg	milligram(s) per kilogram
LOAEL	Lowest Observable Adverse Effect Level
LRES	Land Reclamation Evaluation System
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MLR	multiple linear regression
NCP	National Contingency Plan
NEC	no effect concentration
NOAA	National Oceanic Atmospheric Administration
NOAEL	No Observable Adverse Effect Level
NRD	Natural Resources Damage
O&M	Operations and Maintenance
OU	Operable Unit
PBERA	Preliminary Baseline Ecological Risk Assessment
PCEL	plant community effects level
ppm	parts per million

LIST OF ABBREVIATIONS AND ACRONYMS (Continued)

PRAO	Preliminary Remedial Action Objective
PRP	Potentially Responsible Party
RAR	Relevant and Appropriate Requirement
RCRA	Resource Conservation and Recovery Act
RDM	RDM Multi-Enterprises
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RRU	Reclamation Research Unit
SC	specific conductance
SO_2	sulfur dioxide
STARS	Streambank Tailing and Revegetation Study
TAG	technical assistance grant
TOC	total organic carbon
TRV	toxicity reference value
VA	vegetation area
WER	water effects ratio
WMA	waste management area

1.0 INTRODUCTION

1.1 OVERVIEW

EPA prepared this responsiveness summary in conjunction with the Decision Summary portion of the ROD to document EPA's responses to issues raised by ARCO and the public regarding the RI/FS, the Final BERA, and the preferred alternative as presented in the Proposed Plan for the ARWW&S OU of the Anaconda Smelter NPL site. EPA received comments prior to, during, and after the formal public comment period, which ran from October 22, 1997 to January 30, 1998, and EPA's responses to these written and oral comments are presented here. EPA evaluated and considered all comments before making the final decision on a cleanup remedy for the ARWW&S OU.

For the most part, those members of the public who commented on EPA's preferred alternative did not express outright opposition. However, they questioned specific aspects of the proposal, and indicated a desire for more detail in the plan, and a seat at the table during the design process. They also expressed concern about dust suppression for the tailings ponds, requested additional protective actions (such as removal) on the stream side tailings of Warm Springs Creek, and reminded EPA about private property issues associated with any cleanup on private property.

The State of Montana submitted comments during the public comment period through the aegis of four of its departments: Fish, Wildlife and Parks, Natural Resources and Conservation, Environmental Quality (EPA's support agency at the OU), and the Natural Resources Damage Program of the Montana Department of Justice. The State indicated its desire for additional cleanup measures, but did not oppose the remedy as presented in the Proposed Plan.

ARCO, as well as the State agencies and some general public members, have submitted extensive comments which are addressed in the Comprehensive Response to Specific Legal and Technical Questions. Additionally, EPA responds to a series of comments ARCO submitted that address issues such as the ecological risk assessment (BERA). For organizational clarity, EPA has approached those issues separately from the general responsiveness summary, as each ARCO issue and response is lengthy and detailed. Some issues will cross over both the general public comments and the specific technical and legal comments.

1.2 COMMUNITY INVOLVEMENT BACKGROUND

EPA has conducted community involvement activities for the Anaconda Smelter site in accordance with CERCLA, the NCP, and EPA guidance documents since 1983. However, as a result of working on the Anaconda site and with the public for over 15 years, EPA has developed additional means of involving the public in the decision-making process.

The first group EPA heard from was Citizens in Action (CIA), which formed during demolition of the smelter and was concerned especially about dust blowing off Smelter Hill. They lobbied EPA to use the new Superfund law at Anaconda. CIA's county-sponsored successor, the

Anaconda-Deer Lodge Environmental Advisory Council (EAC) worked toward two goals: to be informed about site activities, and to obtain on-site monitoring by EPA of demolition activities.

Based on these goals, in 1985 EPA hired a part-time community relations liaison. That position assisted EPA in its efforts to increase the community's awareness of and participation in the Superfund process, and facilitated EPA's effort to be more accessible to the general public. In 1991, EPA received office space in the Anaconda courthouse for the liaison, thus increasing public availability. After the position ended, Bureau of Reclamation construction oversight personnel used the space in much the same manner. EPA's Montana Office also hired a full-time Community Involvement Coordinator and a full-time contractor to work in Butte (and Anaconda if needed) in 1990, thus increasing EPA's ability to communicate with the public. To address EAC's other goal, EPA initiated on-site monitoring using a contractor.

The EAC also served as a forum for the concerns of Mill Creek residents during the investigation and relocation; then the residents formed the Mill Creek Residents Association. Over time, EAC's focus shifted to economic development, and became the Anaconda-Deer Lodge Reclamation Advocates. EPA also worked with the Arrowhead Foundation, which formed to advocate development of a Jack Nicklaus golf course, the Opportunity Concerned Citizens, which formed to oppose parts of the Warm Springs Ponds 1989 Proposed Plan, and historic preservation groups. The latter activity resulted in a programmatic agreement between federal, State, and local governments and agencies calling for a comprehensive approach to addressing important historic resources throughout the entire area affected by Superfund activities. The product of the agreement is a Regional Historic Preservation Plan, which has addressed historic preservation issues from Butte to Anaconda, and provided for development of an historic trail in the Old Works area.

In December 1992, EPA produced a Revised Community Relations Plan for the Anaconda Smelter Superfund Site. Within this document, EPA presented the concerns expressed by citizens during interviews conducted in 1992. The key concern expressed at that time (after the Mill Creek and Flue Dust RODs, prior to the Old Works and Community Soils RODs) was the citizens' desire for immediate action. They said that Anaconda faced economic disaster, and that living with the stigma of Superfund would only delay economic recovery. While people also expressed varying levels of concern about the potential threats to human health, they indicated that they did not, for the most part, believe their health was at risk from exposure to contamination.

EPA has struggled with the question of economic development and Superfund, and how to make decisions that allow for the former. In Anaconda, EPA worked diligently to enable the County to buy property from ARCO without threat of future liability, and to craft a decision that would allow development of the Old Works as a world class golf course. EPA pushed schedules in response to the concerns expressed during community interviews and other meetings. EPA has also worked closely with the community in determining preferred land uses and the corresponding cleanup levels. While EPA did not compromise human or environmental health protection, the agency always strove to remove Superfund obstacles to economic development where possible.

Another issue raised in the interviews was the continuing need for clear and constant communication from EPA about site activities. They stressed that they heard from ARCO frequently, largely due to ARCO's office being located in Anaconda. EPA increased its informational activity in Anaconda with a comprehensive site update in May 1993, which addressed all of the information needs expressed in the interviews. This was sent to every mailing address in Anaconda (over 3000 addresses), and included a post card sign up to get on EPA's Anaconda mailing list. About 300 people responded. Also, the EPA Remedial Project Managers and other staff spend significant time in the community meeting with local government and civic leaders, environmental group representatives, and other concerned citizens both collectively and individually. EPA's Bureau of Reclamation construction oversight manager addresses issues that might arise on a day-to-day basis.

In 1994, EPA funded a Technical Assistance Grant (TAG) for the Anaconda site. The TAG is unusual in that its purpose is to analyze site activities in terms of public policy, not necessarily technical issues. EPA has worked closely with the technical advisor and members of the Arrowhead Foundation, which was awarded the TAG, to clearly explain site activities and the impacts of potential and existing cleanup remedies. EPA and BOR staff have also met with civic and environmental groups to keep the public informed. In the last 18 months, EPA has made a concerted effort to inform the public about all aspects of the impending decision. Listed below are just a sample of the many meetings and other public outreach activities EPA has been involved in at the Anaconda site.

September 1993 - Old Works/East Anaconda Development Area OU Proposed Plan

May 1994 - Opportunity Public Meeting on well sampling

November 1994 - "EPA Cleanup Reshaping Old Works" site update

February 1995 - "EPA Looks at Health Risks to Anaconda Residents" site update

March 1996 - Anaconda Superfund Update: "EPA studies nearing end, final projects underway."

March 1996 - Public Meeting on Community Soils, ARWW&S, and Old Works

July 1996 - Community Soils Proposed Plan mailed out to over 300 people

October 1996 - Superfund Remedy Summary, Community Soils OU

February 1997 - ARWW&S OU Feasibility Study Public Meeting

June 1997 - Meeting with the George Grant Chapter of Trout Unlimited, the Skyline Sportsmen's Association, and the Anaconda Sportsmen's Club.

October 1997 - News Conference in Anaconda Court House to release Proposed Plan to public and describe the preferred alternative.

October 1997 - Full page display advertisement for Proposed Plan in Anaconda Leader

October 1997 - Mailed Proposed Plan to over 700 people on EPA's mailing list and Anaconda Local Development Corp's mailing list.

November 1997 - Three-day Open House in Anaconda to discuss preferred alternative.

November 1997 - Public Meeting/Open House in Opportunity to discuss preferred alternative.

January 1998 - Formal Public Hearing to accept oral public comment.

1990-1998 - Numerous (at least monthly) meetings with County officials, civic leaders, and others (including individuals) to discuss site activities and various proposals for site cleanup.

In the process of meeting with Anaconda citizens and leaders and discussing site issues, EPA incorporated comments, suggestions, and other information in the documents that have resulted from site investigations. Only comments received since October 1997 (and during the FS as relates to ARCO comments) are addressed in this responsiveness summary.

1.3 SUMMARY OF PUBLIC COMMENTS RECEIVED DURING PUBLIC COMMENT PERIOD AND AGENCY RESPONSES

The comment period on the draft FS and the Proposed Plan lasted from October 22, 1997 until January 30, 1998. EPA originally set a 60-day public comment period, but extended it at the request of the County and civic leaders. EPA received 30 separate comments during the public comment period, as well as 60 separate legal and technical comments from ARCO throughout the final FS. EPA has collected all comments and categorized and summarized them by issue or concern. Table 1 presents a list of community and local government issues and concerns. EPA responds to specific legal and technical questions in Section 2.2. Most of the State and Federal agency-submitted comments are addressed in Section 3. As mentioned above, ARCO comments are addressed separately due to their length and level of detail. Responses to ARCO comments are presented in Section 4.

2.0 RESPONSES TO PUBLIC COMMENTS

2.1 RESPONSES TO LOCAL COMMUNITY CONCERNS

1. Public Participation

The County, the Anaconda Local Development Corporation (ALDC), the Arrowhead Foundation, and individuals all called for public (County) involvement in the design of the remedy. The County said "the Record of Decision should specify a meaningful level of involvement."

Response: EPA has increased public involvement in the design process at other operable units, especially Warm Springs Ponds. EPA is committed to informing the public on a regular basis about the design process. The final remedy calls for development of a site management plan to help track and communicate remedial action on an annual basis. EPA will work with the community to develop other specific ways to communicate implementation of the remedy.

2. Dust Suppression

Numerous people voiced concern about dust from tailings ponds and the slag pile, and questioned whether the remedy would adequately address dust storms. One commenter said he was unable to attend a public meeting due to suffering the ill effects of a dust storm. Another indicated that the dust "has stopped my plans to create a nice place to live and thrive...I see no future here...."

Response: Dust suppression is an important consideration. EPA is not only concerned with existing tailings ponds and slag piles releasing dust to adjacent areas, especially residential areas, but also with any dust that might be created during remedy implementation. The remedy, as presented in the Record of Decision, calls for dust suppression at the Opportunity and Anaconda Ponds by implementation of an 18" vegetative growth media, and requires dust suppression activities during remedy implementation. ARCO is currently performing some dust suppression activities, but given the number of complaints about blowing dust. EPA will evaluate the effectiveness of ARCO dust suppression activities.

3. Time Frame for Remedy Implementation

Several comments dealt with the time frame for remedy implementation. Most expressed concern that the remedy would take many years to complete. The County said that" a remedy that takes 30 years to implement" does nothing to "mitigate the negative connotations that are associated with being one of the nation's largest Superfund sites." Another individual wrote "if we have to wait 30 years or more for complete dust suppression that is the same as doing nothing at all" as the average person's working life is about 30 years.

One person, however, indicated that he "would like to see this work stretched out over a longer period of time." He was concerned that a remedy implemented in a shorter period of time (two to three years) would require hiring a lot of "outside" contractors versus hiring locally.

The State senator for Anaconda also suggested that the community "not rush through a project...and then have to have it redone...a few years later."

Response: For a site the size and complexity of Anaconda, it is virtually impossible to determine exactly how long a cleanup project will take. Still, based on acreage and actions planned, EPA estimates that a minimum of 10-15 years will be necessary to completely implement the final remedy for the entire Anaconda site. This estimate will be refined over the next two years, as design activities progress. Additionally, EPA will look at prioritizing remediation on those lands (e.g., Opportunity Ponds and Smelter Hill) which continue to pose a more immediate need for dust suppression. EPA understands the community's concerns about the negative image associated with Superfund, and is looking at options to delist parts of the Anaconda site that may have completed remedies.

4. Institutional Controls and Funding

A commenter told EPA to reconsider the use of institutional controls; that "if these sites were cleaned up to a proper level, there would be no need for ICs which only restrict access and exposure to 'residual contamination.'" The comment continued with concerns about the County's ability to "live up to" its responsibilities at the Old Works. The commenter said the County has failed to make required annual inspections or file required reports. He concludes by questioning EPA for proposing to "give an under-staffed under-funded County more responsibility for ICs and O&M on ARWW&S." The County also expressed concern about the Proposed Plan's lack of specificity about how to adequately fund the County's Development Permit System through the establishment of a trust fund.

Response: Consistent with CERCLA and the NCP, this remedy does not use ICs as a substitute for active response measures (e.g., treatment or containment off source material, restoration of ground water to beneficial uses) as the sole remedy, unless active measures are deemed not practicable, based on a balancing of trade-offs among alternatives that is done during remedy selection. The ICs supplement engineering controls to prevent or limit exposures to hazardous substances. Institutional Controls are an integral part of this remedy in order to assure protection of human health and the environment (as is the case with ICs for ground water, which is technically impracticable to remediate) and to assure the integrity of certain remedial actions (such as the zoning and deed restrictions on the Opportunity and Anaconda Ponds).

The comment about ADLC and its ability to implement institutional controls is a serious consideration. EPA must be assured of a County's ability to successfully deal with all the issues that arise in the implementation of institutional controls. EPA has funded Arrowhead Foundation additional grant funds to hire technical advisors who can assess the institutional controls program and how best the County can implement them. This issue is specifically addressed in Section 9.7.4, Institutional Controls Funding, of the Decision Summary.

5. Restoration and Remediation Conflicts

Many comments addressed the issue of restoration versus remediation. All encouraged EPA to work with the State and ARCO to settle the issue. (The comments preceded the State and ARCO's June 1998 settlement offer on many areas of the Clark Fork basin Natural Resource Damage suit.) Some comments dealt with the proposal to waive ground water cleanup standards in the East Valley; others with the revegetation plans (and previous attempts), and called for more trees to be planted versus "weedy species of grass." ARCO stated that the company wants this final site remedy to be complete and "the settlements (to) be global. ARCO indicated that they wanted to close out all concerns and liabilities regarding remediation and restoration before they "embark on this cleanup."

Response: EPA is committed to the settlement agreement that the State and ARCO devised in June 1998, and in areas where cleanup has not yet occurred, EPA intends to work with the State to integrate restoration with selected remedial actions where EPA believes the actions can be coordinated. EPA has also encouraged ADLC and others to work with the State of Montana Natural Resources Damage (NRD) Program to address ground water restoration and compensation issues in the East Valley, as EPA cannot require restoration.

In those areas where EPA is requiring ARCO to revegetate, EPA will require the appropriate species to be planted. "Appropriateness", as set forth in Appendix A, and consistent with ARARs, is based on those species that are native or adapted to the area and would provide diverse and abundant vegetative canopy. In some instances, formerly grass and forb areas will not be able to be reclaimed because of lost soil resources, and in those cases, tree and shrub species will have to be satisfactory.

6. Lack of Detail in Proposed Plan

Several commenters expressed concern that the Proposed Plan did not contain enough detail for them to understand what EPA really planned to do and thus for them to comment on the plan in a meaningful manner.

Response: EPA guidance encourages agency personnel to summarize as much as possible the information contained within a site feasibility study when preparing a proposed plan for public distribution. In fact, Regional guidance suggests that proposed plans should be about eight to ten pages in length. Montana Office staff struggled with writing the ARWW&S OU proposed plan because of the sheer size of the operable unit and the many associated areas of concern. We opted to craft a shorter plan that summarized in table form much of the information, recognizing that for some readers even that much information would be too much, while other readers would criticize the lack of detail. For the latter reader, however, the plan referred to the feasibility studies, which had more detail than any proposed plan could have without rewriting them in their entirety. We believe that our approach made the most sense because it allowed a wider audience to have at the very least a sense of the type of activity that EPA proposed, and the areas that activity could be expected to take place.

7. Ground Water, Technical Impracticability

One commenter took strong exception to EPA's decision to waive ground water ARARs in the East Valley based on a technical impracticability study. He said the "no further action alternative which is based on 'prohibitive cost' and the convenient excuse of technical impracticability is totally unacceptable and is in direct conflict with NCP criteria that 'must be met by the remedial action.'" He wrote that "there is no justification for 'writing off' millions of gallons of ground water" and suggested that "EPA has apparently forgotten what their mandate is."

Response: EPA did not forget that our mandate is to protect and restore ground water resources. The National Contingency Plan (NCP) states that:

> EPA expects to return usable ground waters to their beneficial uses *wherever practicable, within a time frame that is reasonable* given the particular circumstances of the site. (NCP §300.430(a)(1)(iii)(F) emphasis added).

EPA and MDEQ required extensive site investigations on the regional ground water system which were conducted over ten years (1985 - 1995). This information was used during the Feasibility Study which assessed the practicability and time frames for ground water remediation in the Anaconda area. EPA determined that at a cost of >$2.2 billion to remove waste materials and the impracticability of removing soils over +28,000 acres and no ability to pump and treat the bedrock aquifer, a technical impracticability waiver was appropriate for this site. CERCLA allows for waiver of specific ARARs (in this case meeting the State of Montana arsenic ground water standard of 18 μg/L) and the case of a waiver, EPA's general expectations are to prevent further migration of the contaminated ground water plume, prevent exposure to the contaminated ground water, and evaluate further risk reduction. This final remedy meets the alternative goals when ground water cannot be remediated.

8. Ground Water, Lost Resource

Anaconda-Deer Lodge County stated that "it is not possible for us to accept the premise...that this plan identifies substantial (ground) water contamination and then proposes that this community live with that contamination forever." They "insist that...ground water be treated... in a manner that acknowledges its importance as a resource for today and tomorrow, not only for this community, but for those downstream."

Response: EPA, consistent with CERCLA and the NCP, has determined that it is technically impracticable to restore ground water for much of the ARWW&S OU. Where it is practicable, EPA is requiring standards to be met through source control and natural attenuation. The impracticability of restoration of much of the ground water is carefully documented in FS Deliverable No. 3A (EPA 1996a) and presented in Appendix D. EPA acknowledges the value of the lost ground water to the community but believes the selected remedy best meets the objectives to prevent further migration of the plume, prevent exposure to contaminated ground water, allows alternative uses (industrial or agricultural, if appropriate), and provides reduction of arsenic into the aquifers by implementing wide-scale land reclamation.

9. Economic Development

EPA received conflicting comments on economic development and the agency's role in increasing economic activity in the Anaconda area. Most commenters stated their belief that EPA must cooperate with the County and ARCO in order to leave Anaconda with a viable community after cleanup. However, one commenter accused EPA of "putting economic development ahead of the NCP threshold and balancing criteria." He stressed that EPA should not work with local community groups in any way that "interferes with or compromises the scope or effectiveness of Superfund remediation."

Response: EPA walks a tightrope between conflicting community interests. While EPA works closely with local governments to devise site remedies that are mutually acceptable, the agency is sometimes asked to do more for the purposes of economic development than the agency is able to do under CERCLA. In past discussions, EPA has told the public that Superfund does not have an economic criterion, and that economic issues cannot be taken into account in our decision-making process. However, EPA strived to consider economic development in situations where there were two equally protective remedies. Thus, the agency worked with ADLC and ARCO to facilitate development of the Old Works Golf Course, and EPA continues to work with the community to devise remedies that will not preclude economic activities. Our mandate remains protection of human health and the environment, but where there is more than one way to meet that mandate, a community's needs, as expressed by their elected officials and civic groups, can sometimes be addressed at the same time.

10. Technical Assistance Grant

One comment addressed the technical assistance grant EPA awarded to the Arrowhead Foundation. Stating that it was given to the Anaconda Local Development Corporation (ALDC), the comment was "EPA has no business assisting ALDC in any way that interferes with or compromises the scope or effectiveness of Superfund remediation."

Response: EPA awarded a technical assistance grant (TAG) to the Arrowhead Foundation in 1994 for the Anaconda Smelter site. Their intent was to hire technical advisors to analyze Superfund activities in terms of public policy. The existence of a TAG should not compromise Superfund remediation; however, the input received from a TAG can be influential on a decision, as such input has its basis in at least a portion of the community. EPA encourages all citizens to be aware of and active in the TAG in their community so that they have another forum for their views to be represented to the agency. EPA will still listen to individuals, although as with the TAG, EPA may not be able to satisfactorily address all concerns and desires.

11. Waste Disposal Areas

ADLC stated that Cell A in the Opportunity Ponds should be remediated to the extent necessary and Cell B should be recognized as ADLC's waste disposal area.

Response: EPA originally identified Cell A of the Opportunity Ponds as the location of the proposed County's mine waste repository based on the 1992 Master Plan. Subsequent to the Master Plan adoption, ARCO extended a railroad spur and constructed unloading facilities for disposal of the Lower Area One Removal mine tailings (Silver Bow Creek/Butte Addition NPL Site). This active disposal in the Opportunity Ponds was ceased in 1997 in favor of disposal in Silver Bow County at a nearer location.

ARCO owns all property of the Opportunity Ponds. The County and ARCO will have to determine the most appropriate location for disposal of mine wastes slated for removal and relocation into the Ponds. It is apparent to EPA and MDEQ that Cell B2 has certain factors which favor continuing use as an active disposal facility: infrastructure in place. However, if the County and ARCO agree that Cell A is more appropriate, this location is also agreeable to EPA. The point is that an active repository must be sited somewhere on the Ponds, and all remaining properties, either in the Cell A or Cell B2, must be reclaimed to meet the requirements of the ARWW&S remedy.

12. Health Risk Associated with the Site

Most comments did not address this issue, but the few that did indicated that human health concerns were not a priority for them. One person said he had worked in the smelter for 34 years and "I guess I'm still alive...I don't have cancer or all these bad things." ARCO stated that they " will proceed the best we can with this cleanup...we want to be sure...we are dealing with real risk and effectuating things that really mean something." Another person said she "managed to survive in what other people have felt is a terrible environment...and I have survived well."

One commenter indicated dust from the Main Slag Pile had made him ill.

Response: As discussed in Section 2 of the Decision Summary, EPA's initial actions at the site (i.e., Flue Dust ROD, Old Works ROD) were focused on the most immediate human health threats. The ARWW&S OU ROD addressed the remaining current and potential health risks . In accordance with CERCLA and the NCP, the human health risk assessment characterized the current and potential threat to human health that was posed by contaminants migrating to ground water or surface water, releasing to air, leaching through soil, remaining in the soil, and bioaccumulating in the food chain. EPA believes the ARWW&S OU remedy is protective of human health and the environment, and although current and potential risk may not be as evident to the community as earlier human health concerns, dust suppression remains a major goal of cleanup activities.

13. Level of Cleanup

Some comments directly questioned how EPA selected cleanup levels (e.g. 1,000 ppm in recreational areas); others wondered if it was necessary to do much because many trees and wildlife had already returned (since smelter closure, assumedly). One asked what the County really needs, and "do we need the impossible...or can we let some of this thing take care of itself?"

Response: EPA based its risk-based cleanup levels on determinations made in its site risk assessments. While EPA acknowledges that some site recovery may occur without cleanup actions EPA analyzed this alternative and determined that the No Action Alternative was not protective of human health and the environment and was not compliant with ARARs, and therefore, did not meet the NCP threshold criteria for selection of the remedy. The agency asserts that the ARWW&S OU remedy will allow a more immediate reduction of risk to human health and the environment and more rapid recovery of plant and wildlife resources. This is explained more fully in Sections 6 and 9 of the Decision Summary and Section 4 of the Responsiveness Summary. The Land Reclamation Evaluation System (LRES), discussed in Section 9 and Appendix C of the Decision Summary, will take into account whether a certain discrete area is "taking care of itself" and will take that into account in remedial design and remedial action.

14. Private Property Rights

Citizens United for a Realistic Environment commented that "it's imperative that everyone recognize that (ARCO holdings in the East Valley) are private property holdings" and ARCO "should have the right to determine the use of their property within the confines of the law."

Response: EPA does not disallow the takings clause of the United States Constitution. However, the majority of CERCLA actions throughout the nation take place on private property and EPA has the authority to act consistent with CERCLA and the NCP on private property as well as public property. EPA does, however, take current and reasonably anticipated use into account in remedy selection. For example, the county's zoning of the Ponds for waste management is reflected in a greater allowed arsenic contamination level (1,000 ppm) than the arsenic level for residential use (250 ppm). See Section 4 of the Responsiveness Summary for EPA's response to ARCO comments on this private property issue.

15. Desire for Cost-Effective Remedies

Several comments touched on the need for a remedy or remedies that reduced risk in a cost-effective manner.

Response: CERCLA requires EPA to take cost into account in evaluating remedies, and if EPA can meet threshold criteria, and achieve other criteria such as short- and long-term effectiveness and implementability, EPA will choose a less expensive of two equally protective remedies. EPA also works to refine costs, and in fact did an extensive evaluation of costs after release of the Proposed Plan to further refine the agency's cost estimate for the Anaconda remedy. At this point, EPA estimates that the remedy will cost between 80 and 150 million dollars, compared to the estimate of $180 million in the Proposed Plan. Those cost estimates (and hopefully the actual costs) will be further refined during design and implementation of the remedy.

16. Support for RDM's Use of the Slag

An employee of RDM Multi-Enterprises asked for "input" on what could be done to support RDM continuing to use slag material for commercial purposes. The company president *expressed RDM's hope that "a long term contract with ARCO can be negotiated for continued development of the slag."*

Response: EPA works with local government and the local economic development group to overcome any obstacles created by Superfund. However, success is not always possible and EPA cannot guarantee the success of a specific commercial enterprise. RDM must work out contract issues with ARCO without EPA assistance.

17. Other Uses of Slag

EPA received a letter about the potential for slag to be used in Portland Cement. No specific comment was offered other than that the writer "was pleased to see the comments 'No Further Action' or the rock amendment" for the slag.

Response: EPA acknowledges the comment. If any information or assistance is needed in determining potential uses for the slag, EPA will be pleased to cooperate with any request.

18. Mechanism in ROD to Allow Economic Development Opportunities

A commenter asked that the ROD contain "a mechanism...that would allow for" economic development opportunities in the future.

Response: While there is no specific mechanism that EPA can put in the ROD to allow for economic development opportunities in the future, EPA is committed to involving the community in the design of the remedy, and will work to address economic development issues as they arise. The remedy is based on the County's Master Plan, which designates expected uses of land. If this were to change in the future, the County's Development Permit System will require further remediation of lands to meet more stringent clean-up criteria.

19. Land Use Changes

ARCO submitted a letter regarding the County's desire to obtain changes on restrictive covenants on transferred land. ARCO expressed its dissatisfaction with the County's proposal that "removing the restrictive covenants (at the proposed prison site) is not considered a barrier, therefore emphasizing the need for greater degrees of remediation than those proposed." ARCO wrote that the company could revise its restrictive covenants to prohibit modifications if it felt forced to do so.

The County Planner asked EPA to re-examine remedies proposed for areas where previously development was not expected.

Response: EPA looks to local government in EPA's determination of current and reasonably anticipated land uses on a Superfund site. In the Anaconda area, much of the property is owned by ARCO or has been transferred to other entities with restrictive covenants attached. EPA understands both the County's and ARCO's frustration, but has no authority over restrictive covenants on private property. EPA based its remedies on protectiveness and effectiveness and on the County's own Master Plan for land use.

20. <u>Desire for Year Round Recreation Opportunities</u>

A representative of the Anaconda Sportsmens' Club asked for "clean water, like Silver Bow Creek (remedy) and fish in the creek...birds in Opportunity Ponds, and access sites when the projects are completed." They also want to create a shooting range.

Response: EPA's selected remedy is protective of human health and the environment. A result of this should be more fish in Warm Springs, Mill, and Willow creeks, and birds and other wildlife around the Opportunity Ponds. As for access sites, the Anaconda Sportsmens' Club should work with the property owners to gain access. Any desired use of County lands will have to be addressed by the County, but as long as the cleanup of a specific area does not preclude recreational use, there should be no human health reason to reject a shooting range.

21. <u>Cleanup of Warm Springs Creek</u>

One person commented that ARCO "should have fixed the Warm Springs Creek channel before they built a golf course next to it." He wrote that after the closure of the smelter, water previously used for the plant was allowed to flow through to the creek, but now that a pipeline was installed to Butte there would be diminished flow.

Response: EPA required ARCO to stabilize the Warm Springs Creek stream bank during the Old Works cleanup. The surface water quality of the creek is actually quite good as it flows through the Old Works area. As for the water being diverted to Butte, EPA does not have jurisdiction over water rights issues.

22. <u>Contaminated Soils in Anaconda</u>

The extension service agent for Deer Lodge County asked that boulevard/sidewalk soils be addressed in the community soils remediation to enhance tree plantings downtown. The County stressed that all identified non-vegetated areas should be remediated to pre-smelting conditions. An individual asked for more information about what would be done for his agricultural soils, which he said tested at over 1,800 (ppm) arsenic.

Response: The final remedy will address effects of metals and arsenic in wastes and soils on vegetation. Reclamation, removals, and/or soil covers are the options available for addressing site-specific concerns. EPA is generally aware of the problem with urban tree planting within the community of Anaconda, and expects that part of the problem is related to residual wastes remaining underneath sidewalks and roads. While the sidewalks and roads provide a "cover" over waste material, and therefore provide a barrier and protection for any human health risks, the wastes are phytotoxic to trees and shrubs. EPA and the County can develop a specific program to address removal or remediation of these areas during remedial design.

The County asks for remediation of non-vegetated areas to "pre-smelting conditions." EPA cannot restore lands impacted by smelter emissions to a "pre-smelting" or baseline condition. EPA does require remediation of the soils to reduce risk to human health and the environment through *in situ* revegetation or soil cover treatments and planting of native and adapted plant species capable of creating a self-sustaining plant community. The specifics of the type of revegetation will be developed based on site-specific factors and following the process outlined in Appendix C, Land Reclamation Evaluation System (LRES).

For the individual that raised concerns about his agricultural lands in the South Opportunity Subarea, EPA contacted the individual in June 1998 to respond to immediate concerns about arsenic concentrations in soils and ground water. EPA will continue to work with individual property owners throughout the remedial design process to identify areas of concern, assess vegetation and erosion conditions on the properties (using the LRES), and develop site-specific remediation plans.

23. Alternate Methods of Cleanup and Revegetation

EPA received a letter applauding the cooperative attitude of both EPA and ARCO, and their willingness to solicit community input and flexibility to incorporate community wishes. The writer expressed hope that the needs of the community would continue to be balanced with environmental decisions. She asked that we "not insist on return(ing) our area to its pristine state." She cited that schoolchildren successfully planted trees on the hills in Anaconda, and suggested this type of project could "help restore vegetation without tremendous cost." She also made a plea that millions of dollars not be spent on cleaning up contaminated ground water if another source is available, and asked that as little waste material be moved as possible because of the hazards of blowing dust and transport. She encouraged deep-tilling and liming of soils instead.

Response: EPA appreciates the comment, and intends to continue to work closely with the community to achieve a satisfactory remedy. The agency does not believe that it is possible to return Anaconda to a pristine state, nor does EPA have the authority to return the site to pre-mining conditions, even if is was desired by all parties. EPA recognizes that community efforts over the years have helped to revegetate parts of Anaconda, and hopes to build on those efforts. The agency would certainly not discourage additional citizen efforts, but will focus on remedy implementation through other means to ensure completion. EPA has determined it is technically impracticable to clean up the ground water in the East Valley, but may require alternate sources of drinking water for Anaconda should such a need develop. Finally, EPA does intend to do deep-tilling and lime additions where possible.

24. Lack of Public Response

The County Planner wrote that he believed that the size and diversity of the site made it difficult for the average citizen to comprehend all of the impact that any remedy may have on this area. He said that is why there was little citizen response at the public meetings and the hearing. He also indicated that the citizens trusted their elected officials and community based groups to *represent their interests. He said that trust is why it is imperative that those officials and the groups' representatives be included in the design process.*

Response: EPA agrees that the size, complexity, and diverse nature of the contamination may be difficult to take in and comment upon a proposed plan to deal with the site. EPA was gratified that so many people attended the various information sessions and hearing, and believes that their listening to other comments may have been satisfactory to them. EPA also assumes that local government and community groups represent the interests of some significant segment of the local population, and evaluate their comments accordingly.

As stated earlier, EPA intends to involve County, TAG, ALDC, and other citizens in the design process as much as possible. EPA will rely on the above-named public entities to disseminate information about the design meetings until design is completed, and EPA will require a design report to be published and hold a public briefing.

25. North Slag Pile

The County engineer reminded EPA that he had submitted a report that identified the north slag pile as a potential source of contamination being detected in the County's landfill monitoring well. He said this concern should be fully addressed and a solution implemented.

Response: EPA named the slag pile located north of the Main Granulated Slag as the Anaconda Landfill Slag. As noted in the Decision Summary of this ROD, the slag pile is currently being marketed for commercial use and is almost depleted. The area will have to be characterized and an appropriate closure and cleanup plan that is consistent with surrounding land uses will be approved as part of the final remedial action for this area.

During the site-wide ground water remedial investigations (1991 - 1993) EPA assessed potential loading of arsenic and cadmium into the alluvial aquifer from the Anaconda Landfill Slag. No arsenic has been detected in the area. EPA determined that the cadmium loading identified could not be tied to the Anaconda Landfill Slag. If, during the monitoring phase of the RD/RA, cadmium is detected in the closed county landfill monitoring wells, EPA can reassess potential loading from the slag source area.

26. Georgetown Lake Contaminated Railroad Beds

The County engineer said that an investigation of potentially contaminated railroad beds in the Georgetown Lake area should be conducted.

Response: Railroad beds located within the town of Anaconda were addressed in the Community Soils ROD (1996) which calls for construction of an engineered cover over all contaminated materials and a separation of the railbed from residential and commercial/industrial areas with a barrier to restrict access and to control surface runoff through the use of retaining walls and/or curbing. This remedy was selected because some homes within Anaconda are built next to railbed material that was constructed from mine tailings and which exceed COC clean up action levels.

The Georgetown Railroad Site is an abandoned railroad spur located east of Georgetown Lake. It runs north-northeast for approximately 5.5 miles to the community of Southern Cross. The Montana Department of Health and Environmental Sciences (now MDEQ) conducted a CERCLA Preliminary Assessment (PA) for the Georgetown Railroad site in 1991. The PA reports elevated levels of heavy metals along an abandoned Butte, Anaconda and Pacific Railway line. Fine-grained tailings and waste rock material appear to have been used for ballast in the railroad bed and most of the railings were removed in 1924. The site investigations were limited to the area around Georgetown Lake since no target populations existed elsewhere along the line; two residential areas are located down-gradient of the railroad grade near Highway 1 and another is located adjacent to and on the rail bed. This area is listed as a separate site under CERCLA and CERCLA authorities and an appropriate response action will be taken for the Georgetown Lake railroad beds.

27. Solid Waste at the Main Granulated Slag Pile

The County engineer said that ARCO has been permitted to place solid waste at the southeast corner of the main slag pile. He believes that the Montana Code Annotated, the Administrative Rules of Montana, and County Ordinances require that waste to be placed in a Class-II landfill.

Response: The County Engineer is correct in noting that solid waste material (construction and demolition debris) has been disposed of at the southeast corner of the Main Granulated Slag Pile during the Mill Creek relocation effort, Flue Dust remedial action, Johnson's Corner demolitions, and other site work conducted by the PRP. EPA and MDEQ have identified the Federal and State RCRA Subtitle D and Solid Waste Requirements as applicable for this site. Final delineation of this solid waste repository will be conducted during Remedial Design on Smelter Hill and an appropriate solid waste management and closure plan approved.

28. Provision to Address Unidentified Issues

The County engineer requests language in the Record of Decision that will provide a basis for addressing "the unknowns."

Response: EPA provided this language in Section 9.2 "Miscellaneous Waste Materials" of the Decision Summary. EPA expects that there may be additional wastes identified on the site in the future and generally calls for waste consolidation into a WMA.

29. Ground Water Contamination Affecting the Mill-Willow Bypass

Trout Unlimited submitted a letter with specific questions regarding the contaminated ground water plume under the Opportunity Ponds. These questions are:

1. *Who will be responsible for sampling the wells? A private or public entity?*

2. *Will the testing schedule conform to the hydrology of the plume? Specifically in frequency as the water table dictates.*
3. *What specific parameters and limitations will be prescribed for any exceedances and will the said guidelines be included in the ROD?*
4. *At the determination of said exceedances, what remediation/procedures will be undertaken? What time interval will there be between the detection of exceedances and subsequent remediation?*
5. *What provisions will be established in the ROD for the public to access the sampling data?*

The author of the letter also expressed concern about the tailings in the Warm Springs Creek floodplain. He suggests another evaluation be made of the tailings and that they eventually be removed.

Response: The PRP is responsible for all ground water monitoring across the site, including the Point of Compliance (POC) at the edge of the Opportunity Ponds. ARCO may elect to contract with an independent party to collect and report sampling data, however, EPA reviews the technical and professional qualifications of ARCO's contractors and has final approval of contractors working on the site. All data will be reported to the agencies and made available to the general public. Proposed details of monitoring (locations of wells, parameters, data quality assurance, reporting) were presented by EPA in FS Deliverable No. 4 (in an appendix to FS Deliverable No. 5). A final monitoring plan will be completed as part of the RD/RA work plan.

EPA set a POC for attainment and protection of applicable Montana ground water standards at a location near the Opportunity Ponds which will detect any potential future movement of contaminated ground water in plenty of time before the water would recharge to the Mill-Willow Bypass. If contaminated ground water exceeding the ROD COCs is detected at the POC, EPA will require assessment of ground water controls (interception trench, slurry walls or extraction wells). These controls could include treatment and disposal of water.

There are no specific provisions in the ROD for public to access the sampling data. All data collected by EPA is public information and will be accessible. EPA would gladly solicit suggestions from the local community about ways to make monitoring data readily accessible.

EPA, MDEQ and Montana Department of Fish, Wildlife and Parks have had continued discussions since October 1997 about floodplain tailings in Warm Springs Creek and long-term channel stability. EPA initiated a more extensive investigation of the creek in September 1998 and will be using this data to further define the extent of the floodplain tailings problems and design appropriate channel stabilization, tailings stabilization and selective removal options for the Remedial Action Work Plan.

30. Land Ownership

An individual expressed concern about ARCO transferring land to the County, and potential conflicts that may result if there are conflicting claims to the land.

Response: EPA cannot regulate land transfers between private parties and local governments. Land claims must be addressed through normal channels. EPA will work with property owners regardless of their affiliation to protect human health and the environment.

31. Desire for Cooperation Between EPA, ARCO, and the County

Several people encouraged EPA, ARCO, and other entities to work cooperatively.

Response: EPA intends to work with ARCO to negotiate a consent decree to conduct all cleanup work at the Anaconda site. The County will be involved to the extent possible, except in legal negotiations with ARCO.

3.0 RESPONSES TO STATE AND FEDERAL AGENCY COMMENTS

EPA received six sets of comments on the ARWW&S OU Proposed Plan from State of Montana and Federal agencies. Responses to each set of comments are outlined in this Section.

1. Letter to Julie DalSoglio, EPA, from C. Richard Clough, Regional Supervisor, Montana Department of Fish, Wildlife and Parks, Re: EPA's Proposed Plan for the ARWW&S OU, Anaconda/Deer Lodge County, Montana, January 28, 1998.

Montana Department of Fish, Wildlife and Parks (MDFWP) commends EPA on developing a remediation plan for the site and raises specific concerns about Warm Springs Creek.

Presence of tailings within the Warm Springs Creek flood plain

"...problems with tailings...when a significant flood occurs in the future, it is likely these tailings will be eroded into and along the creek and Clark Fork River...could cause additional metals loadings and serious problems for the trout...the presence of these tailings prevents the Department, and possibly others, from implementing projects to restore the natural channel and habitat of Warm Springs Creek."

Response: During the Remedial Investigation for the Anaconda Regional Water and Waste (ARWW) OU, two separate field reconnaissances were conducted to attempt to identify stream bank tailings which may be contributing to periodic metals exceedances in Warm Springs Creek. Approximately 1200 cy of tailings were identified on the RSN Johnson Ranch and were slated for removal as part of the Proposed Plan. Furthermore, the BERA identified these stream bank tailings and overland run off from aerially contaminated soils as the source of metals loading causing exceedances of ambient water quality criteria which posed a potential threat to aquatic life in the stretch of stream from the Old Works OU to the confluence with Silver Bow Creek.

"...*terminated a project of this nature* [projects to restore the natural channel and habitat of Warm Springs Creek] *in the vicinity of the Gochanour, Johnson and Ueland ranches after significant quantities of mine tailings were discovered in the project area...the Department requested that ARCO voluntarily provide the financial assistance necessary to remove and dispose of these tailings. The Department's request was declined."*

Response: EPA recognizes the Department's long term desire to protect and improve aquatic habitat on Warm Springs Creek, in special regard to the importance as critical spawning habitat to trout from the Clark Fork River. Where the Department identifies specific projects to enhance channel renaturalization, an assessment of the possibility of tailings and the potential threat they pose to the aquatic environment should be conducted. In 1998 EPA initiated a more intense site characterization of the geomorphology of the creek to help the agencies understand where potential creek movement is occurring, and what, if any, threat exists from tailings in the old creek channels. This information will be used to address immediate or potential threats from contaminated stream bank erosion under appropriate CERCLA authorities. The MDFWP may also use this information in conjunction with independent Department approved habitat renaturalization projects. If the Department's projects impact areas where tailings could pose a problem for stream water quality, EPA will apply the appropriate CERCLA remedial authorities.

"It is the Department's opinion that removal of the tailings and other wastes along the entire Warm Springs Creek corridor (from the city of Anaconda to the Clark Fork River) is necessary to allow the creek along this stretch to be restored and to preclude a re-contamination of the creek and the Clark Fork River from future flooding and other erosive events. Such removal would be consistent, at least to some degree, with the removal of tailings which is to occur along Willow Creek under the proposed plan and along Silver Bow Creek under the ROD for the Streamside Tailings Operable Unit. We do not favor reclamation using the STARS technique in this area for a number of reasons, including the high probability of future erosion and stream channel migration."

Response: The definition of a remedial action under CERCLA permits only actions taken "to prevent or minimize the release of hazardous substances so that they do not migrate to cause substantial danger to present or future public health or welfare or the environment." 42 U.S.C. 9601(24). EPA is not authorized to take action for restoration of habitat. To date, EPA has identified limited areas with tailings that are posing a current or future threat to the aquatic habitat of Warm Springs Creek. However, EPA recognizes that long-term stability of the creek is of concern and has initiated site studies to assess the geomorphology of the creek to assess potential problems related to stream migration and release of buried tailings. EPA has proposed in this final remedy a combined remedial design of selective removal and stream stabilization techniques to minimize the release of contaminants into the creek.

It is also noted that the tailings deposition on Silver Bow Creek, Willow Creek and Warm Springs Creek are all very different. While Silver Bow Creek has extensive deposition of barren fluvially deposited tailings, Warm Springs Creek has limited pockets of tailings which are covered with uncontaminated soils and are generally well vegetated with riparian vegetation. In contrast, Willow Creek is impacted by a very thin veneer (less than 2 inches) of tailings just below the surficially clean material, tailings which were from historic flooding from Silver Bow Creek crossing the joint flood plains. EPA believes that the removal option should be selective to the site conditions and that in the case of Willow Creek and Warm Springs Creek, other options (partial removal, STARS, engineered controls) have merit in meeting the objective of minimizing release of COC into the surface waters. Remedial designs, which may include some STARS treatment will be available for review and comment by the Department.

2. Letter to Julie DalSoglio, EPA, from Greg Mullen, Montana Natural Resource Damage Litigation Program, Re: DOJ/NRDLP Comments to EPA On the Anaconda Proposed Plan, January 28, 1998.

"The State's Natural Resource Damage Litigation Program generally supports the proposed EPA actions at the Anaconda Smelter Site for the Anaconda Regional Water, Waste and Soils Operable Unit...EPA concluded that metals and arsenic dispersed by smelter emissions and waste disposal continue to pose a risk to the vegetation, the primary energy producer in the ecosystem's food web and primary determinant of wildlife diversity and abundance. The State's

studies fully support this determination...The Proposed Plan acknowledges that clean up of ground water is technically impracticable...Neither the State's Restoration Determination Plan nor EPA's proposed remedy if implemented, would bring all of the injured resources back to baseline conditions in the foreseeable future. However, if implemented the plans would restore some of the resources over time and jump start the recovery of other resources."

Response: EPA acknowledges these comments.

Opportunity and Anaconda Ponds

"It is not clear what specific reclamation measures will occur at these ponds...the State cautions that if a capping scenario is used, observance of proper cap placement techniques is warranted..."

Response: The final remedy does not call for a capping scenario. Final remedy of the ponds will be accomplished through attainment of 18" of growth media to support a permanent vegetative cover which can be achieve through a soil cover, *in situ* (ARTS) treatment, or a combination of both.

Upland Reclamation

"...there are areas that are not included in the Proposed Plan that the State's Restoration Plan proposes should be addressed. Most of these areas are located in the Mount Haggin Area."

Response: EPA conducted an assessment of the areas on the site thought to have been impacted by smelter emissions in the past and in which our regional soils studies indicated that metals and arsenic levels in the soils continue to pose a phytotoxic risk to vegetation communities. EPA carefully addressed current environmental risk posed by metals. During this time frame, the State was properly informed about the BERA assessment and the issue of current environmental risk within the State's identified injured areas was not raised. If the State had data and information about potential risk to injured areas in the Mount Haggin area, this information should have been brought forward during the RI/FS. EPA believes that we have accurately identified the areas of concern for remedial action.

"Also, the State, through its assessment found much of the upland areas was forested in the past. Approximately 70% of both the Smelter Hill and Mount Haggin areas were forested...therefore, the State's Restoration Plan call for extensive tree planting in these areas, whereas the Proposed Plan does not."

Response: EPA does not have authority to require restoration of injured resources to baseline conditions. EPA believes that the reclamation plan outlined in the Decision Summary provides for reduction of risk by revegetation. EPA acknowledges that in some areas of the site, steep slopes prohibit active tilling of areas and planting of trees and shrubs may be an appropriate remedy. However, planting of trees to attain a restoration goal of 70% tree coverage is an issue the State will have to negotiate with the PRP in settlement of restoration claims.

3. Letter to Julie DalSoglio, EPA, from Matt Marsh, MDEQ, Re: Anaconda Regional Water, Waste & Soils OU - Proposed Plan and Draft Feasibility Study, January 30, 1998.

"DEQ generally supports and concurs with the remedies selected for these areas with those exceptions listed below..."

1. High Arsenic Soils, Sparsely Vegetated Soils, Opportunity Ponds, Anaconda Ponds, Smelter Hill Disturbed Areas and other Waste Areas

" DEQ disagrees with the determination that Reclamation Levels I and II should be the selected remedy in all cases...a preference should be stated in the ROD for soil cover...there are numerous borrow sources within zero to 10 miles of several of the sites requiring remediation...if reasonable quality is available within a cost effective distance...the soil cover alternative would then become the selected remedial action rather than reclamation levels I and II (ARTS)."

Response: Based on the comments received by DEQ, EPA and ARCO agreed under an Administrative Order on Consent amendment to conduct a more detailed review of available quantities and quality of borrow material nearer to the site than the original estimated 50 mile round trip haul distance. Preliminary results indicate that material is available near site and EPA adjusted cost factors for cover soil haul distance from 4 to 2 miles round trip (see Appendix E, Decision Summary). The final remedy allows for either cover soil, *in situ* reclamation (ARTS), or a combination of both to meet the design criteria of 18 inches growth media at these locations.

2. Cell A of the Opportunity Ponds

"DEQ support ADLC's comment about changing their selection of a waste disposal site from Cell A to the B2 Cell of Opportunity Ponds...the ROD should include requirements that the waste disposal site comply with solid waste laws, similar to other waste disposal sites throughout the State, and that the ROD also include a revegetated soil cover or similar appropriate remediation for the finished portions of this disposal site."

Response: EPA notes that this request has been made by ADLC. Final location of a county mine waste repository will have to be decided by the land owner (ARCO) and the County and could potentially be located anywhere within the Opportunity Ponds system. EPA has changed the final remedy to reflect that where-ever the waste disposal site is located, it must comply with appropriate solid waste laws (including a closure plan) and that both Cell A and Cell B2 will include a revegetated closure plan for remaining areas not designated the active repository.

3. Main Slag Pile

"The selected alternative ... is "No Further Action"...it should be noted that the slag pile will be a contaminant source area until such time that the pile is consumed...slag will continue to be transported from the pile by wind...clean cover soil caps adjacent to the slag stockpile which could be recontaminated with metals and arsenic contained in the slag...A temporary cover would be more protective of the adjacent land uses by preventing wind-borne transport of slag.

Covering the slag with either a temporary or permanent cover would also be more protective of human and ecological health..."

Response: EPA has attempted to accommodate community and PRP interests in maintaining use of the slag as a marketable product while protecting human health and the environment through the duration of use. The ROD calls for guaranteed long-term contracts allowing commercial use of the material as a base resource, and until these contracts are in place, EPA cannot predict the life of the operation of slag mining. This time line will have to be assessed during the site management planning phases and areas slated for cover or *in situ* reclamation near the slag will have to assess the potential recontamination problem. The ROD also calls for operation of the mining facility on the slag so that it is in compliance with other applicable regulations. Minimization of blowing slag will be a key requirement. The ROD requirements provide the best balance of objectives and allow continued use of the slag as a product.

4. South Lime Ditch and Triangle Waste

"DEQ disagrees with the preferred remedy (Land Reclamation I and II or ARTS) for these areas...an adequate soil cover should be the remedy in certain of these cases..."

Response: The final remedy in the ROD allows a choice of soil cover, *in situ* reclamation or a combination.

5. Warm Springs Creek, Willow Creek, and Blue Lagoon

"Removal of tailings and waste material within or adjacent to an active stream channel is the best alternative..."

Response: The ROD allows for selective removal and stream stabilization in active channels. The remedy for Willow Creek and Blue Lagoon will be partial removal.

6. Yellow Ditch

"DEQ concurs with the soil cover alternative."

Response: Comment noted.

7. East Anaconda Yards

"The proposed plan incorrectly listed 8 inches of cover soil rather than 18 inches...(need) monitoring data to determine if 18 inches of cover soil is sufficient to intercept all of the precipitation and water movement at this site...18 inches of cover soil may be insufficient to maintain the vegetative cap..."

Response: Reclamation in the East Anaconda Yards has primarily occurred under the Flue Dust and Old Works/East Anaconda Development Area RODs. Soil cover ranging from 12 - 18 inches has been placed across the site. The final remedy calls for 18 inches of soil cover across the yards. Ground water monitoring will be conducted during O&M to determine whether there are increasing concentrations of arsenic and to monitor for plume migration. The vegetative cap will be assessed using final performance criteria to be developed in remedial design.

8. Ground Water

"...DEQ believes only those areas which meet the requirements of a technical impracticability waiver can avoid remediation of ground water...EPA should prevent further migration of the plume(s), prevent exposure to the contaminated ground water, and evaluate further risk reduction...DEQ agrees future additional evaluations of ground water will be critical. DEQ also believes a more proactive approach to ground water cleanup should be taken..."

Response: EPA has incorporated these general objectives into the final remedy and acknowledges the importance of ground water as a state and local community resource. The long-term ground water monitoring plan, O&M, source controls (land reclamation), and contingencies for proactive remediation are all important aspects of the final remedy.

9. Surface Water

"DEQ believes remediating a majority of the ARWW&S site should help reduce the impacts to surface water. DEQ agrees future additional evaluations of surface water will be critical. DEQ also believes a more proactive approach to surface water cleanup should be taken as explained in the comments above. (Ground water comments.)"

Response: Comments noted.

10. Storm Water Control

"...there is an inherent conflict between the construction of sediment detention basins and the requirements of clean up efforts to further minimize contamination and degradation of ground water if ground water cannot be restored. Since significant infiltration of storm water to ground water typically occurs from sediment detention basins and transport ditches, speciality evaporative lined detention basins and possibly ditches may be required to control storm water infiltration to ground water."

Response: EPA notes these comments and believes they will be addressed in the remedial design phase of the project.

11. Opportunity Ponds, Anaconda Ponds

"DEQ believes other methods in addition to those mentioned need to be evaluated for these sites: soil cover..., combination soil cover/reclamation, wetland establishment, and any new or development technologies."

Response: All these proposals have been incorporated into the final remedy.

12. Stucky Ridge Pilot Project

'DEQ agrees that the development of a system such as the LRES would be a very valuable tool for use in delineating areas in need of remediation..."

Response: The LRES system was further developed and expanded in 1998 and has been incorporated into the final remedy (see Appendix C).

13. Reuse

"...In the future, it is relevant to postulate that the tailings may also have some economic value for reuse. The ROD should leave the door open to this possibility. Since any reuse would in all likelihood result in the further detoxification of tailings materials, it is an appropriate consideration, both economically and environmentally."

Response: EPA believes that if site conditions change to accommodate reuse of tailings material, the remedy can be changed to continue to be protective of human health and the environment.

14. Reclamation

"DEQ objects to EPA's use of the word "reclamation" to describe this proposed remedy...should this remedy truly be a reclamation remedy, consistent with the reclamation laws of Montana, a much more complex and extensive and costly remedy would be required."

Response: EPA uses the word "reclamation" in a broader meaning than is implied by the State in these comments. In the literature, "reclamation" is applied to the remediation of drastically disturbed lands. Land managers have employed a continuum of light- to heavy-handed techniques to address these types of lands. EPA has chosen a remedy which meets the primary objectives of CERCLA, protection of human health and the environment, and requires reclamation of lands that were disturbed by smelting and mine waste disposal activities.

15. EPA's titled "Partial Reclamation" alternative

"DEQ agrees that the partial reclamation remedies fail to meet the NCP criteria."

Response: Comment noted.

16. Storm Water

"DEQ objects to storm water requirements being met only at construction completion. DEQ believes that these requirements can and should be met during the remedial action rather than at construction completion. In addition, construction completion is not defined in the proposed plan and could be many years into the future. DEQ also objects to the time limitation for the

storm water monitoring program. Monitoring must be ongoing through out construction and continue a minimum of three years to determine compliance with state water quality standards..."

Response: EPA did not mean that storm water requirements would not be met until construction completion *of the entire site*. EPA envisions that there will be many phases of remedial design and project specific construction completions. When individuals areas are complete, storm water issues will have been addressed (either through BMPs, engineering controls, or a combination of both) and monitoring will begin for attainment of ARARs. Storm water controls to address construction specific problems will be implemented during construction activities.

17. Conclusion

"...challenges lie ahead in defining what quality of reclamation will be performed and how the success of these efforts will be evaluated...flexibility in implementing the remedy is essential, but it is also necessary not to be so flexible that ARCO takes the lead on defining the character of the remedy to suit financial constraint rather than environmental quality..."

Response: EPA agrees that implementation of these remedy will need to balance flexibility to address area specific needs against criteria to maintain the protectiveness of the remedy. Remedial design/remedial work plan negotiations will be important in outlining this balance.

4. Letter to Julie DalSoglio, EPA, from Mary Capdeville, MDEQ, Re: Anaconda Regional Water Waste and Soils Operable Unit - Proposed Plan & draft Feasibility Study, January 30, 1998.

1. Ground Water Restoration and Waste Management Areas

"...it appears from the proposed plan's definition of Waste Management Areas that EPA may determine that State ground water standards do not apply beneath an area designated by EPA as a Waste Management Area. DEQ objects to this dismissal of State applicable ground water standards as an unreasonable and an impermissible interpretation of the NCP and CERCLA...." DEQ provides a lengthy discussion in support of this argument.

Response: EPA disagrees. EPA's definition of WMAs is well supported in the NCP and the preamble to the NCP. The NCP provides that EPA may eliminate remedial alternatives, during the "screening step," before each alternative is studied in detail.[1] However, a remedial alternative may not be "screened out" unless it is either: 1) not effective; 2) not implementable; or, 3) too costly.[2] These criteria ensure that a remedial alternative will not be screened out without first

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[1] 40 C.F.R. § 300.430(e)(1).

[2] "Alternatives providing significantly less effectiveness [or] that are technically or administratively infeasible . . . may be eliminated from further consideration. . . . Costs that are grossly excessive compared to the overall effectiveness of alternatives may be considered as one of several factors used to eliminate alternatives." 55

being seriously considered and evaluated. Only after an alternative is deemed impractical, based on one of the three criteria listed, will it be discarded.

In the case of the ARWW&S, EPA screened out waste removal and ground water restoration alternatives based on inordinate cost of removal. Waste removal was eliminated as an alternative. Ground water ARARs cannot be met because it is impracticable to restore ground water beneath wastes-left-in-place. Here, if waste removal is eliminated as an alternative, it is unlikely that ground water ARARs will be met, because waste removal is one of the few methods available for reclaiming ground water.

Essentially, the decision to screen out removal in this case is also a decision to create a "waste management area." A "waste management area" is simply an area where wastes will remain in place, instead of being removed.[3] It is well supported in the NCP that compliance with ground water ARARs is measured at the edge of a waste management area, not directly underneath it. The NCP acknowledges, first, that when EPA recognizes an ARAR, EPA must also decide where and how that ARAR is to be implemented, or, its POC.[4] Second, the NCP recognizes that, for waste management areas, the appropriate POC is at the edge of the area. The NCP states,

> "[T]here are general policies for establishing points of compliance. For ground water, remediation levels should generally be attained throughout the contaminated plume, or at and beyond the edge of the waste management area, when the waste is left in place. . . ."[5]

Because ground water ARARs will not be met inside the waste management area, the decision to screen out removal and to create a waste management area has the same practical effect as a technical impracticability waiver. Under either approach, the end result is that ground water ARARs will not be met. The primary difference between screening and issuing a waiver is a matter of timing. Screening takes place early in the RI/FS process whereas technical infeasibility waivers come into effect at a later stage, after removal has been studied as an alternative.

C.F.R. § 300.430(e)(7)(I)-(iii).

[3] The term "waste management area" is mentioned several times in the preamble to the NCP, see 55 FR at 8713 and 8753. Although not defined in the NCP, it seems clear that the term is borrowed from the RCRA concept referred to as the "waste management unit" or "land disposal unit." See the discussion at 55 FR 8758-60. CERCLA AOC's, or, "areas of contamination", are defined as areas of "continuous contamination of varying amounts and types at NPL sites. These are considered to be the CERCLA counterparts of RCRA "land based units" or "landfills." See 55 FR at 8760. Thus, it seems safe to say that a "waste management area" is an area of continuous contamination which will be left in place.

[4] See 40 C.F.R. § 300.430(f)(5)(iii), stating:

> "The ROD shall . . . [i]ndicate, as appropriate, the remediation goals . . . that the remedy is expected to achieve. Performance shall be measured at appropriate locations in the ground water . . . ."

[5] 55 FR at 9713.

Aside from this difference in timing, the screening process is substantially similar to the ARAR waiver provisions of CERCLA and the NCP, because the two types of decisions employ essentially the same criteria. ARARs may be waived where it would be "technically impracticable from an engineering perspective" to meet them.[6] ARARs may also be waived if the engineering needed to comply with an ARAR is inordinately costly.[7] Similarly, a remedial alternative may be screened out for technical impracticability or grossly excessive cost.[8]

Because the screening analysis is virtually the same as the process for waiving ARAR requirements, screening should not be interpreted as a less rigorous or less responsible approach. On the contrary, the early screening of non-viable options is sensible and consistent with the emphasis in the NCP on making the superfund process more efficient.[9] Where it is clear early in the RI/FS process that a remedial alternative does not meet one of the three criteria, it would waste energy and resources to wait and do a technical infeasibility waiver at the tail-end of the process. By screening out removal early on, EPA avoids carrying through the RI/FS process, which is costly and time consuming, regarding a remedial alternative that is not technically or economically feasible.

2. Feasibility Study Potential ARARs

"...further refining is necessary between the agencies prior to finalization of the feasibility study ARARs and the ROD ARARs...."

Response: EPA responded to MDEQ's request for further refinement of the ARARs as presented in Appendix A, Decision Summary.

5. Letter to Julie DalSoglio, EPA, from Fred Staedler, Anaconda Unit Manager, DNRC, Re: Input on the Proposed Cleanup at the Anaconda Superfund Site, January 30, 1998

"...The Montana Department of Natural Resources and Conservation (DNRC) manages the following school trust lands...Old Works/Stucky Ridge Subarea - 480 acres N1/2, N1/2S1/2 Section 36 T5N R11W; North Opportunity Subarea - 320 acres W1/2 Section 16 T5N R10W; South Opportunity Subarea - 640 acres Section 36 T4N R11W...The Stucky Ridge tract has potential for single family residential dwellings, condominiums and other commercial uses. In order to develop this tract, it will require soils which are cleaned up to residential standards and a supply of drinking water...Our tract in the North Opportunity Subarea was productive dry land pasture...The soils on this tract appear to have been heavily impacted by heavy metal

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[6] See CERCLA § 121(d)(4)(C), 42 U.S.C. § 9621(d)(4)(C) and 40 C.F.R. 300.430(f)(1)(ii)(C)(3).

[7] See 55 FR at 8748.

[8] See 40 C.F.R. 300.430(e)(7)(ii) and (iii).

[9] "EPA agrees . . . that focusing the development of alternatives only on those that show promise in achieving the goals of the Superfund program is a significant means by which the program can streamline the process and achieve a more rapid cleanup." 55 FR at 8714.

contamination. At a minimum this land needs to be returned to a condition which supports a healthy native grass community...I am concerned that the proposed method of handling the site specific cleanup would place substantial financial burden on the State, its lessees, licensees and contractors. This additional cost would result in reduced revenue to the Trust..."

Response: In the LRES process, cleanup action levels for a specific area (e.g., residential or open space/recreational) will be based on land use. For the State Trust lands on Stucky Ridge, if residential and commercial uses are determined to be the appropriate land use, the remedial design will call for attainment of those action levels. EPA did not identify State Trust lands in the North Opportunity Subarea within our "areas of concern". If the State has additional information on the effects of metals in soils affecting vegetation, these properties can be assessed during the remedial design phase of the project. Land use will be a critical determining factor in choosing the initial clean up action levels and degree of land reclamation. EPA is committed to working with all land owners on the site, including the State of Montana, in assessing the reclamation needs of each individual piece of property.

6. Letter to Julie DalSoglio, EPA, from Robert Stewart, Regional Environmental Officer, U.S. Department of the Interior, Office of the Secretary, Re: Comments on the Anaconda Regional Water, Waste & Soils OU Proposed Plan, January 29, 1998

1. The ROD should specify a Cabbage Gulch and Yellow Ditch water quality monitoring program be developed and implemented to determine whether source control and removal have achieved attainment of ambient water quality criteria. The ROD should also specify the time lapse after completion of the removal action when those criteria will be met, and if not, what actions will be implemented to achieve compliance.

Response: The final remedy in this ROD describes a requirement for a water quality monitoring program to assess attainment of the water quality standards. A schedule for meeting water quality criteria will be included as part of the remedial design process which will detail the frequency of monitoring and determination of attainment of the water quality standards.

2. The ROD should address the environmental protectiveness of the revised human health arsenic action level for soil and waste sources and the 1,000 ppm cleanup action level proposed for remaining lands used for waste management, agricultural/grazing and recreational/open space land uses.

Response: The 315 ppm arsenic phytotoxic value was used solely as a screening tool to help determine where elevated levels of arsenic may be posing a risk to vegetation. Where the site investigations have determined the probability of arsenic soil concentrations >1000 ppm, there is a continuum of vegetation diversity and abundance. The selected remedy in this ROD calls for reducing total surficial arsenic concentrations to below 1,000 ppm for protection of human health. The EPA believes that soil cover or deep tillage will bring the total concentrations significantly below 1,000 ppm and reduce the phytotoxicity of the soils. Appropriate amendments, seed mixture (possibly more metals and arsenic tolerant species), and plowing depth (for better dilution) will be tailored to the site specific conditions, significantly reducing risk to the environment.

3. The ROD (and/or attached scope of work) should specify that final reclamation include vegetation with primarily native species and that noxious weeds will be controlled.

Response: As noted above, EPA believes that through either soil cover or deep tillage plus amendments, total arsenic concentrations should be significantly below 1,000 ppm arsenic. EPA and their contractors have experience in using native, metals and arsenic tolerant plant species that are considered early successional plant species on these drastically disturbed lands. The State of Montana mine reclamation ARARs listed in Appendix A and the LRES reclamation decision process both require use of native and adapted plant species . Noxious weeds will also be controlled. Specific plant performance criteria will be developed as part of the remedial design package and these performance criteria will take into consideration site specific needs.

4. A copy of any detailed analysis of impacts to wetlands and associated Mitigation Plans should be provided to the Fish and Wildlife Service for review prior to implementation.

Response: EPA outlined use of the wetlands evaluation and mitigation planning process in the ROD. Wetlands ARARs, and the associated consultation role of the Fish and Wildlife Service, are included in the ARARs section of the ROD. Specific details of coordination will be outlined in any consent decree negotiations.

4.0 RESPONSES TO ARCO'S COMMENTS ON THE PROPOSED PLAN

4.1 INTRODUCTION

ARCO's comments on the ARWW&S OU Proposed Plan were submitted to EPA on January 30, 1998. Accompanying the cover letter was a two-part presentation: Part I - Conceptual Remedial Design Work Plan; and Part II - ARCO's Legal and Technical Comments on EPA's Proposed Plan for the Anaconda Regional Water, Waste & Soils Operable Unit, Anaconda Smelter NPL Site. The legal and technical comments were supported with twelve separate attachments which expanded on ARCO's conceptual remedial design work plan and their legal and technical arguments to support their premise that, "...the Preferred Alternative in the Proposed Plan is not authorized under CERCLA, exceeds EPA's authority and is inconsistent with the NCP."

EPA has chosen to structure the agency's response to all ARCO comments in the same order as presented. The following are specific responses to the issues raised in Parts I and II of the cover letter: Attachment A - Reclamation Plan; Attachments G/H - Menzie-Cura and ENSR comments on the BERA; Attachment I - Dirt Bike Rider and Trespass Scenario; Attachment J - Supplemental FS Comments; and Attachment L - ARCO's Previously Submitted Comments. EPA believes that the remaining attachments specifically address remedial design issues. EPA will submit a Remedial Design/Remedial Action Scope of Work which will incorporate concepts as presented by ARCO in the comments on the Proposed Plan. Attachments which are not responded to in detail include: Attachment B - Revegetation Success Criteria; Attachment C - Storm Water Management Plan; Attachment D - Institutional Controls Management Work Plan; Attachment E - Performance Standards; Attachment F - Site Management Plan; Attachment K - Conceptual O&M Plan.

The following are responses to ARCO's comments on EPA's Proposed Plan for the ARWW&S Operable Unit, January 30, 1998.

4.2 PART I. CONCEPTUAL REMEDIATION DESIGN WORK PLAN

4.2.1 GENERAL RESPONSES

Since the development of the Stucky Ridge Pilot Project, EPA and the State have worked with ARCO to refine the Land Reclamation Evaluation System (LRES) and apply it throughout the ARWW&S operable unit. Many of the ideas and concerns expressed by ARCO in their Conceptual Remedial Design Work Plan were incorporated into the LRES and used during the 1998 field work. The following sequence of events demonstrates EPA's willingness to incorporate ARCO's reclamation ideas, where they are anticipated to meet EPA's remedial goals, into reclamation planning.

February and March 1998 - EPA and the State reviewed the remedial actions presented by ARCO and developed a list of conditions at the site (e.g., steep slopes, low soil pH, etc.) that will require specific reclamation approaches. Based upon these conditions, EPA developed a list of applicable reclamation technologies, and then combined these into 11 reclamation alternatives.

During this process, EPA incorporated ARCO's SAM (surface broadcast seeding plus amendments) and PTSG (plant, tree, shrub, and grass) alternatives and many of ARCO's reclamation ideas into the set of reclamation alternatives.

March through June 1998 - EPA and the State developed and validated (in the field) the numeric portion of LRES and made the LRES Work Plan available for ARCO review.

July 1998 - EPA and the State met with ARCO and their subcontractors to address their comments and concerns. EPA and the State revised the numeric portion of the LRES based upon ARCO's comments and conducted additional validation.

July - September 1998 - Representatives of EPA and the State worked with ARCO and their subcontract personnel in the field refining and applying the LRES to specific areas throughout the operable unit.

EPA and the State anticipate continuing to work interactively with ARCO during the synthesis of the LRES data into the ARWW&S Conceptual Reclamation Design Report, which is scheduled for completion by December 1998.

4.2.2 SPECIFIC RESPONSES

Reclamation Work Plan

Responses to comments from Page 5.

ARCO's spacial delineation of land units and the selection of reclamation technologies for those units was accomplished using aerial photographs and without detailed knowledge of the physical and chemical site conditions. This resulted in a very optimistic estimation of the acres to which reclamation is needed and the level (intensity) of reclamation required. ARCO's reclamation plan was prepared with some first-hand knowledge of site conditions, but without the level of knowledge required to make design-level decisions. ARCO is now discussing with the agencies development of a Conceptual Remedial Design using the LRES, as discussed above.

The following table provides EPA comments on the reclamation treatments suggested by ARCO.

ARCO Reclamation Treatments and EPA Comments

Treatment	Components	EPA Comment
No Further Action Treatments		
WV	Well Vegetated lands have a minimum of 25% live plant cover.	ARCO's designation of areas that have >25% live plant cover estimate is very optimistic since these areas were delineated from aerial photographs and the recollection of personnel; and must therefore be field truthed. ARCO designated a high percentage of land in certain Areas of Concern, such as the Barren/Sparsely Vegetated areas as being well vegetated (WV). The use of a "25%" criteria does not address vegetation quality. EPA's field reconnaissance trips in 1995, 1996, and 1997 indicate that many of these areas are dominated by noxious weeds. The WV designation also includes areas that ARCO believes are "recovering" fast enough to preclude active reclamation. Based upon EPA's field work, the number of acres where range condition is improving (at a substantial rate) is much less than ARCO's optimistic estimation. Even in areas exhibiting improved vegetation cover, some intervention, such as weed spraying or interseeding, will be required to meet remedial goals in a reasonable amount of time. ARCO has also neglected monitoring of these lands, which is required. EPA also disputes the use of a 25% live plant cover criteria. These criteria have yet to be developed but will depend upon the composition of the plant community capable of developing on a site and the measurement technique used.
A	Agricultural lands will not be treated.	Some of these areas may require treatment.
RA	Existing or planned Remediation Areas.	Areas "planned" for reclamation are not precluded from EPA's remedial action, and all reclaimed areas will be monitored and repaired or reclaimed as necessary.
OT	Other features or structures not requiring remediation.	These must be assessed on a case-by-case basis.
Coversoiling and Capping Treatments		
CAP	6" veneer cap of coversoil, lime rock, industrial, and/or slag.	ARCO's treatment would be for the tailings ponds. Six inches of coversoil is too thin to meet the remedial action objectives/goals and slag would be inappropriate because of potential for fugitive dust.
CAP/ SEED	Smelter Hill caps.	Soil cover would be used in the Smelter Hill area and would be similar to the caps already in place.
Ecosystem Enhancement and Land Reclamation Treatments		
PTSG	Plant trees, shrubs, and/or grass plugs into sparse vegetation where access is too difficult or terrain too steep for equipment.	This approach to vegetation enhancement has merit; however, ARCO's assessment of where the use of equipment would not be possible is very conservative. Many areas designated by ARCO for PTSG have slopes that are shallow enough (i.e., slopes between 3.5 and 2:1) to till.
AGT	Using standard farming equipment to till to 6-8".	ARCO's assessment of where this treatment could be applied is very optimistic. For example, ARCO designated this treatment for large tracts of land in the eastern portion of Stucky Ridge. Based on data colleted by EPA during the 1997 field reconnaissance trips, metal and pH levels below 8" present risks to vegetation, which would make shallow plowing an ineffective treatment.

ARCO Reclamation Treatments and EPA Comments

Treatment	Components	EPA Comment
SAM	Surface broadcasting of seed and fertilizer, or fertilizer alone. Herbicide applications where necessary and surface scarification.	This is a minimal-type treatment that will have utility. Again, however, ARCO has overstated the acreage to which this treatment can be applied. A thorough testing of this treatment is warranted in several areas having a range of surface metal and pH levels.
DT	Deep tilling to incorporate amendments to 18".	Similar to EPA Level II; appropriate for many areas.
A-SM	ARTS technology applied to the Smelter Hill area.	This is applicable to Smelter Hill; however, ARCO's reclamation plan does not include the use of ARTS technology for the Anaconda or Opportunity Tailings Ponds.
OPP	Opportunity Tailings Pond mosaic.	Combinations of reclamation treatments will likely occur for the very large tailings ponds due to economic considerations. However, not all the treatments mentioned by ARCO will be appropriate (see above and responses to Attachment A).

ARCO plans on performing treatability tests to determine the efficacy of SAM, AGT, ARTS, and DT treatments. EPA will provide a detailed review of the sampling and analysis plans for these projects. The agencies will also participate actively in selecting the treatability test sites and in soil sampling.

Opportunity and Anaconda Tailings Pond Reclamation (beginning on page 7)

ARCO's Cap Reclamation (page 7)

Six inches of pit-run overlain by 6 inches of finer material will not meet the remedial action objectives/goals and is therefore an unacceptable remedial action. This treatment would not reduce the amount of water percolating to the ground water and may increase the amount of noxious weed cover on the ponds, which would necessitate additional maintenance.

Wetland Development (page 7)

Wetland development may be an acceptable outcome of remedial actions at the ARWW&S OU. It must be bourne in mind, however, that the creation of wetlands involves a high level of engineering design and sophisticated construction. The operational definition of jurisdictional wetlands in the Clark Fork Basin by the U.S. Army Corps of Engineers excludes open water areas deeper than 6.6 feet. This requirement may effectively limit the amount of borrow material removed if ARCO intended to create a jurisdictional wetland. A cost/benefit analysis should be performed to determine if creating wetlands will be desirable in relation to the amount of borrow material that would be obtained from the excavated area. Additionally, plant communities in areas where wetlands could be created (i.e., where ground water is near the soil surface) may possess certain attributes, such as high species diversity and cover, that the agencies may not want destroyed just to remove a relatively small amount of borrow material. The EPA requires that these and other issues surrounding borrow source areas and wetlands creation/enhancement be addressed during the remedial action phase of this project.

Page 7, Third Bullet

Creating unlined wetlands in the D cell for storm water control may be appropriate. The D1 cell has been historically used as a water clarification cell before discharging to the Warm Springs Ponds. However, EPA would require testing of the water to see if it is contaminated and whether it poses a risk to wildlife, and whether the impoundment of water in this area would increase the quantity of contaminated water percolating through tailings material and reaching ground water. These effects may be counter to EPA's remedial action objectives/goals for the tailings ponds.

Page 7, Fourth Bullet

Slag would be an inappropriate cover by itself since this material is also susceptible to being entrained by wind. Any material used to cover the tailings ponds that has fine particles will provide rooting media for invading plant species. The initial colonizing species will be noxious weeds which will require constant, active control. Therefore, the physical attributes of the borrow material used for capping should be carefully examined to help limit weed infestations.

Page 7, Demonstration Plots

Any experimentation with remedial techniques for the tailings ponds is welcomed, but will require the full scrutiny and participation of the agencies. The EPA may require ARCO to initiate reclamation of the Anaconda and Opportunity Tailings Ponds immediately following the ROD using known reclamation techniques (i.e., ARTS), which would be prior to having the results of the new experiments suggested by ARCO. If new reclamation techniques are discovered during these experiments, they can be incorporated into the on-going reclamation of the tailings ponds.

Page 9, First Paragraph

ARCO states that approximately 5,350 acres are adequately vegetated based on the 25% live plant cover criteria and that this is "considered adequate to meet the remedial action goals of minimizing wind and water erosion". First, a large portion of the area designated by ARCO as well vegetated actually has a significant component of noxious weeds. These areas are, therefore, good candidates for vegetation enhancement techniques such a herbicide application and broadcast seeding, as the remedial alternative. Field verification will be required of site-specific vegetation conditions that would allow the selection of the No Further Action alternative. Second, the use of a 25% live vegetation criteria for all range sites at the ARWW&S OU is erroneous simply because many environmental conditions affect a site's erosivity and ability to support vegetation. EPA's land reclamation evaluation system (LRES) provides a logical methodology to quantify an area's erosion potential and quality of vegetation, and to decide whether active remedial action is necessary. Once this is determined for a particular area (i.e., a Remedial Unit), an evaluation of the appropriate data types (from existing or newly collected data) will allow the decision makers to decide which remedial alternative best meets the remedial action objectives/goals. This LRES decision tool will be used by EPA at the ARWW&S OU during remedial action design.

Page 9, First Paragraph

EPA agrees that plant community condition is improving in some areas of the ARWW&S OU; however, ARCO's use of the term "natural recovery" implies that these communities are progressing toward pre-smelting conditions. This assumption is erroneous; no evidence has been presented demonstrating that environmentally sensitive, pre-smelting plant species are invading the site. Some areas may be experiencing an influx of hardy, metal-tolerant species such as redtop and Great Basin wildrye, species which may help stabilize areas against erosion. Furthermore, use of 1988 and 1997 aerial photographs to indicate that some areas are "recovering" is also erroneous because 1988 and 1997 were, respectively, very dry and wet years. Due to differing soil moisture regimes during these two growing seasons it is likely that plant canopy coverage was significantly less in 1988 than in 1997.

Using the LRES decision tool in the field during remedial design, EPA may require only monitoring of some of these "recovering" areas because vegetation and erosional parameters are being met or are likely to be met within a short time frame. Conversely, EPA may require the use of vegetation enhancement techniques, such as herbicide application, interseeding, or planting trees, shrubs, and/or grass plugs, where vegetation invasion will not likely meet the remedial action objectives/goals in a reasonable time frame.

Page 9, Second Paragraph

EPA disagrees that the remedial action objectives/goals would be met for all areas of the ARWW&S OU by applying ARCO's treatments. In general, ARCO's proposed land reclamation treatments are less intense than what is required to meet the remedial action goals. EPA agrees that the revegetation success criteria must be geared to site-specific micro-climatic conditions (see EPA response to Attachment B - Revegetation Success Criteria), and plans to develop a comprehensive set of criteria during remedial design.

Storm Water Control and Surface Water Plan

Page 10, Third Paragraph

EPA requires removal of the Toe Waste and their consolidation into the Opportunity Tailings Ponds because the location of these materials is outside this waste management area (WMA) and therefore represent a release of contaminants.

Page 10, Fourth Paragraph

ARCO suggests using constructed wetlands as a "hydrologic boundary to reduce the potential flow of impacted ground water from beneath the ponds to downgradient areas". This implies that these constructed wetlands would be used as mixing zones to dilute contaminated water. EPA may reject use of jurisdictional wetlands, as defined by the U.S. Army Corp of Engineers for the U.S. Fish and Wildlife Service, to purposely dilute contaminated water. Depending on the quantity of waters being mixed, water quality in these wetlands may not meet water quality criteria or wildlife drinking water standards. The EPA requires an evaluation of the resulting water quality expected in these areas.

Ground Water Management Plan

Page 11

Comments acknowledged.

Main Granulated Slag

Page 11, Last Paragraph

The selected remedy for the Main Granulated Slag pile is No Further Action, provided that it is used as a resource. If the mining of this material is abandoned, other alternatives for this waste will be evaluated by EPA.

Institutional Controls Work Plan

Page 12, Second Paragraph

ARCO indicates that they intend to have several entities manage the ICs for their property in perpetuity. The ROD allows for appropriate private and governmental ICs (including the county and state controls) to become part of an approved package of ICs.

Operations and Maintenance Plan

The O&M Plan presented in FS Deliverable No. 5 (FSD 5) was not intended solely for the purpose of estimating O&M costs. Rather, the FSD 5 O&M Plan provides a detailed plan for implementing O&M at the ARWW&S OU. For example, the FSD 5 O&M Plan provides a list of ground water wells and a schedule for their sampling. For the monitoring and maintenance of revegetated areas, the FSD 5 O&M Plan provides a schedule for the type and frequency of data to collect. On the other hand, ARCO's three page conceptual O&M plan (Attachment K) provides little information for developing a useful O&M plan. EPA intends to prepare a revised version of the FSD 5 O&M Plan for the ARWW&S OU during the remedial design phase.

Vegetation and Engineered Cover

Page 13, First Paragraph

Comments acknowledged. Also, vegetation performance criteria will be developed by EPA during the remedial design phase and will be based upon the work of reclamation scientists at Montana State University and in consideration of criteria used for other reclaimed sites in the Clark Fork River Basin (e.g., Butte Priority Soils Operable Unit).

Ground Water Monitoring

Based upon additional discussions between ARCO, the State, and Anaconda-Deer Lodge county, EPA will prepare and implement a revised version of the FSD 5 O&M Plan, which will include the identification of the ground water monitoring network.

Surface Water and Sediment Monitoring

Any media that transports contaminants is of concern to EPA, especially sediments that could move contaminants to a perennial stream. EPA agrees that the frequency of surface water monitoring should be adjusted based upon the on-going results. The surface water monitoring frequency will be established in the O&M Plan, which will be developed during remedial design.

Monitoring and Maintenance Drainage Ditches and Storm water Control Structures

Comment acknowledged.

Performance Standards

Surface water runoff performance standards will be established in the Remedial Design/Remedial Action Work Plan based upon EPA's determination of the pertinent ARARs for this operable unit.

Site Management Plan

The Site Management Plan for the ARWW&S OU will be developed during the beginning of the remedial design phase of site work. The plan will be developed jointly by EPA and the State, and will meet standards set by the agencies.

4.3 PART II. ARCO LEGAL AND TECHNICAL COMMENTS

4.3.1 SPECIFIC COMMENTS

1. *EPA's Proposed Plan relies on a fundamentally flawed and inadequate characterization of human health and ecological risk.*

Response: EPA generally disagrees with ARCO's comment. EPA may take a response action itself or allow another party by agreement to take response action "(w)henever (A) any hazardous substance is released or there is a substantial threat of such a release into the environment, or (B) there is a release or substantial threat of release into the environment of any pollutant or contaminant which may present an imminent and substantial danger to the public health or welfare... ." See CERCLA section 104(a)(1). EPA may order a party to take action whenever "there is an imminent and substantial endangerment to the public health or welfare because of an actual or threatened release of a hazardous substance... ." See CERCLA section 106(a).

2. *Remediation to address phytotoxicity cannot be justified by EPA's Final Baseline Ecological Risk Assessment ("BERA") for the site.*

Response: EPA disagrees. EPA stands by the Final Baseline Ecological Risk Assessment. EPA responds in detail to ARCO's assertions concerning ecological risk in its Responses to Attachments G and H to ARCO's letter of January 30, 1998 commenting on the proposed plan for the ARWW&S OU.

3. *EPA's analysis of risk to terrestrial and aquatic biota is likewise flawed.*

Response: EPA disagrees. See answer to A, above.

4. *Remediation of soils at the ARWW&S OU cannot be justified on the basis of risk to human health.*

Response: EPA disagrees. EPA stands by the Baseline Human Health Risk Assessment ("BHHRA"). EPA responds in detail to ARCO's assertions concerning human health risk in its Responses to Attachment I to ARCO's letter of January 30, 1998 and the RODs for OW/EADA (1994) and Community Soils (1996) and their Responsiveness Summaries.

5. *Reclamation of the Anaconda and Opportunity Ponds cannot be justified by human health or ecological risk.*

Response: EPA disagrees. EPA believes that remediation of the Anaconda and Opportunity Ponds is well justified, as explained fully in EPA's Responses to Attachments G, H, and I to ARCO's letter of January 30, 1998. ARCO implies in this section that EPA may take action only where there is "substantial danger" to public health from the possible migration of hazardous substances as provided in the definition of "remedial action" at CERCLA section 101(24). EPA disagrees. EPA's authority to take or require action to address threats to human health or the environment is governed under sections 104 and 106 of CERCLA, discussed above, not by the definition of "remedial action" at section 101(24) of CERCLA. As provided for at section 104(a)(1) of CERCLA, EPA may take "any response measure consistent with the [NCP] which [EPA] deems necessary to protect the public health or welfare or the environment... ."

6. *EPA's Preferred Alternative thus is not authorized by CERCLA and the NCP because it goes beyond measures required to address human health and ecological risk.*

Response: EPA disagrees. As supported in the references mentioned above, the action set forth in the ROD to address human health and environmental risk at the ARWW&S OU is well justified.

7. *The Proposed Plan relies on faulty analysis of the criteria for remedy selection under CERCLA and the NCP.*

Response: EPA responds to ARCO's letters of March 18, 1997 and May 12, 1997 in the Responses to Attachment L of ARCO's letter of January 30, 1998.

8. *In the Proposed Plan, EPA has improperly rejected any reclamation alternatives less extensive or intensive than EPA's alternative on grounds that they do not meet the threshold requirements for remedy selection.*

Response: EPA has not rejected reclamation alternatives less extensive or intensive as outlined in the final selected remedy (Section 9) and further explained in Appendix C, Land Reclamation Evaluation System. EPA has gone to great lengths to continue to refine the appropriate reclamation alternatives to be applied to a vast and varied topographical area. This effort was initiated in 1997 with the Stucky Ridge Pilot Project, part of the Feasibility Study Administrative Record. ARCO provides no mention or acknowledgment of this effort. EPA appropriately reject the "partial reclamation" scenario assessed in FS Deliverable No. 5 as not being protective of human health and the environment and not attaining ARARs. The partial reclamation scenario was included in the detailed analysis of alternatives to assess ARCO's 1996 proposal to EPA (and reiterated to the National Remedy Review Board) that only the visual corridors along local highways needed to be revegetated.

9. *A refined reclamation approach . . . meets and exceeds the balancing criteria and should have been selected as the Preferred Alternative.*

Response: EPA agrees that a refined reclamation approach should be used in addressing the risks at the ARWWS OU. That is why EPA conducted the pilot test on Stucky Ridge in 1997 as reported on page 10 of the Proposed Plan. That pilot test resulted in the Land Reclamation Evaluation System, which will be applied during the remedial design process to tailor remediation of the ARWW&S OU acre by acre. EPA therefore has adopted a "refined" approach. ARCO emphasizes the need to "control costs" in its comments and makes much of the plan it submitted to the National Remedy Review Board in 1997. However, although ARCO's "plan" was not expensive, it was not a legitimate remedy as it simply provided for cosmetic work to address unsightly areas of barren ground and mine waste where they could be seen from roadways and from the town of Anaconda.

10. *EPA's cost estimates are not accurate.*

Response: EPA has always provided the most accurate estimates of costs possible at any point in time. EPA has provided accurate costs in Appendix E.

11. *A POC downgradient of the Anaconda Ponds and the Red Sands mound is not required to comply with ground water ARARs.*

Response: EPA has dealt with this issue in its Responses to Attachment L to ARCO's letter of January 30, 1998 (response to letter of September 17, 1998 concerning ARWWS POC for ground water ARARs).

12. *Consolidation of Toe Wastes is not required for protection of human health and the environment nor compliance with ARARs.*

Response: EPA discusses the ditches that drain the Opportunity Ponds, including the D-2 drain, in the BERA, specifically as a drinking water source to wildlife. The D-2 Drain, which passes through the Toe Wastes and empties into the Warm Springs Ponds, exceeds water quality standards for arsenic. EPA believes that the high arsenic levels in the drain are partially due to the arsenic levels in the Toe Wastes. Remediation of these wastes would reduce arsenic levels in the ditch.

13. *Numeric effluent limits for monitoring storm water discharges are inappropriate.*

Response: EPA addresses this issue in its Responses to Attachment L to ARCO's letter of January 30, 1998 (response to letter of October 16, 1996 concerning storm water discharge ARARs).

14. *EPA's Proposed Plan fails to incorporate National Remedy Review Board recommendations.*

Response: ARCO's assertion that EPA has failed to incorporate the NRRB's findings in the Proposed Plan is wrong. As already mentioned, the LRES as described at page 10 of the Proposed Plan is EPA's response to the NRRB's recommendations to tailor remediation to ecological endpoints and to focus the intensity of remediation work. ARCO emphasizes the need to implement a remedy that is "cost effective." EPA agrees that a cost effective remedy is important. However, cost effectiveness continues to be only one of 9 criteria that EPA is required by law to consider. See 40 C.F.R. § 400.430(e)(9). Cost effectiveness is not even one of the 2 threshold criteria, protection of human health and the environment and compliance with ARARs, that every remedial alternative *must* meet. See 40 C.F.R. § 400.430(f)(1)(I).

15. *In accordance with NRRB's recommendation to "tailor remediation driven by ecological endpoints to those areas where the results are reasonably expected to be sustained," EPA must refine acreages to reflect current land use and land ownership which are inconsistent with those endpoints.*

Response: ARCO accuses EPA of choosing a remedy in the Proposed Plan which is inconsistent with the land uses at the ARWWS OU. Since most of the land is designated for use as WMAs and since it is privately owned, argues ARCO, it is improper to require "grasslands or otherwise to maintain land in a condition optimal for wildlife habitat ." See letter of January 30, 1998, at page 29.

EPA agrees that land use is an important component in determining risk to human health or the environment and in choosing a remedy to address that risk. However, the mere fact that much of the land at the ARWW&S OU has been designated for use as WMAs and is privately owned by ARCO does not mean that there is no risk to human health or the environment there, that no remedy should be implemented there, or that EPA has no authority to require remedial action there. See Response to Attachment L to ARCO's letter of January 30, 1998 (response to letter of May 27, 1997 concerning wildlife habitat as a remedial objective). EPA's BERA and BHHRA demonstrate that there is both human health and environmental risk at the WMAs in spite of the fact they are WMAs and are privately owned by ARCO. Remedial action there is therefore entirely proper.

16. *As the NRRB stated, to "take advantage of existing soil or hydrogeologic characteristics to refine and focus the extent or intensity of remediation work," requires that EPA (I) rely on "monitored natural attenuation" for acreages which will recover naturally within a reasonable amount of time; (ii) rely on field-truthed "recipes" (or "recipes" proposed for future pilot testing) for reclamation and vegetation success criteria.*

Response: Both of these recommendations by the NRRB were addressed in the Stucky Ridge Pilot Project and the LRES. The LRES will allow for monitoring of areas deemed to be improving with the goal toward eventual delisting. Reclamation specialists working in the Clark Fork Basin have had 10+ years of experience implementing certain levels of land reclamation and this body of knowledge will be used for development of reclamation and vegetation success criteria. Other types of land reclamation posed by ARCO and included in this final remedy (e.g., modified Seeding and Amendments or SAM) have been approved by EPA for field demonstration beginning fall 1998. The final remedy calls for an O&M Plan which will continually incorporate information into future land reclamation decisions.

17. *EPA cannot require natural resources restoration at the ARWW&S OU in the guise of remediation.*

Response: EPA has addressed this issue in its Responses to Attachment L to ARCO's letter of January 30, 1998 (response to letter of March 18, 1997 concerning the authority to restore natural resources).

18. *EPA's initial identification of ARARs for the ARWW&S OU is flawed and is not authorized under CERCLA.*

Response: EPA disagrees. EPA has provided detailed response to all letters from ARCO raising issues concerning ARARs. The letters listed by ARCO are all addressed in EPA's Response to Attachment L to ARCO's letter of January 30, 1998.

Response to ARCO Comments in Attachment A

In Attachment A, ARCO presents a conceptual reclamation plan for the ARWW&S OU. Included are definitions for each of ARCO's proposed reclamation technologies and maps on which ARCO has identified where their technologies should be applied. It is very difficult to provide a definitive statement with respect to the adequacy of ARCO's reclamation plan. The spatial application of any given remedial technology to a specific ground location is a function of the physical and chemical conditions of the current condition and the degree to which these conditions require alteration during reclamation. Furthermore, the remediated condition must be in alignment with EPA's long term objectives for revegetation success, and not merely an improvement in the existing condition. Incremental improvement in ecological condition will occur without remedial intervention; however, EPA's mandate is to apply remedial technologies of sufficient intensity to reduce risk and improve the ecological condition of the site, thereby reducing the release of metals and arsenic to the environment, rather than relying on stabilization of the site through natural successional processes occurring over decades to centuries of time. While the exact approaches suggested for remediation remain suspect, ARCO is to be credited with moving ahead in considering how and where remediation is to occur at the site. And even though ARCO has presented sweeping plans for remediation, the selected ARCO remedial technologies are generally within the realm of plausible alternatives. Meetings between ARCO and the Agencies during 1998 have resulted in a refinement of the reclamation technologies that are applicable to the range of environmental conditions at the site. These ideas will be integrated with the results of the LRES 1998 field work and presented in the Conceptual Land Reclamation Plan in December, 1998.

With the disclaimer stated that remedial design can only be performed with data, and the data is absent at the present time to initiate remedial design, some professional judgement can be applied to the reclamation intensity postulated by ARCO. Using sites where some specific investigation has been performed and the reclamation intensity generally known, a rough validation of ARCO's approach was performed. The result of this validation is that ARCO's reclamation intensity is toward the low end of the spectrum for what would be reasonably expected to yield good reclamation success. While ARCO's technology classes may not result in automatic failure of remediation, they should be considered higher risk. An example would be the eastern end of Stucky Ridge.

The soils of eastern Stucky Ridge are highly erosive, barren or sparsely vegetated across an area of approximately 1,000 acres. ARCO has recommended agricultural tillage, presumably with lime amendments. Based upon Agency field work, low pH conditions persist deeper than the 6-8 inch tillage depth achieved by agricultural tillage. Deep tillage with lime, therefore, is probably required. Deep tillage would allow for dilution of surface metal and arsenic levels, removal of active erosion channels and establishment of vegetation cover that would reduce erosion and likely meet remedial objectives. While agricultural tillage would improve the site condition, it is likely that the level of improvement would not be of sufficient magnitude to warrant the cost. The results of deep plowing would be far superior to agricultural tillage at only a slightly higher cost. In short, many other examples across the site serve to validate the opinion that the techniques suggested by ARCO are a technology or two less intense than the approach that would be expected to yield an acceptable result.

In providing a conceptual reclamation plan ARCO has been careful not to suggest any action outside areas previously defined by EPA. During the course of the 1998 LRES field work EPA has identified areas that will likely be removed from remedial consideration. Conversely, some areas need to be added that have not here-to-for been considered for remediation. It must be bourne in mind that EPA's current remedial boundaries, as presented in the Proposed Plan, are not rigid; some adjustment will be required during remedial design. Furthermore, EPA's Proposed Plan should be considered as a preliminary concept that was useful for general planning.

ARCO's reclamation plan is a good first step toward a conceptual remedial design for the ARWW&S OU. Much additional soils and vegetation data have been obtained in 1998 and the discussions between EPA, the State and ARCO have helped solidify the thinking about what reclamation technologies have efficacy and where additional data need to be collected in order to complete more detailed designs. Currently, ARCO and the Agencies have fundamental agreements about reclamation technologies and intensities appropriate for the site.

Response to ARCO Comments in Attachments G and H

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I. REBUTTAL TO ARCO'S CLAIM THAT EPA DID NOT FOLLOW ITS OWN GUIDANCE

Several ARCO comments suggest that the EPA did not follow their own guidance in the preparation of the risk assessments for the Anaconda Smelter Site. These comments relate to general, nonspecific comments that EPA did not follow guidance, and specific comments that the use of phytotoxicity data fails to establish that an actual risk exists, and that the use of screening level tools to draw final conclusions is not in accordance with guidance. In doing so, the commenters make selective use of statements within guidance material and use them in generic conclusive statements. For example, ARCO reviewers suggest that EPA guidance mandates that in the absence of clear stressor-response relationships, there is **no** demonstrable ecological risk by which the agency may take remedial action. Clearly, in its entirety, EPA guidance warrants a weight-of-evidence approach describing potential uncertainties. EPA Region 8 feels that this has been done in the risk assessment work completed to date at the Anaconda Site. ARCO reviewers are apparently unaware of the most recent ecological risk assessment guidance for Superfund (EPA 1997), since they cite older versions of guidance and guideline documents in their comments (EPA 1995, 1996). ARCO reviewers should be cognizant of the distinction the Agency draws between "Guidelines" and "Guidance". EPA offers "guidelines" which are not program specific, but are generic enough to be used for several different programs and applications. "Guidance" is program specific, and supersedes the more generic "guidelines". ARCO reviewers have focused their critiques on this subject-matter toward "guidelines", rather than on the "guidance" under which the Final BERA was drafted (Ecological Risk Assessment for Superfund, EPA 1997). It should also be noted that the risk assessment guidance documents do not preclude the use of professional judgement in applying these practices to specific sites.

EPA strongly disagrees with ARCO's assertions that EPA did not follow its own guidance in preparing the various risk assessment documents for the Anaconda Smelter Site. On the contrary, EPA has followed appropriate and current risk assessment guidance at every step of the risk assessment process, for every iteration of the report, from the screening level document to the final BERA, as shown in the following table:

Anaconda Risk Assessment Document	EPA Guidance in Effect at the Time of Document Preparation
Phase 1 Screening Level Document, CDM Federal 1994	EPA 1992, 1994
Preliminary Baseline Ecological Risk Assessment (PBERA), CDM Federal 1995a	EPA 1994, 1995
PBERA Supplement, CDM Federal 1995b	EPA 1994, 1995
Draft Final Baseline Ecological Risk Assessment (BERA), CDM Federal 1996	EPA 1995
Final BERA, CDM Federal 1997	EPA 1997

ARCO should note that the information presented in the Draft Final BERA was reorganized in the final BERA to demonstrate that the approaches used followed the eight-step process, as outlined in the most current guidance (EPA 1997). A thorough review of the various ecological risk assessment documents prepared for the Anaconda Site since 1994 demonstrates to the reader that EPA did follow guidance in the assessment of potential ecological risks for this site. Also, ARCO reviewers seem to have lost sight of the fact that the assessments of risk were done in an iterative process, incorporating site-specific data (much of it from ARCO), to continue refining areas of greatest concern while systematically eliminating areas that do not have elevated contaminant levels, have mitigating factors to counteract contaminant of concern (COC) concentrations, or that appear to be naturally recovering.

The steps to be included in an ecological risk assessment, per EPA guidance (EPA 1997), include the following:

1. Screening level problem formulation and ecological effects evaluation
2. Screening level exposure estimate and risk calculation
3. Baseline risk assessment problem formulation
4. Study design and data quality objectives process
5. Field verification of sampling design
6. Site investigation
7. Risk characterization
8. Risk management

Each of these components was addressed in the assessment of risks for the Anaconda Smelter Site. This process included the development of the Phase I Screening Level Ecological Risk Assessment, the Preliminary Baseline Ecological Risk Assessment (PBERA) and Supplement, the Draft Final Baseline Ecological Risk Assessment (BERA), and the final BERA, and is briefly summarized below.

Phase I Screening Level Ecological Risk Assessment

This document was prepared prior to the publication of EPA's current eight-step guidelines for conducting ecological risk assessments, but included pertinent components of the first two steps as recommended in the current guidance. This document used data that were readily available at the time, and included documentation of problem formulation to identify:

- environmental setting and contaminants known or suspected to exist at the site;
- contaminant fate and transport mechanisms;
- mechanisms of ecotoxicity, and likely categories of receptors;
- complete exposure pathways that may exist at the site; and
- selection of endpoints to screen for ecological risk.

The screening level document also presented a preliminary ecological effects evaluation by presenting conservative thresholds for adverse ecological effects. The site data were then evaluated to calculate exposure levels for use in the risk calculations. The risk characterization was conducted by comparing arsenic and metal exposure levels in soil, sediment, and surface water to the conservative threshold values.

The outcome of the screening level risk characterization was the identification of broad habitat areas of the site that may require further study, and to eliminate areas unlikely to be at ecological risk. This analysis did not indicate that all areas selected as habitats of concern represented areas of risk to ecological receptors; rather, that these were areas to be evaluated in greater detail in the next phase of the project to determine the likelihood for potential ecological risks.

Preliminary Baseline Ecological Risk Assessment, and Supplement to the Preliminary Baseline Ecological Risk Assessment

These documents expanded upon the problem formulation phase in the screening level analysis by more specifically identifying potential receptors, identifying complete exposure pathways, specifying assessment and measurement endpoints, incorporating site-specific data into the effects evaluation and risk characterization, developing a site conceptual exposure model, and identifying data gaps requiring further study to reduce uncertainties. A deliberate effort was made to incorporate site-specific data from several lines of evidence to help ascertain whether there is a causal relationship between metals contamination and ecological effects, and to identify further studies where these data could be acquired. Nearly 60 site-specific documents were reviewed to obtain media data, ecological survey results, and toxicity testing results in this effort. Following the completion of these documents, and identification of known data gaps, a field sampling program was planned and initiated, with design input and sampling participation from ARCO and its contractors. The additional field sampling was conducted in late summer 1995.

Draft Final and Final Baseline Ecological Risk Assessment

The results of the 1995 sampling effort were integrated with the information presented in the PBERA, to develop the Draft Final BERA, and a range of No Observable Adverse Effect Level (NOAEL) and Lowest Observable Adverse Effect Level (LOAEL)-based toxicity reference values (TRVs) were used to provide the risk manager with more information regarding the range of potential risks. Further modifications are provided with this responsiveness summary to incorporate modified bioaccumulation factors into the wildlife food chain model, per ARCO's suggestions. In addition, a comprehensive plant stress analysis (CPSA) method was introduced, to qualitatively consider non-chemical stressors that may be cofactors influencing phytotoxicity. ARCO reviewers fail to recognize the significance of this approach in the identification of areas of potential concern, compared to the identification of areas not considered to be of concern, due to other factors that may mitigate the effects of high soil metals concentrations. In addition, EPA guidance (EPA 1997) lists four lines of evidence that can be used to demonstrate whether site contaminants have the potential to cause adverse effects on the assessment endpoints:

1. Comparing estimated or measured exposure levels to chemical X with levels that are known from the literature to be toxic to receptors associated with the assessment endpoints;

2. Comparing laboratory bioassays with media from the site and bioassays with media from a reference site:

3. Comparing *in situ* toxicity tests at the site with *in situ* toxicity tests in a reference body of water; and

4. Comparing observed effects in the receptors associated with the site with similar receptors at a reference site.

A thorough review of the Anaconda ecological risk documents will demonstrate that several lines of evidence have been reviewed and used to show that virtually the same portions of the site have the potential for ecological risks, regardless of the source of data reviewed, and regardless of the year of publication.

In response to new EPA guidance issued in 1997, the information presented in the Draft Final BERA was reorganized to demonstrate that all eight steps recommended in the guidance had been addressed. This document includes maps that spatially demonstrate portions of the site where potential risks occur to vegetation, maps that indicate the relative contribution of each COC to the predicted risks to vegetation, maps showing the portions of aquatic habitat that are potentially at risk, and recommendations for a biomonitoring program to gather additional information regarding potential risks to wildlife. This information will be used by the decision makers to make informed decisions regarding remediation at the site.

II. RESPONSE TO ARCO'S CRITICISM THAT EPA HAS NOT ESTABLISHED CAUSE AND EFFECT RELATIONSHIPS BETWEEN ARSENIC AND METALS CONTAMINATED SOILS AND STRESSED VEGETATION

A. INTRODUCTION

Another of ARCO's comments claimed that the use of phytotoxicity data by EPA failed to establish that an actual or potential threat exists at the site, per EPA guidance. EPA strongly disagrees with this statement, and ARCO has misinterpreted the guidance on this issue. Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), EPA has a mandate to protect human health and the environment, and to demonstrate the potential for risks. EPA risk assessment guidance was never intended to require years of study to show precisely-correlated risks. There should be an attempt to show a stressor response, but if this is not possible, the data will either lead to the conclusion that there are no risks, or if there is not enough statistical power to show a correlation, the Agency allows qualitative and semiquantitative analysis to demonstrate whether there are potential risks at the site. In accordance with EPA guidance, EPA took the risk analysis to the appropriate level needed to make decisions about the site. If the screening level analysis had indicated no potential for ecological risks, the assessment would have stopped at that point. On the contrary, the potential for ecological risks was shown, through various lines of evidence, and therefore, the analysis was taken to a BERA. In the baseline assessment, EPA incorporated site-specific data, including data provided by ARCO, to reduce uncertainties associated with the screening level assessment. EPA is not required to confirm that risks exist, only that the potential for risk is present. The weight of evidence is overwhelming in support of our conclusions that the potential exists for risks to ecological receptors in some portions of the site. ARCO fails to acknowledge that EPA has not indicated that all portions of the site having the potential for risk represent areas that must be remediated, or that EPA supports the evaluation of potential risks to wildlife receptors through additional biomonitoring beyond the BERA. Further, EPA guidance (EPA 1997) states that a risk can be demonstrated to exist if 1) the stressor has the ability to cause one or more adverse effects, and 2) it co-occurs with or contacts an ecological component long enough and at a sufficient intensity to elicit the identified effect. The numerous studies used in the assessment of potential risks add strength-of-evidence in support of potential risk to ecological receptors in certain portions of the site.

A synopsis of studies that document the historic and current environmental conditions at the site is provided below.

Vegetation Conditions in the Anaconda Area: Pre-Smelting and Current

The climax vegetation in and around Anaconda is represented by three range/forest sites, each dominated by native, perennial plant species (Ross and Hunter 1976).

1) Silty range sites are dominated by perennial grasses (bluebunch wheatgrass, rough and Idaho fescue, needle-and-thread, prairie junegrass, western and thickspike wheatgrass, green needlegrass, and basin wildrye), forbs (danthonia, sticky geranium, arrowleaf balsamroot, larkspur and prairie smoke), legumes, and shrubs (winterfat and big sagebrush).

2) Saline lowland range sites are dominated by perennial grasses (basin wildrye, alkali sacaton, alkaligrass, cordgrass, slender and western wheatgrass, and inland saltgrass), and shrubs (greasewood and buffaloberry).

3) Subalpine fir, Douglas fir, and Engelmann spruce forests with an understory composed of grasses, forbs and shrubs such as pinegrass, basin wildrye, Idaho fescue, grouse whortleberry, arnica, huckleberry, beargrass, and serviceberry.

The primary rangeland habitat types (h.t.) found in the vicinity of the Anaconda Smelter Site classify into either the rough fescue or Idaho fescue climax series (Mueggler and Stewart 1980).

1) Rough fescue series consists of either the rough fescue/bluebunch wheatgrass h.t. (needle-and-thread phase) or the rough fescue/Idaho fescue h.t. (Richardson's needlegrass phase).

2) Idaho fescue series consists of the Idaho fescue/bluebunch wheatgrass h.t. (western needlegrass phase).

In addition to these plant communities being dominated by native perennial plant species under climax or near climax conditions, each would be very diverse and productive, and provide excellent wildlife habitat. This is in sharp contrast to the current plant communities in many areas of the Anaconda Smelter Site that are dominated (or co-dominated) by weedy, introduced plant species, and exhibit low density, canopy coverage, and above-ground production.

In general, plant canopy coverage and plant community diversity within the Anaconda Smelter Site increases with distance from the smelter complex. In areas not contaminated from smelting activities, upland forests are generally dominated by Douglas fir, lodgepole pine, and juniper, while upland shrublands are composed of willows, alders, red osier dogwood, chokecherry, buffalo berry, low bush cranberry, and silver berry (RCG/Hagler, Bailly 1995; MNRDP 1994; Taskey 1972). Grassland/native range in uncontaminated areas is composed of native species of wheatgrasses, fescues, and bluegrasses. In contrast, grasslands in contaminated and disturbed areas are dominated by weedy species such as spotted knapweed and Canada thistle, metal-tolerant grass such as basin wildrye, and the non-native redtop (RCG/Hagler, Bailly 1995; MNRDP 1994).

Environmental Contaminants

The Anaconda Smelter Site contains large volumes of wastes, debris, and contaminated soil from copper ore milling, smelting, and refining operations that took place from 1884 to 1980. Various smelter operations occurred in and around the town of Anaconda, along Warm Springs Creek, and on Smelter Hill. These operations produced an average of from 180 to 500 tons of copper per day.

Byproducts of smelter operations included slag, slime wastes, and tailings that were generated during the copper concentrations process, and aerial emissions of arsenic, metals, and sulfur compounds during smelting. A study conducted in 1907 found that the average *daily* release from the main chimney in Anaconda was more than 37 tons of arsenic, copper, lead, and zinc (RCG/Hagler, Bailly 1995). Between 1911 and 1916 the average arsenic concentration in smoke ranged from 40 to 62 tons *per day*, and between 1914 and 1918 arsenic emissions were about 75 tons *per day*. Emission controls began in the 1920s; the total emission of arsenic, copper, lead, zinc, and sulfur in October 1976 was 578 tons. Slag and tailings production averaged 4,500 and 8,000 tons per day, respectively, during the life of ore-processing in Anaconda.

Dustfall has been and continues to be a potential problem at the site. From July 1989 to March 1991 the maximum monthly concentrations of arsenic and metals in dustfall from the re-entrainment of wastes on Smelter Hill was 115,333 milligrams per kilogram (mg/kg) arsenic, 10,800 mg/kg cadmium, 390,000 mg/kg copper, 51,333 mg/kg lead, and 199,677 mg/kg zinc (RCG/Hagler, Bailly 1995).

In 1995, ARCO conducted a geostatistical modeling of the Anaconda Smelter Site using kriging analysis as part of the Smelter Hill remedial investigation. This analysis indicated that arsenic and metal concentrations in the soil surface are elevated in an area surrounding the smelter complex greater than 200 square miles. Today, the area and volume of tailings and other waste material at the site are approximately 6,159 acres and 258,245,116 cubic yards. Soils and ground water having elevated levels of the COCs cover more than 13,000 acres.

Environmental Impact Investigations

Early Beliefs and Studies

Taskey (1972) provides a detailed history of Anaconda smelter operations and the impacts that stack emissions and the release of ore-processing wastes had on the environment. In the early years of smelting, it was recognized by the public and the Anaconda Copper Company that the release of smelting and ore-processing wastes was having a deleterious effect on plant and animal life throughout a large portion of the Deer Lodge Valley, especially in the vicinity of Stucky Ridge, Smelter Hill, Mount Haggin, and the Anaconda and Opportunity Ponds. Most of the effects were believed to be due to the large amounts of sulfur dioxide being released; however, early in the 1900s researchers began to realize that other pollutants in "flue dust", especially arsenic but also copper and lead, were contributing to the observable harmful effects on vegetation and livestock. Surface soil samples collected by Haywood in 1906 and 1907, who was working for the Anaconda Copper company, showed levels of copper sulfate recognized as being detrimental to plant growth (Taskey 1972). Formally acknowledging the dangers of releasing large amounts of pollutants from the Anaconda smelter, U. S. Attorney General George W. Wikersham formed the Anaconda Smelter Smoke Commission in 1911 to monitor the discharges of arsenic into the atmosphere (see previous section on stack discharges).

Taskey (1972) reported an inverse relationship between metal concentrations in the soil and plant coverage and diversity. Douglas fir and lodgepole pine seedling growth was greatly reduced when grown in soil with greater than 1,000 mg/kg of metal. This corresponds to an area approximately five miles in radius from the smelter complex. Poor growth may have been due to the abnormal growth of plant roots in the contaminated soil. Taskey (1972) recommended prioritizing active reclamation in the Anaconda area. First priority areas include Smelter Hill and Weather Hill, Stucky Ridge, and hills north of Lost Creek, while second priority areas are the hills in the Mill Creek and Warm Springs Creek drainages.

Olsen-Elliott (1975) used infrared aerial photographs coordinated with on-the-ground reconnaissance to detect unusual patterns of plant community distribution, unusual infrared reflectance characteristics, and areas with low vegetation coverage. The most striking feature was the zonation effect of increased bare ground, reduced vegetation coverage, reduced species diversity, and stressed vegetation within approximately three miles northeast, east, and southeast of the smelter complex. Also observed was the very slow reestablishment of trees on north and north-western slopes. Olson and Elliot (1975) concluded that the observed vegetation effects were generally due to chronic, abiotic stress caused by sulfur dioxide fumigation, low levels of soil moisture due to the lack of topsoil, on-going wind erosion, and chemical components of the soil.

Recent Environmental Impact Investigations

According to the State of Montana Natural Resource Damage Program (MNRDP), approximately 18 square miles (11,400 acres) of upland areas have been visibly altered by smelting activities (MNRDP 1994). These alterations include near total elimination of native plant communities and extensive topsoil loss from lack of vegetation, and shifts in plant community structure.

Specifically, areas that were forests with open grasslands are now predominantly bare ground or sparse grassland, composed primarily of weedy metals-tolerant species (RCG/Hagler, Bailly 1995). Historical photographs of the Old Works (circa 1886) indicate that Stucky Ridge was formerly vegetated by arid grassland and open steppe communities on exposed slopes and forest communities in the moist drainages (RCG/Hagler, Bailly 1995). Today, Stucky Ridge is barren of vegetation or sparsely vegetated with predominantly metals-tolerant species. The surface of Smelter Hill presently consists of large areas of bare ground and evidence of stressed vegetation, and is also composed primarily of metals-tolerant species (RCG/Hagler, Bailly 1995).

Additional information can be found in Olsen-Elliot (1975) and Taskey (1972)

Recognition of Plant Stressors and Revegetation Efforts

Substantial portions of this summary of reclamation and revegetation efforts within the Clark Fork River Basin, and specifically at the Anaconda Smelter Site, has been excerpted from a literature review prepared by the Reclamation Research Unit (RRU) of Montana State University and published in the *Anaconda Revegetation Treatability Studies Phase I Final Report* (RRU 1993).

Reclamation and revegetation activities in the Upper Clark Fork River Basin and Anaconda area over the past 55 years have been performed by diverse parties working on behalf of the Anaconda Minerals Company (AMC), ARCO, the State of Montana, and local citizens groups. Although the exact purpose, timing, and technical approach to reclamation has varied, all parties shared the common interest of mitigating environmental impacts caused by historic ore extraction and processing activities.

As early as the 1920s, fugitive dust emanating from the dried and unvegetated surfaces of the Anaconda tailing impoundments was recognized as a serious problem that required active intervention. In the 1937 AMC report on tailings disposal, W.F. Flynn considered fugitive dust the "... most serious problem ..." associated with operating the Anaconda tailing pond system. Although many dust suppression techniques were tried, revegetation was recognized early on as the best long-term solution to preventing wind dispersal of tailings material. According to Richmond and Sjogren (1972), "The Anaconda Company recognized that revegetation is the ultimate answer for permanent stabilization of concentrator wastes." The search for a solution to the dusting problem was the initial impetus for reclamation/revegetation research in the Anaconda area. During the early stages of this research, the phytotoxic nature of tailings material and contaminated soils was acknowledged and ways to ameliorate those toxic properties were sought through site-specific greenhouse and field demonstration projects.

Attempts at dust suppression during the 1920s and 1930s included the use of snow fences, maintaining water on tailing surfaces, or covering tailings with a slime product, oil, slag, or earth (Flynn 1937). These approaches quickly proved unsuccessful. During the 1940s, the addition of wood chips, gypsum (phosphate plant filter cake), and chemical treatment to tailings material was attempted. It was believed that soil covering was the best solution, though wood chips had appeal as E.P. Dimock (1944) stated "... when the wood rots, a soil capable of supporting plant growth might result."

An interesting reclamation discovery was inadvertently made during chemical analysis of the tailings that were reprocessed between 1941 and 1946. During this period the ponds that received lime materials mixed with tailings (B1) had a pH of 7.2-7.8, while wastes found in other ponds had much lower measured levels of pH (3-4). By this time (mid-1940s) it was clear to the vegetation researchers working in Anaconda that the success of revegetation efforts was dependent upon ameliorating the toxic properties of the tailings and selecting plant species that were resilient to the harsh growing conditions.

In June 1957, a program was initiated to study the tailings areas and to assemble information that would lead to successful revegetation. A vegetation survey identified 30 species of plants growing in the Anaconda area including grasses, legumes, weeds, shrubs, and trees. It was believed that vegetation was on the increase in certain areas where the pH was in the range of 6-8. Eliason (1958) stated that "it will be necessary to carry on considerable experimental work with plant life and soil treatments to arrive at practical solutions." Under the direction of AMC, greenhouse experiments made during 1958 and 1959 indicated that soil condition and location had a greater influence on survival than did other factors. Lime was applied, as burnt lime (calcium hydroxide), to toxic soils immediately prior to tree planting, though it was believed that liming should be performed a year prior to tree planting "... to give plenty of time for the reaction process ahead of planting." (Eliason 1959a). Greenhouse testing of grasses planted in tailing soils amended with a variety of chemical and organic amendments demonstrated "...outstanding..." (Eliason 1959b) results. Though good one year plant response may have been attained in the greenhouse, the lack of understanding of pyrite oxidation, acid generation, and acid neutralization processes may have been a significant technological limitation of this early tailing revegetation (stabilization) research, resulting in insufficient quantities of lime addition and poor long-term vegetation success.

By 1960, real progress had been made in understanding what it took to establish vegetation on disturbed lands in the Anaconda area (Eliason 1959c, Holderreed 1959). In addition to the use of vegetation to stabilize toxic salts and tailings, greenhouse and field plant response trials were conducted using manure, fine burnt lime, straw, clay, gravel, irrigation (sprinklers and flooding to leach salts), oil, emulsified asphalt, slag, a mixture of calcium chloride and acid plant precipitator effluent, bentonite, chemical binders, phosphate plant waste, lumber mill wastes, limestone, and lime kiln wastes (Eliason 1959c, Richmond and Sjogren 1972). Besides revegetation, all other approaches to tailings stabilization were considered short term solutions. Stabilization with vegetation was regarded as the most promising long-term solution.

The tree planting activity of 1958, 1959 and 1960 was monitored, and in 1961, 16,921 live trees were growing of the original 32,014 trees planted, representing a 53% survival rate (Eliason 1961a). These results and others were presented by Leonard Eliason in December of 1961 (Eliason 1961b) to the Northwest Mining Association Meeting in Spokane, Washington. The text of his presentation reflected an advanced level of understanding of the revegetation problems present in the Anaconda area. He stated: " The common toxic inorganic salts are iron, copper, zinc and aluminum which are soluble under acid conditions..." and "The toxic salts were rendered insoluble by changing the pH with a treatment of lime, and by introducing fertility and microorganisms with barnyard manure." Further the generation of acid from tailing material was recognized as Eliason remarked: "... concentrator wastes in two years time through weathering and oxidation changed from 7.7 pH and 0.22% soluble salts to a 2.55 pH and 1.18% water soluble salts..." The general text of the paper suggests optimism that revegetation will become a major part of the tailing stabilization program in Anaconda, yet the revegetation efforts were not wholly successful.

Subsequent revegetation efforts by AMC were performed by different individuals that departed from the *in situ* revegetation of waste materials performed by Eliason and the Extractive Metallurgical Research Division. The ensuing reclamation efforts focused primarily upon capping toxic materials with coversoil, followed by revegetation. This preference for using coversoil caps was due to the researchers being unaware of the *in situ* revegetation efforts or because of the variable results obtained with the *in situ* approach. As mentioned, poor plant growth results on amended tailings was probably due to an incomplete understanding of the chemical nature of the tailings material, which resulted in the application of too little lime, the wrong type of lime, or the wrong grain size for complete acid neutralization.

Other approaches to stabilizing the tailings ponds (and encouraging the establishment of vegetation) were the addition of water and sewage. Sewage effluent was added to the entire Opportunity Pond system beginning in the late 1950s. Vegetation was well established in this area as a consequence of water and nutrients from the sewage effluent, resulting in enough grass that hay was harvested from the Opportunity B and C Ponds in the 1960s (Schafer 1986). The Opportunity Ponds were described by Richmond and Sjogren (1972) as a "...lush, semi-aquatic environment..." used by migratory waterfowl. Vegetation established quickly following the dewatering of areas treated with sewage sludge by grass seed carried to the pond by wind and water (Richards 1984). The dominant plant species in this area were metal tolerant grasses (redtop and tufted hairgrass) requiring relatively wet soil conditions. Beginning in 1980 and proceeding slowly through the mid 1980s, the tailing ponds were allowed to dry, resulting in acidic metalliferous soil and very sparse vegetation cover (RRU 1993).

During the 1980s, reclamation and revegetation demonstration plots, known as the Texas Avenue Study plots, were established by Roger Gordon in Butte, Montana using two to six inches of lime reject material (<¼ inch) placed over regraded mine waste and covered with 20 inches of alluvial coversoil, and then seeded. The major revegetation efforts successfully initiated in Anaconda in the mid-1980s utilized this approach, which was specifically used to revegetate large areas around Smelter Hill, on the Anaconda and Opportunity Pond dike faces, and along the greenbelts which parallel Highway 1 (MSE 1991). Though this reclamation approach was effective, the high cost of implementation and the apparent lack of suitable coversoil was regarded by EPA and the State as restricting the capping approach to small, highly contaminated areas of the site and not using it to reclaim large areas such as the tailings ponds.

The next attempt at establishment of vegetation without the use of capping materials was the Streambank Tailing and Revegetation Study (STARS), which was preceded by the Leachate Reduction Pilot Study (CH2M Hill 1987a and b). The STARS study, directed by the State, was implemented at five locations between Butte and Opportunity adjacent to Silver Bow Creek in materials similar to the tailings and contaminated soils at Anaconda. Liming agents were incorporated directly into tailing material using various incorporation methods. These areas were then seeded and monitored for plant growth response and soil chemistry. By the fourth growing season (1992) the vegetation was thriving in the amended tailing material (RRU 1993). Findings from the STARS experimental plots were applied to the reclamation of one-half mile of tailing contaminated land adjacent to the Clark Fork River below the Warm Springs Ponds (The Governor's Demonstration). Successful stabilization of the stream channel and revegetation of the adjacent land was accomplished without the use of capping material (Schafer and Associates 1991). Other reclamation related work was performed in the Anaconda area early in the 1990s using soil amendments to moderate the phytotoxic effects of tailings material and contaminated soils (Dutton 1992, Jensen 1992, Holzworth et al. 1993).

Additional *in situ* stabilization/revegetation test plots were implemented to address tailings and contaminated soils at the Anaconda Smelter site; these are referred to as the Anaconda Revegetation Treatability Studies (ARTS). Plant growth on these plots in 1995 (after two growing seasons) was remarkable: with the right combination of amendments and the use of thorough incorporation techniques even pure tailings could be revegetated. Furthermore, through a combination of high plant density and proper surface manipulation, erosion was reduced by more than 90 percent. These plots continue to support very good plant growth. In the mid-1990s ARCO began reclaiming portions of Smelter Hill, Stucky Ridge, and the Old Works area using the knowledge gained from the ARTS investigation.

ARCO's Risk Assessment for the Upper Clark Fork River

In 1994, ARCO completed an ecological risk assessment for riparian areas in the Upper Clark Fork River Basin, which included sampling stations located adjacent to Warm Springs Creek approximately three miles east of Anaconda (ARCO 1994). The general objectives were to evaluate the relationships between plant communities and tailings deposits in riparian habitats and to evaluate food-chain transfers of metals to selected wildlife species. The bioaccumulation of metals was evaluated in vegetation, terrestrial invertebrates, and deer mice. Potential reproductive effects in deer mice were evaluated by direct measurements. For other wildlife species, bioaccumulation was interpreted in the context of food web exposure models. As stated by ARCO, the focus of this investigation was the riparian areas and the results should therefore not be extrapolated to other habitats. However, some extrapolation may be appropriate and these are explained below.

The primary results from ARCO's investigation were as follows:

- Using multiple linear regression (MLR), results indicated that the sum of the soil metal (arsenic, cadmium, copper, lead, and zinc) concentrations and soil pH were the primary factors that contributed to a prediction of plant biomass and species richness (i.e., the plant community endpoints). None of the other ancillary soil parameters improved this prediction. The soil moisture variable only improved the predictive ability of the model where the soil pH was greater than 7.0. Soil pH in much of the metals-impacted area at Anaconda is less than 7.0.

- ARCO developed a plant community effects level (PCEL) predictive model based on the MLR. The PCEL model predicts how phytotoxic effects should manifest themselves in riparian plant communities along Warm Springs Creek; as the sum of the soil metals increases and/or the pH decreases, there should first be a loss in species and the plant community should demonstrate a decrease in biomass. Based on a review of the kriged maps prepared for the Anaconda Regional Soils Operable Unit Remedial Investigation Report (ARCO 1997), a significant portion of the Anaconda site is expected to show a loss of species and a decrease in biomass due to elevated soil metal concentrations. This cursory review of the kriged maps shows that the total concentrations of the five COCs in many of the kriged cells exceed 3,500 mg/kg and the pH values are less than 5.5, which should have a negative effect on plant communities over a large area of the site.

- An apparent threshold for significant reductions in the number of plant species relative to the reference sites was observed at a pH value of approximately 5.5.

- Waste affected areas are dominated by redtop and tufted hairgrass, species tolerant of low pH soils. Along a gradient of increasing metals concentrations and decreasing soil pH, there is a sharp threshold for the transition from a meadow dominated by redtop and/or tufted hairgrass (i.e., the tolerant species) to a more diverse community that includes many of the more sensitive species.

- According to the ARCO report, health risks to primary and secondary consumers was not significant.

Summary

Per EPA guidance (EPA 1997), one of the lines of evidence that can be used to ascertain whether site chemicals are causing adverse effects on vegetation is to compare observed effects in site vegetation to vegetation at a reference site. Numerous studies have been published and summarized above to demonstrate sharply-contrasting conditions and shifts in plant community structure between vegetation communities associated with the Anaconda Smelter Site and nearby reference areas (Ross and Hunter 1976, Mueggler and Stewart 1980, RCG/Hagler, Bailly 1995, MNRDP 1994, and Taskey 1972).

In addition, historical accounts by the Anaconda Copper Company itself have documented that the release of smelting wastes was having a deleterious effect on plant and animal life throughout a large part of Deer Lodge County. Since the 1920s, researchers working in the Anaconda area have known that smelting activities, which result in sulfur dioxide, arsenic, and metal emissions, were at least partially responsible for the loss of vegetation and the lack of plant recolonization of impacted areas. The results of plant response research conducted since then indicates that raising soil (or tailings) pH with liming agents will reduce the direct phytotoxic effect to plant roots of high hydrogen ion concentration and will reduce the plant available metals, which are also known to cause phytotoxic effects at elevated concentrations.

Further, ARCO's own risk assessment for the upper Clark Fork River showed that as the total arsenic, cadmium, copper, lead, and zinc (the Anaconda COCs) concentration in the soil increases, there is initially a loss of plant species from the community followed by a reduction in above-ground plant biomass. Using ARCO's plant community effects model and the results of their kriging analysis, it is indicated that the soil in a large portion of the Anaconda site has total

COC concentrations that could cause phytotoxic effects. This is consistent with results from EPA's risk assessment which delineate a large area where soil COC concentrations exceed the established phytotoxic effect concentrations (ECs) and therefore could be providing a potential risk to the establishment and growth of plants. Vegetation data collected by EPA in 1995 confirms that, in the absence of moderating influences such as a high soil moisture regime, soil having COCs in excess of the phytotoxicity ECs are often barren of vegetation or only sparsely vegetated. These areas also have less canopy cover and production, and have fewer species than would be typically found on these range sites in the absence of contamination.

What ARCO reviewers have neglected to acknowledge is that EPA has implemented a CPSA model and the Land Reclamation Evaluation System (LRES) to demonstrate reasonableness in its current approach to defining areas of the site requiring remediation.

For example, the essence of any environmental risk assessment should be to establish a common thread among sources, complete pathways of potential exposure, document increased exposure and uptake, and ultimately either document that effects are occurring or have the potential to occur. For vegetation at the Anaconda site, this entire string of evidence has been noted as illustrated below:

Is there a source?	Yes, tailings and elevated metals concentrations in soils from smelter emissions.
Does a complete pathway exist?	Yes, metals in contaminated soils are available for roots to take up metals.
Is vegetation exposed?	Yes, ARCO's own comments on the Final BERA document elevated levels of metals in plants from Anaconda soils compared to those from reference areas.
Are there documentable effects or is there potential for risk?	Yes, historical information documents ongoing phytotoxicity for several decades and limited ability for vegetation to re-establish. The question as to whether or not sulfur dioxide (SO_2) emissions were the original cause of devegetation is a moot point. When one considers EPA's reasonable and potentially rather liberal phytotoxicity benchmarks (see below), the potential for phytotoxicity in site soils remains quite strong.

Obviously, this is only a brief description of the complicated aspects of phytotoxicity on the site. It does, however, point out the fact that EPA has been reasonable in its current approach and has gone well beyond this simplistic viewpoint by developing the CPSA model, as presented in the BERA. This model considers soil and environmental factors, other than soil ECs, that may have a mitigating effect on phytotoxicity. See Section C for clarification of the CPSA model.

Furthermore, the agency realizes the uncertainty in such an analysis and is incorporating more data collection in an effort to more definitively refine areas of remediation via the LRES during the remedial design phase.

Additional work has been done by EPA using field reconnaissance, aerial photographs, infrared images, and other information to provide a preliminary identification of areas where vegetation is at risk from soil COC concentrations and where remedial action may be warranted. These areas, which are within the phytotoxicity zones, are identified in the Feasibility Study (FS) and the Proposed Plan. The Barren/Sparsely Vegetated Area of Concern is one of the areas identified.

Using the LRES decision making tool, EPA conducted a test in 1997 at the site to identify areas that require some type of remedial action. This tool was applied within areas where soil COC concentrations exceeded the phytotoxicity ECs and therefore posed a potential risk to the vegetation. The quantitative portion of the decision making tool scores the condition of the vegetation and the potential for COC movement via wind or water erosion. In general, the lack of vegetation or low plant canopy coverage was an indicator of existing toxic effects and the potential for COC release. The LRES is currently being refined and will be used in 1998 to identify remedial units and the pool of reclamation techniques that may be applicable to each unit and to determine the types of additional data that the decision makers will need to select the most appropriate reclamation approach.

Several additional comments from ARCO reviewers offered both a challenge to defend the technical merit of work presented in the Final BERA, and clarification of the models and assumptions used in the determination of vegetative risk on the site. Therefore, the following several paragraphs are EPA's response to both the technical challenges and some additional analyses and descriptions for clarification.

B. REBUTTAL TO ARCO'S CLAIM THAT PHYTOTOXICITY EFFECTS CONCENTRATIONS ARE UNREASONABLY CONSERVATIVE AND LITERATURE AND SITE-SPECIFIC STUDIES USED TO DERIVE THEM ARE NOT SCIENTIFICALLY DEFENSIBLE

The following table (and it's appropriate references) list several phytotoxicity benchmarks used quite readily for screening purposes in the development of terrestrial ecological risk assessments.

Literature-Based Phytotoxicity TRVs

Source		Phytotoxicity TRVs (in parts per million)				
		Arsenic	Cadmium	Copper	Lead	Zinc
CDM Federal (1996)	pH<6.5	136 - 315	5.1 - 20	236 - 750	94 - 250	196 - 240
	pH>6.5	224 - 315	8.6 - 40	1,062 - 1,636	179 - 250	379 - 500
CH2M Hill (1987a and b)		100	100	100	1000	500
Efroymson et al. (1997)		10	4	100	50	50
Rice and Ray (1984)		200	5	400	NA	NA
Kabata-Pendias and Pendias (1992)		15 - 50	3 - 5	60 - 125	100 - 400	70 - 400
Range	**Lowest**	**10**	**3**	**60**	**50**	**50**
	Highest	**315**	**100**	**1636**	**1000**	**500**

What is important to note from examination of the table, is that EPA has **not** used unreasonably conservative values in the development of the ECs for screening purposes in the assessment. A more legitimate argument could very well be that EPA's values were not conservative enough. This further points out the fact that EPA incorporated site-specific data derived from site-specific toxicity tests and went well beyond typical screening tools and furthers EPA's position to be described below that the Final BERA is more than what ENSR toxicologists argue as nothing more than a collection of screening tools.

The primary basis for the phytotoxicity benchmarks were two-fold; the East Helena studies completed by CH2M Hill, and the toxicity assays completed by Kaputska et al. (1995). Appendix B contains peer-reviews of the East Helena studies provided to the primary author of the document, D. Neuman of the RRU at Montana State University. It is provided as documentation that both the compilation of literature and the phytotoxicity studies completed on Anaconda soils have been peer-reviewed and judged on their scientific merit by several scientists and that EPA was far from arbitrary in deriving these values.

C. FURTHER DESCRIPTION AND CLARIFICATION OF THE CPSA MODEL

Introduction

Some of the information in this section has been taken from the Final BERA (CDM Federal 1997) and from responses to ARCO comments on the BERA. The last section herein provides a detailed description of how the concentration of the COCs and the other plant growth environmental factors were used to estimate the primary sources of plant stress in the vegetation areas (VAs) at the ARWW&S OU.

The concentrations of the COCs in the soil are just one of many influences on plant growth and development at the ARWW&S OU. These, together with the soil texture, landscape features and land-use all contribute to the current assemblages of plants in a given area of this OU. To assess the effects of the COCs on vegetation and plant community characteristics, EPA used a CPSA model to evaluate the relative influence of the COCs and the other physicochemical soil components, landscape factors (including slope steepness, slope aspect and landscape position), and land-use history on the potential to cause plant stress at the ARWW&S OU. This was accomplished using data and information gathered during the 1995 EPA survey, data from other researchers who had worked at the site, and remote sensing data. Specifically, the CPSA 1) compares surface soil COC concentrations to established soil ECs that are protective of vegetation (i.e., phytotoxicity ECs) and 2) assesses the relative impact of other factors that affect plant growth and development. Qualitative assessments of vegetation and wildlife habitat condition conducted by EPA and others were also discussed in the BERA.

An important aspect of the CPSA is that it does not rely on any one piece of data, such as phytotoxicity ECs, to help define areas of potential risk. Rather, the CPSA uses the phytotoxicity ECs along with other physicochemical soil data and landscape characteristics in a weight-of-evidence manner to identify general areas where smelter and ore processing wastes may significantly contribute to plant stress and change the composition of the plant communities, habitats, and wildlife populations. The vegetation discussion in the BERA includes a comparison of the existing vegetation at the ARWW&S OU to what should be present under climax vegetation conditions and to what currently exists in German Gulch.

Potentially Phytotoxic Areas

The locations of the phytotoxicity zones delineated in the BERA were derived by comparing the preliminary results of the regional (general relative) kriging of soil data conducted by ARCO as part of the Soils Remedial Investigation to the soil ECs (Table 5.1-1 of the BERA). The regional (general relative) kriging results represents the most mathematically accurate method available for estimating surface soil concentrations of the COCs throughout the site. Based on the kriging results, four progressively harsher zones of soil COC phytotoxicity are identified in the BERA as follows:

Zone 1	This area is defined by the Low Phytotoxicity Line and encompasses the area where the concentration of **at least one** COC in soil exceeds a **low** (i.e., minimum) phytotoxicity EC;
Zone 2	This area is defined as the High Phytotoxicity Line and encompasses the area where the concentration of **at least one** COC in soil exceeds a **high** (i.e., maximum) phytotoxicity EC;
Zone 3	Within this area, concentrations of **all** the COCs in soil exceed the **low** phytotoxicity ECs; and,
Zone 4	Within this area, concentrations of **all** the COCs in soil exceed the **high** phytotoxicity ECs.

The Low Phytotoxicity Line represents the outer boundary of EPA's area of concern for vegetation receptors. This line is based on the low phytotoxicity EC developed from data collected by the State of Montana (RCG/Hagler, Bailly 1995) (Table 5.1-1 of the BERA). Within this area, one or more of the COCs have a surface soil concentration that has the potential to adversely affect plant growth and community structure. The High Phytotoxicity Line was derived from a review of the toxicological literature, including the exhaustive review conducted to support the East Helena Remedial Investigation/Feasibility Study (RI/FS) (CH2M Hill 1987a and b). A thorough discussion of the development of phytotoxicity boundaries for COCs at this site was presented in Appendix 7 of the BERA.

Soil Physicochemical Properties and Other Plant Influences

In addition to the COCs, the CPSA utilized soil results from the 1995 EPA Survey that were analyzed for specific conductance, pH, cation exchange capacity, extractable N, P, and K, and organic carbon. These results were compared to the level of these constituents typically found in rangeland soils. The other environmental factors affecting plant development assessed during and subsequent to the 1995 EPA Survey were soil moisture regime, surface irrigation, slope steepness, slope aspect, grazing impacts, and the presence or lack of topsoil.

Vegetation Parameters

The plant community attributes evaluated during the field survey and used in the CPSA were: percent canopy coverage of herbaceous perennial and annual/biennial plants species; herbaceous plant composition; and bare ground. These results are presented in Table 5.1-2 of the BERA for each VA.

Environmental Parameter Scoring

CDM Federal compared the absolute values for the COC to the high phytotoxicity ECs. This comparison could have been done using the low phytotoxicity ECs; however, EPA felt that using the upper end of the phytotoxicity ranges (for each COC) represented soil concentrations that were likely to impart some type of phytotoxic influence. The results of these comparisons are shown in Table 5.1-3 of the BERA. A "yes" indicates that the COC concentration exceeds the EC. Phytotoxicity due to the collective influence of all the COCs was evaluated by tallying the number of COCs that exceeded the high phytotoxicity ECs. The results of this semi-quantitative scoring are shown in the "Soil Metals" column in Table 5.1-4 of the BERA.

The absolute values for the ancillary soil parameters and the information on landscape characteristics and land-use were compared to typical rangeland conditions in southwestern Montana to estimate which parameters were potentially having an abnormally positive or negative effect on the vegetation. "Typical" rangeland condition information was obtained from standard texts and through discussions with rangeland/reclamation scientist Frank Munshower (RRU 1996, Valentine 1971). Each soil, landscape, and land-use parameter was given a score of "-", "0", or "+" using the criteria listed below.

- Specific conductance (SC): 0 = nonsaline to slightly saline; - = moderately saline to saline
- pH: - = <5 and >8.5; 0 = between 5 and 8.5
- Cation exchange capacity (CEC): - = <5; 0 = 5-30; + = >30
- Potassium (K) (mg/kg) : - = <125; 0 = 125-250; + = >250
- Nitrogen (N) (mg/kg): - = <5 (low); 0 = 6-10 (normal); + = >10 (above normal)
- Phosphorus (P) (mg/kg): - = <14; 0 = 14-25; + = >25

- Organic carbon (OC): - = <2%; 0 = 2-3%; + = >3%
- Soil moisture regime (from Soil Conservation Service data): + = wet bottomland generally subirrigated; 0 = well drained bottomland that is not subirrigated or areas with topsoil and moisture-conserving exposures (i.e., non-southern exposures);
  - = well-drained upland or areas with moisture-depleting exposures
- Slope: - = >30%; 0 = 15-30%; + = <10%
- Aspect: - = primarily south; 0 = east and west; + = primarily north
- Stone and rock (cover): 0 = 0 to 6%; - = 7 to 12%; -,- = >12%
- Grazing: - = heavy; 0 = moderate; + = light to none (some areas are not utilized due to lack of vegetation)
- Surface soil type: - = disturbed soil or little to no topsoil; 0 = topsoil intact, some erosion or surface disturbance; + = little to no disturbance or topsoil erosion

Plant Community Scoring

Plant community characteristics are thoroughly discussed for each VA in the PBERA Supplement (CDM Federal 1995b) and in the Final BERA (CDM Federal 1997). In the final BERA, the quantitative canopy coverage measurements (Table 5.1-2 of the BERA) were compared to the typical range conditions and scored using the following criteria.

- Herbaceous perennial cover: - = <30; 0 = 30-60%; + = >60%
- Annual/Biennial cover: + = <5%; 0 = 5-15%; - = >15%
- Composition (relative cover) of bare ground: - = > 60%; 0 = 30-60%; + = <30% (percent bare ground cover/ [100 - percent stone and rock cover] x 100)
- Composition (relative cover) of herbaceous perennials: + = >85 (high); 0 = 75-85 (moderate); - = <75 (low); ([percent herbaceous perennial vegetation cover/total percent herbaceous cover] x 100)

These criteria were also obtained through discussions with Frank Munshower and from Bob Rennick's experience in conducting range surveys in southwestern Montana. The summary of the vegetation scoring is presented in Table 5.1-4 of the BERA. As an example, the herbaceous perennial coverage at station number 1 within VA17 was 29 percent, which was less than the 30 percent criteria. Therefore, for this parameter the plant community scored a "-" for having relatively low coverage by the perennial species. At station number 2 in VA17 the coverage of non-desirable plants (i.e., the annual and biennial species) was less than 1 percent. Since this is a desirable characteristic of the plant community (according to rangeland ecologists and managers) it scored a "+".

Plant Stress Evaluation

The information presented in Table 5.1-4 of the BERA was used as the principle reference for the next step in evaluating potential plant stress at the ARWW&S OU: deciding whether the factors were having a positive or negative affect on plant germination and growth. Because of the complicated interactions between the plant species and plant growth factors, and among plant species at any given sampling location, no attempt was made to numerically rank the plant growth factors in terms of which was having the most or least affect on the vegetation.

Table 5.1-6 of the BERA provides a summary of the estimated effects that the principle plant growth factors may be having on the vegetation at the ARWW&S OU. For each VA, the type of influence that the plant growth factors are believed to be having on the vegetation were grouped in categories: positive influences, negative influences, non-negative or neutral influences, and variable influences. Except for the soil metals, each parameter was scored as follows.

Score		**Category**
"-"	=	Negative Influence
"0"	=	Non-negative or Neutral Influence
"+"	=	Positive Influence

If the score varied between the sample depths or stations, the parameter was placed in the Variable Influence category.

For the soil metals the scoring was applied as follows.

Number Exceeding Phytotoxicity EC		**Category**
< 5%	=	Non-negative or Neutral Influence
> 5%	=	Negative Influence

Different scores for a station within a VA resulted in placing the COCs in the Variable Influence category.

The only exception to these criteria was used for categorizing COC influence in VA8A. In this VA, the zinc results (618 and 522 mg/kg - Table 5.1-3 of the BERA) were only slightly higher than the zinc EC (500 mg/kg - Table 5.1-1 of the BERA). These exceedances represent 20% (2 out of 10) of the results for all the COCs. Based on the low absolute values for zinc, the COCs collectively were considered not to have a negative influence on the plant community in this VA. Therefore, in Table 5.1-6 of the BERA the COCs are placed in the Non-negative/Neutral category.

As a fatal-flaw type of evaluation, the categorization of the COC and ancillary parameters in Table 5.1-6 of the BERA were compared to the raw plant community data collected in 1995 and to aerial photographs for all the entire VA (not just where the sampling stations were located). Based on this analysis, no adjustments were made to Table 5.1-6 of the BERA.

D. REBUTTAL TO ARCO'S CLAIM IN THE ABSENCE OF SIGNIFICANT DOSE-RESPONSE STATISTICAL CORRELATIONS BETWEEN VEGETATION ENDPOINTS AND SOIL METAL CONCENTRATIONS

ARCO authors of the comments appropriately point out the high probability of Type I statistical errors (erroneously concluding an effect is occurring when one truly is not) while trying to determine stressor-response relationships between arsenic and metals soils concentrations and plant community endpoints, but fail to objectively discuss the probability of Type II errors (erroneously concluding that there are no effects when there truly are) in such relationships. As

ARCO contractors have repeatedly identified, and fully acknowledged by EPA, other stressors besides metals in the soils impact plant communities. The high number of co-factors (>13; which are quantified in Tables 5.1-3 through 5.1-6 of the Final BERA) are too numerous to determine through grueling statistical applications a true dose-response relationship.

Determining dose-response on this landscape level would require several more basic research questions to be answered. Variability in dose-response of individual metals and metals mixtures for several species of vegetation can occur with homogenous soil characteristics let alone under the heterogenic conditions of the site soils of Anaconda. It has been accurately stated by both ARCO and EPA scientists that pH has a very strong influence on metals bioavailability. However, even this relationship is not exactly straightforward. Consider the relationship between pH and metal ion speciation illustrated in distribution curves of copper and zinc ion hydrolysis. The percentage of the bioavailable cupric ion (1,0) is highly dependent on both pH and copper concentration. When the concentrations in solution change from 10^{-5} *m* to 0.1 *m*, the pH at which 80% of ionic makeup of the solution becomes the cupric ion (Cu^{++}) shifts from 7.5 to 5.5 respectively. What this may infer is that lower soil concentrations of copper may actually not necessarily need low pH soils to create as much bioavailable copper as more contaminated soils. Similar shifts in the ionic composition of the zinc solutions are dependent on concentrations that do not occur. Contaminant physical-chemical variability of exposure and effects of demographic endpoints of metals and plants has obvious complications.

EPA, therefore, feels that using statistical methods alone to establish stressor-response relationships in the complicated mechanisms involved with phytotoxicity and all their potential co-factors would lead to a high probability of type II errors. EPA recognized this early in the RI/FS process and sought the consultation of vegetation restoration specialists at Montana State University. It was recognized by these experts through the research they have completed in the ARTS program, that true dose-response relationships on a landscape level would never be identified because of the numerous potential co-factors. As has been more thoroughly explained above, the CPSA used in the Final BERA was designed to address vegetative risk in a rather atypical manner and may be the reason for the high level of confusion behind the model. Since true dose-response relationships would never be established on a landscape level and no true dose-response phytotoxicity studies have been completed on site soils, the CPSA model was designed to use the research these experts have developed to ask the question: what physical-chemical properties of the soil must be addressed before vegetation can exist? Through the model analyses, when elevated metal concentrations were the predominant factor preventing vegetation growth in each Vegetation Area (VA), it was identified as a VA with metals concentrations posing significant risk to vegetation. See additional comments below on the CPSA model.

E. REBUTTAL TO ARCO'S CLAIM THAT THE AGENCY HAS NOT ACCOUNTED FOR EFFECTS OF pH ON VEGETATIVE AREAS OF CONCERN

EPA Region 8 concurs with ARCO's position that pH may influence phytotoxicity on Anaconda. As a consequence of that position, EPA had used two separate soil toxicity effects concentrations in the Final BERA: one for soils above pH of 6.5 and one for soils below 6.5. However, additional ARCO criticisms pointed out differences in the critical pH value used in the effects concentrations (6.5) and that used in the CPSA model (5.5). This comment is directly answered in the specific responses below, however, the general concept is more thoroughly addressed here, using data from Kaputska et al. (1995), and addresses the more general claim that pH and not metals is the primary determinant of phytotoxicity in Anaconda soils.

Kaputska et al. (1995) studied the phytotoxicity of 20 soils collected from upland areas within the Anaconda Superfund Site. Tests were performed in pots under greenhouse conditions. Test species included three different agricultural crops (alfalfa, lettuce, and wheat). Measurement endpoints included seed germination rate, root/shoot length ratios, root mass and shoot length. A scoring system ranging from 0-72 was used to quantitatively describe toxic response of all three species compared with plants grown in control soil. A low score in this study indicated little evidence of toxicity, while a high score indicated a phytotoxic response.

Results from this study are summarized below:

Score	Description	Number of Samples
< 0.5	Nontoxic	2
0.5 - 9	Mildly toxic	3
9.1 - 18	Moderately toxic	3
18.1 - 36	Highly toxic	11
36.1 - 72	Severely toxic	1

As seen, only two of the site samples did not cause measurable phytotoxic effects, and a majority of the samples (15 of 20) yielded clear phytotoxic responses (>9). In general, the order of sensitivity among the three test species was alfalfa > wheat > lettuce, and the order of endpoint sensitivity was: root length > root mass > shoot height > total mass > shoot mass > germination rate.

In Figure 1, the phytotoxicity scores for each sample are plotted versus the concentration of each metal of potential concern, and versus soil pH. As seen, the relationship between the phytotoxicity score and the concentrations of the individual metals show little evidence of a trend for increased score with increasing metal concentration. There is an apparent trend for scores to increase as pH decreases. Figure 2 plots the bivariate relation between pH, metal levels, and the resulting phytotoxicity score. The figure is based on the sum of all five metals (arsenic, cadmium, copper, lead, and zinc). In almost all cases, the controls (open circles) and site samples which did not display phytotoxicity (open squares) lie in the bottom right quadrant of the figure, while most of the samples which had elevated toxicity scores lie in the upper left quadrant. The line drawn in each figure segregates the data points into regions of phytotoxic response and non-phytotoxic response. These lines (derived by simple visual inspection) are given by the following equations:

$$\text{Total Metals} = 520 \cdot \text{pH} - 2300$$

That is, phytotoxicity is not expected if:

$$520 \cdot \text{pH} - 2300 - (\text{Total Metals}) > 0$$

Based on this equation, upland soil samples taken from VAs on Anaconda may be predicted to be either phytotoxic or non-phytotoxic (Figure 3). From the predictive equations in Figure 3, only VAs 21, 15 and 24 have at least portions that would not be phytotoxic. This is consistent with the determinations previously made in the final BERA.

In interpreting these predictions, it is important to remember the following potential limitations:

- The study used lettuce, alfalfa and wheat as receptors. It is not known whether these agricultural plants are more or less sensitive to metals and pH than native and introduced plants.
- Because the study soils contains a mixture of metals, the relative contribution of each individual metal to the phytotoxic response and the potential interactions among individual metals (antagonism, synergism) cannot be determined.
- Because the predictive curve was generated under laboratory conditions with consistent soil parameters of moisture, top soil, etc., the predictive power of this equation does not necessarily extend beyond that potential influence of pH.

In summary, this analysis demonstrates that pH alone is not primary factor influencing the lack of vegetation on the site, that several sites indicated in the final BERA as presenting risk to vegetative species from metals concentrations in the soils, are consistent with laboratory testing. This finding is not entirely surprising as the final soils effects concentrations were based on Kaputska et al. (1995). It does, however, more straight-forwardly display the influence of at least one major co-factor: pH.

F. SENSITIVE VERSUS TOLERANT PLANT SPECIES TO MINING IMPACTS

The **sensitive plant species** listed below are those that Tom Keck of the Natural Resource Conservation Service used as indicators of smelting-related impacts. Dr. Keck conducted the soil survey for the Anaconda area, and therefore, has intimate knowledge of vegetation and soil conditions throughout the valley and foothills that includes the ARWW&S OU. In addition, it is the experience of Bob Rennick (CDM Federal range ecologist) and RRU staff that these species, which should be present on these rangeland sites under climax conditions, appear to be sensitive to environmental perturbations.

Plant species that are **tolerant** of harsh environmental conditions are those that can be found on all rangeland sites and are often the only species found on severely impacted, high soil-metal sites near the Anaconda Smelter complex.

The **climax plant species** listed in the table are the dominant plant species on most rangeland sites under climax conditions in the ARWW&S OU. Observations by Bob Rennick (CDM Federal range ecologist) during the past ten years indicate that these species are not the dominants, and are often not even present, in plant communities of the Anaconda area. However, many of these species have been observed at locations near Fairmont Hot Springs Resort, near German Gulch, at a site in the foothills seven miles north of Anaconda, and at high elevations west of Anaconda.

Common Name	Latin Binomial	Reference
Sensitive Plant Species		
Rough fescue	*Festuca scabrella*	1, 2, 4, 5
Lupine	*Lupine spp.*	1, 4, 5
Idaho fescue	*Festuca idahoensis*	1, 4, 5
Heartleaf arnica	*Arnica cordifolia*	1
Strawberry	*Fragaria virginiana*	1
Tolerant Plant Species		
Redtop	*Agrostis stolonifera*	1, 4, 5
Great basin wildrye	*Elymus cinereus*	1, 2, 4, 5
Baltic rush	*Juncus balticus*	4
Spotted knapweed	*Centaurea maculosa*	1, 4, 5
Wood's rose	*Rosa woodsii*	1, 2, 4
Sedge	*Carex spp.*	5
Western wheatgrass	*Agropyron smithii*	4, 5
Whitetop	*Cardaria draba*	1, 4, 5
Oregon grape	*Berberis repens*	1
Juniper	*Juniperus spp.*	1
Rabbitbrush	*Chrysothamnus spp.*	1
Douglas fir	*Pseudotsuga menziesii*	1
Limber pine	*Pinus flexilis*	1
Leafy spurge	*Euphorbia esula*	1
Tufted hairgrass*	*Deschampsia caespitosa*	1, 4, 5
Inland saltgrass*	*Distichlis stricta*	1, 5
Aspen*	*Populus tremuloides*	1, 5
Greasewood*	*Sarcobatus vermiculatus*	5
Canada thistle	*Cirsium arvense*	1, 4, 5
Climax Dominant Plant Species		
Bluebunch wheatgrass	*Agropyron spicatum*	3, 4
Rough fescue	*Festuca scabrella*	1, 3, 4
Green needlegrass	*Stipa viridula*	3, 4
Idaho fescue	*Idaho fescue*	1, 3, 4, 5
Sticky geranium	*Geranium viscosissimum*	3, 4
Milkvetch	*Astragalus spp.*	3, 4
Lomatium	*Lomatium spp.*	3
Hairy goldenaster	*Heterotheca villosa*	3

Common Name	Latin Binomial	Reference
Pussytoes	*Antennaria spp.*	3, 4
Phlox	*Phlox spp.*	3, 4
Buckwheat	*Eriogonum spp.*	3
Arrowleaf balsamroot	*Balsamorhiza sagittata*	3, 4
Snowberry	*Symphoricarpos spp.*	3
Skunkbush sumac	*Rhus trilobata*	3
Big sagebrush	*Artemisia tridentata*	3

[1] Referenced by Dr. Tom Keck, Natural Resource Conservation Service, Deer Lodge, Montana (personal communication; memo from S. Jennings to B. Rennick, June 5, 1998; Keck et al., Mapping Soil Impact Classes on Smelter Affected Lands).

[2] Personal communication with Dr. Frank Munshower, Montana State University, Bozeman.

[3] *Rangesite Description and Condition Guide, USDA-SCS-Montana, April 1982.* Northern Rocky Mountain valleys, foothills and mountains west of the continental divide in the 10-14 and 15-19 inch precipitation zones.

[4] Field observations by Bob Rennick, CDM Federal Programs Corporation, Helena, Montana.

[5] Reconnaissance conducted by the Reclamation Research Unit, *ARTS Phase I Final Report, 1993.*

* Found on sites with specialized conditions such as a high water table or salty soils.

G. REBUTTAL OF ARCO'S CLAIM THAT THE FINAL BERA DID NOT ADDRESS HISTORIC INFLUENCES OF SO_2 EMISSION EFFECTS ON EXISTING VEGETATIVE STRESS

EPA takes issue with the ARCO reviewer's broad brush statements that EPA "failed" to consider the effects of SO_2 fumigation in the assessment of ecological risks for the Anaconda Smelter Site. In actuality, through the various iterations of reports, from the Phase 1 Screening Level Ecological Risk Assessment (CDM 1994), to the PBERA (CDM 1995a), to the PBERA Supplement (CDM 1995b), to the Final BERA (CDM 1997), EPA has responded to ARCO's earlier comments and incorporated greater discussion of SO_2 and other non-chemical stressors in the assessment of potential risks at the site.

EPA recognizes and never debated the fact that there were historical SO_2 effects on vegetation at the Anaconda Smelter Site. The State of Montana regulated SO_2 for more than 100 years, resulting in litigation and institution of environmental controls for SO_2 emissions. It was a known constituent resulting in environmental damage to plants, cattle, and crops. EPA does not argue that SO_2 did not have a significant impact to the local environment, but such effects are currently overshadowed by the effects of metals concentrations in some areas of the site where metals levels exceed phytotoxicity ECs. If SO_2 was the primary factor resulting in current vegetation condition in some parts of the site, then natural recovery and ecological succession would be expected to occur after the fumigation ceases. As discussed in the State of Montana's Findings of Fact legal document in support of the MNRDP case, the only residual effects that would remain following cessation of fumigation would be reduced pH and acidification of the soils. Site data reveal, however, that soil pH levels throughout most of the site are within ranges typically found in soils in southwestern Montana. At many of these locations, metals concentrations are high and vegetation is either absent or represented by a near-monoculture of metals-resistant species.

ARCO's reviewers from ENSR make a further comment that EPA failed to consider rates of recovery at other sites to evaluate the likelihood that the hypothesized stressor has caused the adverse effects. ENSR reviewers must not have reviewed the State of Montana's Findings of Facts document, where Larry Kapustka discusses that in studies of other ecological systems recovering from SO_2, grassland and forb communities have recovered within two decades after the emissions were removed, and canopy forest was re-established within 30 years. Therefore, one would expect to see a substantial recovery in areas of the site impacted by SO_2 emissions if SO_2 was the only controlling factor, because all SO_2 emissions ceased in 1980 with the closure of the smelter. ENSR reviewers further commented that EPA introduces the site's historical legacy, but fails to describe the historic emissions and probable effects of a known site stressor, sulfur dioxide. In support of their position, they present Figure 4 to show the estimated levels of emissions of SO_2 from the smelter. This figure also supports Larry Kapustka's deposition and EPA's position that sufficient time has passed from the reduced emissions starting in the late 1930s to the cessation of emissions in 1980 for recovery to be occurring.

Historical effects notwithstanding, CERCLA and the Superfund process require the assessment of current and future transport, fate, and risks of the identified COCs. The Ecological Risk Assessment is designed to answer CERCLA-mandated analysis of whether or not metals pose a potential risk to the environment in Anaconda. In consideration of the potential effects of non-COC stressors, however, the final BERA evaluates COCs in relation to all other major physical/chemical plant growth factors of soil, and identifies areas on the site where COCs are the major factor in the existing vegetation condition or ability of those sites to recover floristically.

As stated numerous times in the BERA, the CPSA considers both chemical and non-chemical stressors in the identification of areas of concern for ecological receptors. EPA never claimed that this analysis would result in a point by point identification of "risk areas" requiring remediation. In fact, EPA has developed an LRES for the selection of sites requiring remediation. The LRES is a decision tree that takes COC as well as non-COC stressors into consideration when recommending sites for remedial action.

For example, if SO_2 fumigation occurred in a certain area, and this resulted in plant loss and total soil erosion to bedrock, no remediation would be recommended for the area. If an area appears to be slightly impacted, but plants are starting to get a foothold in relation to diversity and abundance, and little or no erosion appears to be occurring, remediation would not be recommended for the area. Other areas might have conditions that would result in a recommendation to interseed and monitor, but not do full scale remediation. ARCO has been aware of the development of this decision making document but appears to have not communicated this to their reviewing subcontractor.

ARCO makes numerous comments that it is inappropriate to develop a strategy to evaluate COCs, not SO_2. Based on the discussions above, EPA strongly disagrees with these comments. Numerous scientific/management decision points occurred throughout the development of the risk assessment documents for this site, and the problem formulation was deliberately designed to evaluate potential risks from metals. Regardless of the initial effects of SO_2, EPA is using all available site data to determine why the site is not showing recovery in many areas. In many cases, this is because there are other ecological stressors at the site, namely, elevated metals concentrations in the soil. Therefore, the risk assessment is not focused on the causes for loss of vegetation in the past, it is focused in prospective way on identifying the extent and magnitude of continued stressors in the environment.

III. RESPONSE TO CRITICISMS OF WILDLIFE RISK ESTIMATES AND RE-EVALUATION

After reviewing ARCO comments on the terrestrial wildlife portion on the Final BERA, EPA Region 8 was compelled to reevaluate the results to specifically address many of their concerns. The modeling effort in the initial document was never meant to be a final interpretation of wildlife risk on the Anaconda Smelter Site. Note that the opening paragraph of the Appendix 10 in the Final BERA states the following: "The purposes of this modeling include 1) identifying the range of **potential** health risk to wildlife at the site; 2) identifying the trophic levels that are **potentially** at risk; and 3) identifying the trophic levels at the greatest risk. This information will be used by the risk managers to design future risk-related sampling efforts and post-remediation biomonitoring programs." These statements throughout the section clearly and transparently identifying the use of the results make ENSR's attack on the procedures not only completely useless, but quite confusing and erroneous. To the end of bettering the focus of soon-to-be proposed wildlife studies on the site, however, EPA Region 8 scientists have seriously considered suggestions by ENSR and incorporated many of their comments in the re-analysis in Appendix B of the ROD.

IV. RESPONSE TO ARCO'S REASSESSMENT OF AQUATIC RISKS ON THE ANACONDA SMELTER SITE

It is apparent that the strategy put forth by ARCO in this reassessment is primarily two fold: 1) to refute the possibility of toxic levels of metals and arsenic reaching the river from overland flow and erosion from hillsides highly contaminated with metals and arsenic by demonstrating no response of organisms currently inhabiting the creeks and thereby eliminating the need of revegetation as a remedial alternative on the site; and 2) document examples of what ARCO feels are the most appropriate techniques for assessing aquatic risk in anticipation of the release of future risk assessments in the Region, specifically the Clark Fork River OU. EPA concurs with the general conclusions of minimal demonstrable impacts to aquatic life within most of the area within the Anaconda site. In fact, the ROD requires a reasonable and moderate approach to protect aquatic resources from future potential impacts from COCs. It is for that specific reason why more site data will be collected in 1998 to answer questions of aquatic risks.

EPA evaluated the potential of surface water and sediment loading of arsenic and metals from erosion of non-vegetated hillsides as part of the site-wide fate and transport of COCs. The results of the analysis concluded that the groundwater influx of arsenic and loading from erosional overland flow would serve as a constant source of metals and arsenic to Anaconda streams and its downstream confluences. Although there may be currently low risk to aquatic receptors in Anaconda streams, it is very feasible that allowing contaminated hillsides to continue to contribute metals and arsenic into the watershed during the course of natural revegetation could convert low risk to potentially more grave circumstances.

V. REBUTTAL TO ARCO'S CLAIM THAT THE FINAL BERA IS SIMPLY A COLLECTION OF SCREENING LEVEL RISK ASSESSMENT PRACTICES

ARCO contractors erroneously conclude that the Final BERA was nothing more than a screening level risk assessment ignoring site-specific data by characterizing risks only from risk screening tools. The text from ENSR Toxicology states: "The BERA inappropriately draws its final conclusions based upon the results of a collection of screening risk assessment tools that variously report potential or possible risk."

It is recommended that ENSR risk assessors read pages 2-9 to 2-13 of the Final BERA, which provide a summary of screening-level problem formulation and risk characterization. In doing so, one would note that the first attempt at the characterization of ecological risks on Anaconda was completed in the Phase 1 Screening Level Ecological Assessment (CDM 1994), in an attempt to conservatively eliminate media, by geographic reference, that would be of no potential concern. As stated in the text, surface water, sediment, and soils were screened using conservative benchmarks of abiotic media to indicate areas of potential concern. The next step in the process was to further evolve the ecological risk assessment in the PBERA (CDM Federal 1995a). More specific ecological receptors were identified, refinement of assessment and measurement endpoints was completed with a concurrent effort in the development of a site-conceptual model. Areas of concern were further refined from the Phase 1 screening utilizing additional site-specific data while data gaps were identified and a field data collection program was designed to address the major data gaps. It was decided at that time that phytotoxicity was of primary concern and that although wildlife receptors may be at risk as well, those areas not identified as a risk to vegetation would also not be identified as a risk to wildlife receptors. Therefore, wildlife data collection was not initiated at that time and the focus shifted to potential phytotoxicity.

ENSR toxicologists on page 1-17 contend "While focusing on phytotoxicity, and following an approach congruent with the State's MNRDP injury assessment, EPA has not adequately addressed potential risks to wildlife under the proposed plan". Clearly, by EPA completing 2 levels of screening assessments and collection of vegetation data from the site, it is inconceivable how an objective scientist can read these three documents and come to the conclusion that EPA has focused on vegetation risk simply to have a "...congruent approach with the State's MNRDP injury assessment..." EPA toxicologists agree with ENSR risk assessors that additional characterization of wildlife risk needs to be completed as per the proposal indicated in the beginning of these responses.

The Final BERA incorporated numerous site-specific investigations, including site-specific investigations by ARCO and the state and federal trustees.

VI. RESTORATION VERSUS REMEDIATION

Throughout the ENSR comments, several references are made towards the proposed plan being one of *restoration* and not *remediation.* Rader (1997) and others (Galbraith et al. 1995, Kaputska et al. 1995) all indicate the most phytotoxic soils in the Anaconda area are either of low pH and/or high metals. It was concluded by these authors (and supported by comments offered by Menzie-Cura & Associates in ARCO comments on the BERA), soils of low pH can both be directly phytotoxic and/or lead to increased availability of metals for uptake by plants in the soils. Historically, remedial actions taken by EPA have often been completed to reduce exposure of contaminants to receptors by source control. In this case, vegetation is the primary receptor of concern. Liming treatments described by restoration experts will raise pH levels in soils and, therefore, reduce metals bioavailability and lower the potential for toxicity to plants. Concurrently, through stabilization of contaminated soils by revegetation, the potential of highly contaminated dust transporting from tailings piles and other contaminated areas for exposure to humans and wildlife are also reduced. As recent as 1981-1991, maximum concentrations in dustfall wastes on Smelter Hill were 115,333 parts per million (ppm) arsenic, 10,800 ppm cadmium, 390,000 ppm copper, 51,333 ppm lead, and 199,677 ppm zinc (RCG/Hagler Bailly, 1995). Stabilization of the tailings areas became a prime concern in the 1920s as a means of controlling dust from dried and unvegetated surfaces of the tailing impoundments and reclamation activities by various owners of smelters on the Anaconda site. The Anaconda Company understood that revegetation was the primary means by which dust control should be done: "The Anaconda Company recognizes that revegetation is the ultimate answer for permanent stabilization of concentrator wastes" (Richmond and Sjogren 1972). ARCO has continued to do research into the ability to revegetate areas of Anaconda to reduce the probability of dusting. EPA feels that in this case, some restoration is occurring through remedial action. Thus, what ENSR insists upon as restoration technology inappropriate for EPA's mandate of remediation is not only consistent with historic actions taken by EPA to reduce exposures to receptors at risk, it is an innovative way to also begin restoring the ecology of the site beyond the ENSR proposed climax community of lichens.

VII. DESCRIPTIONS OF INACCURACIES AND ERRORS IN ENSR'S REVIEW OF THE BERA

It is ironic that ENSR risk assessors (ARCO contractors) "scold" EPA for using bad science in the Final BERA, while the reviewers used very poor scientific practice in describing their concerns. The following are numerous examples:

1. The document makes many over-generalizations which do not accurately characterize the work completed in the document. For example, the text states: "The BERA inappropriately draws its final conclusions based upon the results of a collection of screening risk assessment tools that variously report potential or possible risk." This is a misleading and false statement. Although screening applications were used in wildlife risk models presented in Appendix 10 of the BERA, EPA clearly states in the text on page A10-4: "This information will be used by the risk managers to design future risk-related sampling efforts and post-remediation biomonitoring programs." Besides wildlife, however, the BERA incorporated site-specific data collected on vegetation

communities (CDM Federal 1995a), vegetation toxicity studies from the site (State of Montana 1995), water effect ratio testing (ENSR 1996) from site waters, and numerous other examples which will be discussed in a later response which directly answers the charge that EPA did not go beyond a screening level assessment in the Final BERA.

2. The comment authors have numerous misrepresentation of citations. The authors state draft EPA guidances and guidelines for Superfund in 1995 and in 1996 when current guidance with which the Final BERA was written under is clearly stated on page ES-1 of the document as the interim final "Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments" from June of 1997. On page B-3 and B-10 of ENSR's comments, the author makes reference to "EPA Region 8 toxicity reference values for dietary exposure of arsenic, cadmium, copper, lead, and zinc" proposed in July of 1997. These values apparently come from a draft document released to state and federal trustees by EPA for their review and comment. Much of this document was written by ENSR personnel and was not released as a *final* product of any form representing the position of EPA regional scientists. Currently, the region has no finalized ingestion TRVs for metals exposure to trout and continue to be developed for their use in the Clark Fork River OU ecological risk assessment. Similarly, on page 1-24, the commenters from ENSR described the mammalian arsenic TRVs as being overly conservative when in fact, it was ENSR risk assessors Heidi Tillquist and Frank Vertucci who had proposed the values used in the Final BERA in cooperation with EPA Region 8 ecotoxicologist Dale Hoff. In spite of the misrepresentation of the citation, however, EPA is interested in having the best available information in the development of the TRVs and will consider changing the values as ENSR authors suggested in their comments.

3. In an attempt to demonstrate mathematical errors in models used in the wildlife screening assessment, and in the presentation of a proposal for changing bioavailability factors (BAFs) for plant uptake of metals and arsenic, ENSR risk assessors have themselves made erroneous data presentation and mathematical errors.

    - In figures 12-16 on pages 1-44 to 1-48, ENSR risk assessors attempt to document the relationship between metal and arsenic concentrations in the soil with concentrations of the same in herbs/shrubs. In such a relationship, the independent variable should be concentrations in the soil while the dependent variable is the concentration of metals and arsenic in plant tissues. ENSR illustrations are respectively the opposite of this appropriate relationship. However, the concept of using this site data to determine a site specific equation in the development of the most appropriate BAF is noted and is applied in the re-analysis of the wildlife modeling described in comments above.

    - On page 1-28 ENSR risk assessors present their "belief" of how hazard quotients (HQs) were summed to develop a hazard index (HI). The numerator represents exposure concentrations in soils, and denominator represents a TRV. In their example they added 3 fractions by finding a common denominator:

Example 1. 1/2 + 3/4 + 2/3 =
6/12 + 9/12 + 8/12 =
23/12 =
1 11/12

In the Final BERA, the HQs were summed by adding the products from the division of each fraction. To illustrate this point, EPA uses the same example:

1/2 + 3/4 + 2/3 =	equals	0.5 + 0.75 + 0.666
6/12 + 9/12 + 8/12 =	equals	0.5 + 0.75 + 0.666
23/12 =	equals	1.916
1 11/12 =	equals	1.916

However, EPA does understand how ENSR risk assessors could be confused by the methodology as documented in the Final BERA. Furthermore, it agrees that better resolution as to what proportion individual chemicals are contributing to the summed HI factor. In Appendix B, additional wildlife risk modeling addresses this concern in text, tables and figures.

VIII. INSERTION OF LEGAL TERMINOLOGY IN ARCO'S "SCIENTIFIC REVIEW" OF THE FINAL BERA

As scientific critics of the Final BERA, ENSR risk assessors use several references of legal terminology with no clear understanding of their scientific benefit.

1. On page 1-1: "This review documents that the BERA...inconsistent with CERCLA and the NCP and *arbitrary and capricious.*"

Response: It is not appropriate to conclude in this scientific review that a remedial action is "arbitrary and capricious" nor is it appropriate to come to such a judgement based upon only one of the nine remedial decision criteria set forth in the NCP. EPA's decision as to remedy selection are based on the nine criteria set forth in the NCP, not any one criterion alone. It is not possible to judge EPA's final decision based upon only the outcome of a risk assessment. Any conclusion that EPA action is arbitrary and capricious should be based upon all the factors considered by EPA, including all none criteria. In any event, ARCO's claim that a remedial decision based on the BERA would be "arbitrary and capricious" is simply wrong, as explained in detail in EPA's responses to ARCO's comments on the BERA.

2. On page 1-3: "Response actions to improve habitat impacted by SO_2 emissions and factors other than release of hazardous substances is outside CERCLA's remedial authority."

Response: See response to issue 24b, EPA's responses to ARCO's letter of January 29, 1998, Attachment L. In general, EPA does have authority to take remedial action to address threats to human health and the environment posed by the release of hazardous substances. EPA has gone to great effort to document this risk in human health and environmental risk assessments.

Nowhere does ARCO show that any such threat has been caused by something other than a hazardous substance.

3. On page 1-16: "...supports ARCO's position that the site specific WER adjustment to the AWQC is *relevant, appropriate, and protective* of sustaining *aquatic uses* in the Clark Fork River and its tributaries."

Response: It is not appropriate to make the finding claimed by ARCO in a scientific document. The terms "relevant", "appropriate", and "protective" are essentially legal terms. "Relevant" and "appropriate" are defined in the NCP. These scientific documents do not make any of the findings necessary in order to reach the conclusion that WER adjustment is "relevant" and "appropriate".

4. On page 1-28: "*Response actions* described in the Proposed Plan *are not supported* by the findings of the BERA." .

Response: See comment concerning 1-1, above. ARCO should limit itself to technical comments only in its technical documents.

IX. REBUTTAL OF ARCO'S CLAIM THAT EPA HAS CONTINUED TO IGNORE CRITICAL COMMENTS IN THE DEVELOPMENT OF THE FINAL BERA: HISTORY OF COMMUNICATIONS BETWEEN ARCO AND EPA ON THE ANACONDA SMELTER

Throughout the process of developing the ecological risk assessment on the Anaconda site, ARCO has been involved in not only the review of documents, but in the design of site studies. EPA Region 8 has acknowledged ARCO's comments and has made an effort to incorporate those comments and concerns, when appropriate, during ALL phases of the project. In fact, a review of all past EPA documents and ARCO comments shows how many times EPA has incorporated ARCO data into the reports and modified text in response to comments made by ARCO reviewers. Section X contains a matrix identifying specific comments presented by ARCO's various contractors during the development of several documents, and EPA's specific responses to these comments. It is important to note here two of EPA's frustrations that have led to perceived communication problems between ARCO and the Agency. First, contradictory opinions often arise when given comments from different contractors on the same subject manner and represented to the Agency as ARCO's technical position. Such examples are noted below in the response matrix designed to address specific comments. It is quite difficult for EPA to respond to comments from "ARCO", when the Agency is given confusing positions. Second, ARCO appears to have the impression that because the Final BERA does not express ARCO's view of ecological risk that the Agency has ignored their comments. Indeed, there is a fundamental disagreement between ARCO and the Agency as to the existence of vegetative risk at the site. Just because the Agency disagrees with ARCO that there is no such thing as phytotoxicity on the Anaconda Smelter Site, does not mean we have not considered the comments.

The response matrix in the following section addresses the specific comments received from ARCO, dating back to the earliest documents produced by CDM Federal on behalf of the Agency, to demonstrate that EPA considered and incorporated ARCO's previous comments. Based on the most recent comments prepared by ARCO, it appears that current reviewers have not become familiar with historical dialog and resolutions between ARCO and EPA.

X. MATRIX OF RESPONSES TO ARCO'S (MENZIE-CURA'S) SPECIFIC COMMENTS ON ANACONDA BERA

DOCUMENT LIST:

Document Number	Date	Document/Deliverable Description
1	11/95	ARCO Comments from Steve Dole on Final PBERA (before Supplement)
2	4/11/96	ARCO's Final Comments on PBERA Supplement, Flack to DalSoglio
3	11/1/96	ARCO's Preliminary Comments on EPA's Draft Final BERA for the ARWW&S OU, Flack to DalSoglio
4	11/1/96	ARCO Editorial Comments on Draft Final BERA, Bullock to DalSoglio
5	3/4/97	Menzie-Cura's Assessment of Impact to Vegetation by Multiple Stressors at the ARWW&S OU, Flack to DalSoglio
6	1/30/98	Comments on EPA's Proposed Plan for the ARWW&S OU, Attachment G - ARCO Comments on Final BERA, prepared by Menzie-Cura, Stash to DalSoglio
7	1/30/98	Comments on EPA's Proposed Plan for the ARWW&S OU, Attachment H - ARCO Comments on Final BERA, prepared by ENSR, Stash to DalSoglio

SPECIFIC COMMENTS:

Doc. No.	Page	Comment	Response Notes
Issue: General Comments			
1	2	The PBERA does not include pertinent ecological data (PTI Ecorisk report, Smelter Hill phytotoxicity report, Keammerer, Redente, and Reiser reports for NRDA litigation, and fish populations in area streams).	Some of these data were not available when the PBERA was prepared, but were added to the PBERA Supplement and carried through all the way to the BERA.
1	5	PTI's Regional Ecorisk Field Investigation is not discussed in the PBERA (yet PBERA indicates this report was a source for the development of soils ECs).	PTI's report was reviewed in the PBERA Supplement, and results were described in the BERA in appropriate context of the riparian zones on the Anaconda Site. However, although the data was described in the text, the document was not appropriately cited at the end of the chapter. In the Final BERA (Appendix 3), PTI's report was evaluated in the development of BAFs for plants, invertebrates, and deer mice. Furthermore, the CPSA model will be validated using relationships between pH, total metals, and biomass and taxa richness.
1	2	The PBERA requires a consistency check regarding sources of information used.	Agreed, revised in the BERA.
1	3	The use of a LANDSAT image requires further discussion (i.e., date of image, scale, type of coverage, etc).	The sources of imaging were USDI, USGS, and the Earth Science Information Center, acquired from the High Altitude Photography Program. The image date was August 24th, 1984 at a scale of 1:58000. They were enlarged for CDM Federal purposes to 1:29000. See Appendix 2, page 8 in the BERA.
1	3	The PBERA references a USFWS report regarding impact of SO_2 emissions on vegetation, but no citation was provided nor a discussion of the conclusions.	In the PBERA Supplement (see page 23 of PBERA Supplement) and the BERA, results from this investigation (Carlson 1974) were discussed. This included the conclusion that SO_2 impacted trees in the area north of the smelter.

Doc. No.	Page	Comment	Response Notes
2	8	Internal consistency checks are needed between tables and text in PBERA Supplement.	Agreed, revised in the BERA.
3	2	ARCO's preliminary comments on the Draft Final BERA mandate substantial revisions to the final document consistent with Menzie-Cura's comments to be considered a scientifically valid assessment of ecological risk to receptors within the ARWW&S OU.	EPA disagrees with the overall finding of ARCO's interpretation in Menzie-Cura's report that metals are having no impact because of lack of correlative metal stressor-response statistics. Menzie-Cura re-established what EPA concluded several years previously and, consequently, moved more towards an ecologically holistic approach with the CPSA. It is important to note that none of Dr. Menzie's comments demonstrated that the CPSA model is invalid. Further, Menzie-Cura did not say that EPA's approach was scientifically invalid. See response in Section IIB.
3	2	The BERA relies on highly uncertain ECs to characterize risk, without concern to ecological relevance, bioavailability, effects of multiple stressors, or weight-of-evidence from evaluation of multiple assessment and measurement endpoints.	The BERA did consider ecological relevance and other site factors such as bioavailability and ecological stressors. We discussed four zones of phytotoxicity, discussed multiple stressors and endpoints, and ranked vegetation areas based on metals in vegetation and water. ARCO and EPA agreed upon the sampling design and number of samples to be collected, and there are not enough samples, given the spatial extent of the site, to adequately perform multivariate analysis. Uncertainties associated with the ECs are thoroughly discussed in the BERA (Section 5.5). The uncertainty section was extensively revised from the Draft Final BERA to the Final BERA to account for ARCO's concerns.
3	4	ARCO incorporates, by reference, their comments on the PBERA into their comments on the Draft Final BERA, indicating that the Draft Final BERA fails to address many of the previous comments.	EPA has considered all of the comments supplied to EPA from ARCO, some of which were incorporated into the Final BERA and some of which are addressed below.
3	13	The Draft Final BERA does not adequately differentiate between risks posed by chemicals of concern and other stressors, which should be evaluated more quantitatively. Site soil pH levels could be compared to levels expected to result in direct phytotoxicity; statistical correlations could be developed between areas of potentially stressed vegetation and COCs, and soil parameters and characteristics. It may be useful to use multi-factorial statistical procedures to discern effects associated with COCs vs. other factors. The Draft Final BERA also fails to provide a methodology for weighting, comparing, and reconciling multiple lines of evidence.	See Table 5.1-4 of the BERA. Very few areas on the site actually have dramatically low pH. EPA addressed, to the extent possible. This comment is in contradiction to the Menzie-Cura comments.
7	1-1	EPA's approach to assessing risks to terrestrial vegetation, wildlife, and aquatic biota is critically flawed and not a valid basis for remedial decisions.	See responses in Sections I, IIB, C, D, E, F, G, III, IV, V, and VI.
7	1-2	The approach and conclusions of the BERA would not stand up to scientific peer review.	EPA welcomes any type of reasonable peer review proposed by ARCO.
5	2	The (phytotoxicity) data on which EPA relied has failed to establish that an actual or potential threat exists at the site, per EPA guidance.	EPA wholly disagrees with this statement (see responses in Sections I and IIB).
7	1-1	The BERA does not evaluate or characterize ecological risk, and does not follow EPA guidance for ecological risk assessments.	See responses in Sections I, III, IV, and V, and Appendix B of the ROD.

Doc. No.	Page	Comment	Response Notes
7	1-5	The BERA's calculation of HQs by comparing the site COC concentrations and effects thresholds, as a measure of risk w/o further evaluation, is inconsistent with EPA guidance.	See responses in Sections I, IIB, C, E, G, III, IV, and V, and Appendix B of the ROD.
Issue: The BERA is a Screening Level Assessment			
3	2	In reviewing EPA's 1996 guidance, ARCO finds the Draft Final BERA to be a screening level assessment, and therefore inadequate to support remedial decisions.	See response in Section V.
3	3	The Draft Final BERA relies on screening level criteria to characterize risks to fish, wildlife, and habitats. Additional lines of evidence should be incorporated into the risk characterization as part of a weight-of-evidence approach. The weight-of-evidence approach in the Draft Final BERA is limited to selecting effects concentrations from multiple literature sources and studies. Per EPA guidance, a weight-of-evidence approach will require that different types of data are evaluated together, such as toxicity test results, assessments of existing impacts onsite, or risk calculations comparing estimated doses with toxicity values from the literature. The strength of evidence from the different studies, and the precedence that one type of study has over another, should have been determined prior to the assessment to avoid bias. The BERA should reconcile the results of the measurement endpoints associated with each assessment endpoint using a clear and consistent methodology.	EPA concurs that a weight-of-evidence approach can include a triad approach addressing toxicity test results, literature values, and field surveys. EPA guidance (EPA 1997) lists the type of lines of evidence that can be used, but does not state that they are "required". A thorough review of EPA documents from the screening level ERA through the 1995 sampling program and the BERA will demonstrate that multiple lines of evidence, coupled with a field-truthing mapping exercise, were selected and used (some in response to ARCO's requests), in the characterization of risks. Literature reviews, toxicity assays, animal demographic studies, plant community data and chemical determination from several sources listed below were incorporated into a weight-of-evidence evaluation. Literature Review: CH2M Hill (East Helena). These reports reviewed the value and applicability of individual studies and were applied in the BERA. Site toxicity assays: MNRDP Assessment, STARS and ARTS. Field Demographics: Historic Mining company work: Richmond and Sjogerund (1972); Olsen and Elliot surveys; Eliason (1958-1962); Natural Resources Council. LANDSAT photos: ARCO and State; Regional Soils RI (1995); NRDA survey; numerous theses. Chemistry: RI; EPA 1995 survey; ARTS and STARS; NRDA collection.
7	1-1	The BERA draws conclusions based on screening risk assessment tools that report potential or possible risk, and adds more screening assessments which should have been used to establish a stable risk hypotheses based on site data and to evaluate stressor-response gradients.	See above and response in Section V.
7	1-1	Weight-of-evidence is claimed to have been used, but is not.	See above.

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7	1-3	The BERA is a screening level assessment of theoretical risk that is not consistent with EPA's risk assessment guidance. The BERA has not: - evaluated which of the possible stressors is most responsible for observed effects on the vegetation; - evaluated relevant risk hypotheses with site-specific data; - established stressor-response relationships; and - assessed risks beyond a screening level. ARCO states that evaluation of the site-specific risk hypothesis indicates stressor levels are not correlated with measures of effects, and no stressor-response gradient is identified using relevant site data. The hypothesis that risks are not occurring is supported.	See responses in Sections I, II, and V.
7	1-3	Risks in the BERA are based on screening level assessment findings, and no ecologically sound weight-of-evidence approach is used. Instead of questioning the assumptions in the screening assessment tools used, site-specific data are discounted or ignored by EPA when they contradict screening risk characterization results.	See responses in Sections II, III, and V, and Appendix B of the ROD.
7	1-4	All risk assessment documents for Anaconda focused on theoretical risk through refinement of screening tools.	See response in Section V.
7	1-10	With proper problem formulation, the results of the (screening) phytotoxicity assessment could have been rigorously tested with field experiments.	EPA concurs and proposes that ARCO complete such a study. As it stands, EPA stands by the assertion that metals phytotoxicity is occurring, based on the large amount of current and historic data available.
7	1-17	EPA presents only a screening risk evaluation for wildlife risk from metals and arsenic in surface soil, water, and forage. Several of these screening tools have limited value compared with a more appropriate use of site-specific data.	EPA agrees, as clearly stated on page A10-4 of the BERA. See Appendix B of the ROD for proposal for continued biomonitoring.
7	1-17	EPA fails to consider the likelihood of wildlife exposures in their screening estimates of risk.	The analysis is designed to predict the most pertinent pathways to complete biomonitoring, and as such, this variable was not a focus.
7	1-18	EPA has assembled a set of four unrelated, disintegrated screening assessments of possible wildlife risk (bullets on page 1-18).	See Appendix B of the ROD.
Issue: Soils Data Used			
2	5	ARCO provides example text for expanding the discussion on soil sampling method.	ARCO's description of collection technique is accurate. A complete description of the soils collection is in the SAP which references a SOP. There were no significant alterations in the techniques described in the SOP.

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6	7	Some kriged soil concentrations are highly uncertain, in that the mean error for copper and zinc at the site are large. These values should be given less weight in determining phytotoxicity zones or areas of concern at the Anaconda Site.	It is important to note that kriging was completed by ARCO to estimate areas of residential cleanup. EPA recognizes that kriged soil results are only estimates, but to date, this is the most comprehensive and best available information for site-wide characterization. Therefore, in both human health and ecological health RODs and remediation plans, confirmatory sampling will be done .
7	1-19	The geometric mean soil concentrations in Table 3-5, from which daily doses are calculated and compared with TRVs to estimate the hazard quotient listed in Table 3-8, are not the same as the geometric mean soil concentrations shown on Table 3-9. The protective soil concentrations are miscalculated. Finding this sort of obvious yet important error calls into question how exactly risks were calculated and quality was assured in this document.	This was not an error. The soil concentrations in Table 3-5 were those that were used in the PBERA. The soil concentrations in Table 3-9 were obtained for use in the BERA, and included updated soil data. If the PBERA geometric mean soil calculations were used instead for Table 3-9, arsenic values would not change, and protective soil values for cadmium, copper, lead, and zinc would be higher by a maximum of 65 ppm, 1400 ppm, 500 ppm, and 1100 ppm, respectively.
7	1-23	Without a proper citation for the regional background soil data set, the representativeness of the data is questionable.	ARCO is correct. The citation is ESE 1996. Anaconda Regional Water and Waste Operable Unit Final Draft Remedial Investigation Report. Prepared for ARCO, Anaconda, Montana. September.
Issue: Assessment Endpoints (focusing the assessment on vegetation and habitat)			
7	1-5	Site data show that assessment endpoints and management goals are not being significantly impacted by site contaminants. Overly-conservative methods are used to estimate "risk", and ecologically more relevant site data are ignored.	EPA disagrees that site data show that assessment endpoints and management goals are not being significantly impacted by site contaminants. See responses in Sections IIA, B, and C, and Appendix B of the ROD. It is not a unique practice in risk assessment to use conservative assumptions in the absence of site data. If the question is important enough to get site data, it is completed. In the Proposed Plan, chronic risks to aquatic species is not considered to be at a level to warrant remedial action, and therefore, these conservative values in the risk assessment have little impact in the Proposed Plan.
7	1-17	Potential risks to other aquatic systems that may act as a conveyance of storm water, such as the drainage ditches, are not trout habitat and are not directly relevant to the management goals and assessment endpoints.	EPA recognizes that these conveyances such as the Blue Lagoon, Slag Gulch, and Nazar Gulch are not trout fisheries. These resources were looked at as wetlands environment and are not being addressed in remedial planning as a trout fishery. In section 5.2.8 of the risk characterization, the AWQCs are focused towards the protection of aquatic life, not only trout. Furthermore, as noted in the PBERA on page 215: "An adult stage trout fishery at this site is considered protective when metals in surface water and sediments do not cause adverse effects on adult trout or their prey."
Issue: Development and Use of TRVs (General)			
3	3	Literature-based threshold concentrations should be developed for each individual contaminant for each group of potential receptors.	In the Final BERA, ECs were developed for individual contaminants for each group of potential receptors.

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3	4	Many of the ECs used in the Draft Final BERA contain a high degree of uncertainty and may result in significant overestimates of risk. Some of the ECs are based on the protection of human health, rather than ecological receptors. Others were developed from toxicological studies using agronomic plants or livestock. Further, the Draft Final BERA does not consider other toxicological benchmarks that are readily available from the scientific literature.	In the Final BERA, several steps were taken to reduce uncertainty. Several sources of information were incorporated for EC consideration including: sediment ECs from Ingersol et al. (1996) which included Clark Fork River sediments; surface water ECs which included WERs for site-specific consideration; and wildlife TRVs proposed by ENSR toxicologists Frank Vertucci and Heidi Tillquist which were incorporated into the BERA. Furthermore, uncertainty in the ECs was reduced by conducting a ground-truthing field survey to observe actual effects in the field. This resulted in the identification of areas most likely to demonstrate phytotoxicity based on numerous lines of evidence. The site survey was particularly important since it allowed the consideration of mitigating site-specific physical parameters that may result in reduced phytotoxic effects, in spite of elevated soil metals levels. Had we relied only on literature data regarding phytotoxic levels in soil, the NOAEL value that would have been used for each of the COCs would have been much lower, resulting in a much larger area of risk to terrestrial receptors. This illustrates that EC values may have just as easily underestimated risk. For example, ECs for phytotoxicity are effect concentrations and NOT illustrative of no effects. The EC values selected fall within the less conservative range of phytotoxicity values extracted from the literature for a variety of species, including agricultural as well as native plant species. Additionally, VAs of concern for metals phytotoxicity were identified from the high ECs. In lieu of considering site-specific mitigating factors, a conservative reasonable maximum exposure scenario could be used to develop the terrestrial ECs, and the resultant area of terrestrial risk recalculated. EPA also expended a considerable effort to summarize uncertainties and their likely affect on the over- or underestimation of risk in Table 5.5-1. See response in Section IIB.
Issue: Development and Use of TRVs (Sediment)			
1	4	It is a misrepresentation that ECs for sediment could be construed as "national media quality criteria". Further, the NOAA values are of questionable relevance to the freshwater creeks in the Anaconda area.	The language in the Final BERA was edited to remove statements that ECs for sediment represent national media quality criteria. EPA agrees with the limited usefulness of NOAA sediment guideline values, and they were no longer considered as sediment ECs in the Final BERA. To evaluate other information in a weight-of-evidence approach, and to provide information regarding a full range of potential effects, several other studies were considered in the development of sediment ECs for the Final BERA, including Ontario sediment guidelines, sediment effects concentrations developed by Ingersoll et al., (1996), and regional sediment and benthos studies conducted by Essig and Moore (1992) and McGuire (1996).
3	9	The Ontario sediment guidelines may simply reflect statistical variation within environmental data, rather than true effect levels, and should not be used for judging risks.	The Ontario values were considered, along with other sources of sediment toxicity data (see above) to provide information on the range of potential effects in assessing the potential for risks to aquatic receptors. In the final assessment of risks, however, site-specific data were used to assess risks, and the Ontario guidelines were not.

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3	10	All of the studies used to develop the sediment ECs are based on bulk concentrations. Studies have shown that toxicity of divalent metals in sediments cannot be predicted from bulk sediment concentrations, but rather from the available fraction in pore water. This fraction can be predicted using Acid Volatile Sulfides (AVS) and Simultaneously Extracted Metals (SEM) measurements.	EPA recognizes the utility of AVS and SEM measurements, but at this point, such measurements are not needed. EPA does not consider metals in sediments of Anaconda streams to be major risk drivers, and therefore, further data collection is not merited.
2	11	The use of sediment ECs in the ERAs should be tempered by a critical evaluation of their differences and an understanding of the limitations of their appropriate uses.	These uncertainties are discussed in the PBERA, PBERA Supplement, and in the Final BERA in the appropriate references of respective ECs.
Issue: Development and Use of TRVs (Surface Water)			
1	4	It is unclear whether 1994 or 1995 data were used for the WERs for copper. ENSR's final results (end of 1995) differ, and should be used in recalculation of WERs. The geometric mean for each creek should be calculated and applied consistently throughout each creek.	In the Final BERA, the source for WERs was 1994 and 1995 data was used as reported in ENSR 1996, Phase 3 WER Program.
3	6	The water quality ECs exclude important site-specific toxicity information, namely, WER data.	In the Final BERA, site-specific toxicity data (WERs) were used to develop a range of potential aquatic surface water impacts to biota. See page 4-4 (Section 4.3.4) and Appendix A of the Final BERA.
1	5	CDM Federal used the incorrect method for developing dissolved AWQC from the total recoverable AWQC. All figures and text discussions will need to be revised.	Corrections were made using an updated method in the Final BERA, based on the Federal Register May 4, 1995.
1	6	Use of an avoidance behavior test for trout to evaluate chronic effects is highly questionable.	The use of avoidance behavior was not used in the Final BERA in the evaluation of chronic toxicity in fish, but rather AWQCs and WERs were considered.
2	11	Avoidance behavior test for trout is a poor indicator of chronic toxicity. Acute and Chronic ECs for aquatic receptors are not included in Appendix A of the Supplement.	The use of avoidance behavior was not used in the Final BERA in the evaluation of chronic toxicity in fish, but rather AWQCs and WERs were considered.
3	9	The Draft Final BERA should not use avoidance behavior data to judge ecological risks.	The use of avoidance behavior was not used in the Final BERA in the evaluation of chronic toxicity in fish, but rather AWQCs and WERs were considered.
2	12	ARCO disagrees with the assertion that the use of total recoverable method is warranted, and requests a citation for the statement that in some situations, dissolved may underestimate the effective concentration (contradicts EPA guidance).	When data are available to assess dietary exposure, then it is more appropriate to use the dissolved rather than the total recoverable method, in general. When dietary exposure data are not available, the dissolved method alone does not account for all exposure pathways. Therefore, it is conservatively assumed that the use of the total recoverable method is useful in covering most routed of exposure for metals.
Issue: Development and Use of TRVs (Vegetation)			
2	5	Some of the phytotoxic concentrations reported represent more bioavailable forms than others. The phytotoxicity thresholds are not "known" if they fail to address the degree of bioavailability.	This comment is without relevance to EPA's risk assessment. In the PBERA Supplement, this section was a summary of the opinions of those authors and it would be inappropriate for EPA authors (even if EPA would disagree) to misrepresent the opinions of the authors in the a summary text of studies completed on site.

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3	5	Both the high and low range of soil ECs for plants are highly uncertain and may be overly protective of native species. For each COC, the true non-toxic level for the test species used could be considerably greater.	EPA does not agree that these ECs are highly overprotective. Although there are areas with higher soil concentrations that support vegetation, there are also several areas with similar soil levels and no vegetation. Therefore, although the ECs may not be highly predictive, they are more than reasonable for use with the CPSA model to identify vegetation areas most at risk. It is the assertion of the EPA that although the true toxic levels for plants may be greater, they may also be considerably lower for some species. Studies done at MSU with 4 native grasses and arsenic indicate effects levels well within the range of low and high ECs used in the Final BERA. In Appendix 3 of the Final BERA, the low and high ECs for vegetation are illustrated and one should note that they represent a large range of endpoints, soil characteristics, and exposure mechanisms. Therefore, EPA feels that vegetation ECs are both comprehensively and reasonably conservative, and representative of both literature- and site-specific values. See response in Section IIB.
3	6	The zones of phytotoxicity in the Draft Final BERA do not appear to correlate with potentially impacted or stressed areas. The BERA should provide phytotoxicity values based on studies with site soils, or soils with similar properties, native plants of concern, and controls to account for various soil conditions.	For the purposes of this assessment, to identify the areas most at risk from metals concentrations in soil, the phytotoxicity zones do generally agree with areas identified as impacted and are imminently useful in identifying those areas where remediation should be focused. It was never the intent of this assessment to use point-by-point evaluations on the ground to compare to ECs and draw specific conclusions regarding risk at any given point. Rather, this assessment was intended as a tool to identify areas for potential remediation, and is quite applicable for that purpose. Reasons why the phytotoxicity zones don't specifically relate to impact areas in all cases have to do with the large size of the site, the spatial scale and abundance of sampling data used for kriging, and that other site-specific factors appear to be positively affecting plant growth in many cases. EPA used a comprehensive approach to attempt to tease out major factors effecting plant growth in each major study area. It is worth reiterating that the Final BERA did use studies with site soils from the NRDA investigations for designating ECs and did consider multiple species through the East Helena studies. Also see responses in Sections IIB and D.
5	2	The Draft Final BERA concludes that the phytotoxic benchmarks are "poor predictors of vegetation conditions." As such, they cannot form the basis for identifying soil metals levels as a threat to plants or to justify remediation where metals levels exceed benchmarks.	By themselves, the phytotoxic ECs are not necessarily indicative of vegetation condition, but they are potential indicators of phytotoxicity. Vegetation condition and phytotoxicity may be two entirely different things. EPA disagrees that ECs cannot be used to identify areas of potential phytotoxic threat and it is not EPA's position that these values be used as remedial goals. See response in Section II.
3	6	ARCO challenges the development of high phytotoxicity values from tests done with agronomic species, but further states that available data for native species were conducted in sand, and that these data would not be representative of site soils or bioavailability.	EPA agrees that the development of phytotoxicity ECs from studies based on agronomic species may not be representative of native species. However, ARCO has presented no evidence to suggest that native species are more tolerant to soil metals than agricultural species. On the contrary, a review of the literature values presented on tables in Appendix 7 of the BERA show that for many native species grown in soil other than sand, effects levels (i.e., LOAELs) are within the range of phytotoxicity ECs presented in the BERA, and in many cases, below those values.

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6	6-7	The NRDA phytotoxicity study was not designed to yield benchmark or threshold values, and had no concentration ranges or dilutions of native soil. The true nontoxic levels could be considerably greater. The tests exposed plants to mixtures of metals, and it is inappropriate to designate phytotoxicity zones by the exceedance of the soil EC for one metal. Toxicity ranges based on agricultural species are not appropriate to use for developing soil ECs for native plants or perennials used in reclamation. The development of soil ECs does not account for variable effects of other factors besides soil COCs.	EPA recognizes this fact and that is why we put them in context with literature values. EPA does not believe that true phytotoxic levels are considerably higher, and the literature review demonstrates that true nontoxic values may be lower. See above response and response in Section IIB. EPA recognizes this fact and that is why we put them in context with literature values of single chemicals. High ECs were reflective of individual metals and plants. Phytotoxicity Zone 4 was comprised of areas in which all metals concentrations exceed the high phytotoxicity values. EPA is not aware of documentation that describes agricultural species being much more or less sensitive to native species. The use of literature in which agronomic species were used is a useful tool for developing ECs. Both agronomic and native species (e.g., silver sage brush, western wheat grass, bermuda grass, tall fescue) were used in the East Helena studies in the development of the literature ECs. Also see response to comment on Document No. 3, pg. 6. Per a conference call with CDM Federal, EPA, and Larry Kapustka, the BERA text was modified to provide clear language regarding EPA's approach of using multiple sources of data, coupled with site-specific surveys and evaluation of additional mitigating factors, to set response ranges in the BERA. It should be further noted that EPA guidance (EPA 1997) supports the use of professional judgement and latitude regarding exposure and effects assumptions and the incorporation of site-specific data. Had EPA relied solely on literature values, and not considered site-specific conditions, a much larger geographic area of risk would have been designated.
5	28	The Draft Final BERA benchmarks are poor predictors of vegetation conditions.	See response in Section II.
6	5	Soil pH is not adequately considered in the development of soil ECs. The cutoff of pH levels greater than 6.5 to be effective in reducing bioavailability of metals to plants should be further researched, and incorporate dose-response studies. Also, using pH 6.5 as the cutoff value for soil ECs contradicts the classifications used in the CPSA model, which used categories based on soil pH less than or greater than 5.0.	EPA acknowledges pH as a primary influence on bioavailability and agrees that more dose-response data could be helpful. However, changes in the "critical" value of pH would only slightly alter areas identified as phytotoxic concern and not change the overall conclusions. See response in Section IIE. The pH value of 5.0 is classified by rangeland biologists as a value of concern for general rangeland species in areas not athropogenically influenced with metals (Table 5.1-7). Furthermore, EPA notes that if a pH of 6.5, instead of 5.0, were used in the BERA, pH would have been predicted to have less of an influence on phytotoxicity; again, this would only slightly alter areas identified as a phytotoxic concern and not change the overall conclusions.

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7	1-6	ARCO presents graphs showing that Zones 2 and 3 classified sites that span a wide range of hazard values, indicating the insensitivity of this scheme. They also claim lack of correlation between phytotoxicity zones and peak standing crop, as measured by EPA.	ENSR toxicologists erroneously presented the information to draw conclusions of lack of stressor-response for several reasons: 1) The toxicologists misassigned independent and dependent variables; 2) the presentation is of a screening level of which EPA acknowledges no clear dose-response relationship, and therefore, used the CPSA model to more comprehensively evaluate impacts by metals versus impacts of other stressors; 3) the ENSR analysis includes data points from VAs where it has been acknowledged by EPA that there is no phytotoxic risk. Because of the basic and fundamental errors presented by ENSR toxicologists, it is inconceivable how the investigators can draw conclusions of clear evidence of stressor-response relationships.
7	1-8	By their literature review, EPA should have determined which of the stressors has a steeper dose-response phytotoxicity threshold.	ENSR toxicologists site EPA ERA guidelines as published in 1995 with "Hills" epidemiological approach to draw this conclusion. EPA points out to ENSR that guidelines are not program-specific and are not analogous to EPA guidance as cited by ENSR. For the BERA, the 1997 ERAGS *guidance* was applied.
3	12	The Draft Final BERA relies upon plant ECs which are based on the protection of either livestock or human health. More appropriate values can be found in the scientific literature (i.e., the evaluation of risk to herbivores compares plant tissue concentrations to literature regarding mineral tolerances of domestic mammals, some which are designed to protect humans consuming the meat.) Further, the ingestion rates, metabolic processes, detox mechanisms, and other physiological parameters of test species are expected to differ from those of site wildlife. Recommend using ORNL benchmark values.	EPA agrees that benchmarks for wildlife would be more appropriate if based on wildlife rather than domestic animals. Therefore, EPA has reviewed literature and developed ECs that incorporate the techniques presented by Opresko to develop ingestion rates for water and food, but more formally incorporated uncertainty factors for the development of toxicity reference values as per the proposal from ENSR toxicologists Frank Vertucci and Heidi Tillquist.
Issue: Development and Use of TRVs (Wildlife)			
2	11	Use of livestock water quality criteria is questionable, and relevance to wildlife unsubstantiated.	It is a common practice in ecological risk assessment to base the assessment of risks to an organism on the use of toxicological thresholds from surrogate species. However, in the Final BERA, wildlife-specific TRVs were developed.
2	12	Further, water quality criteria for the protection of livestock are no longer provided by the province of Ontario. Similar Canadian water quality criteria for livestock watering include a higher value for arsenic, and none of the measured total arsenic concentration in Willow Creek exceeded this value.	In the Final BERA, wildlife-specific TRVs were developed and arsenic ECs did increase, but, as such, was still a concern in some water bodies.
3	11	The drinking water ECs are highly uncertain since they are based on livestock and poultry and not wildlife. The BERA should incorporate readily-available toxicological benchmarks. Recommend using ORNL benchmark values.	In the Final BERA, wildlife-specific TRVs were developed and arsenic ECs did increase, but, as such, was still a concern in some water bodies. EPA disagrees that "readily-available toxicological benchmarks" justifies values as being technically correct. After doing a more extensive review of toxicological literature, EPA developed more defensible values for the Final BERA.
7	1-23	Wildlife TRVs presented in Appendices 3 and 10 were substantially different. Because the uncertainty factors in Appendix 10 are conservatively biased, they were intended to be overly protective. This can be useful as a screening tool.	EPA agrees the overall approach is generally conservative but NOT overly protective. Most extrapolations have total uncertainty factors <5 and almost all are <10. The most uncertain of TRVs are the arsenic values which have the least toxicity information. EPA will require more biomonitoring during RD/RA to address this uncertainty and either confirm or contrast modeled predictions.
Issue: Food Chain Model			

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7	1-20	The model is highly uncertain, and uses questionable BAFs derived from "site" and literature data. The plant BAF is based on four collocated plant and soil samples collected along Warm Springs Creek, and are not representative of the site. The data set collected by EPA in 1995 is not used to establish soil to vegetation BAFs.	A comparison of plant BAFs used at other Montana Superfund sites shows that the values proposed in the BERA were lower by one to two orders of magnitude, for example, that those developed by ARCO for use at the Clark Fork River. Following ARCO's recommendation to use site-specific data, EPA recalculated BAFs using the 1995 Survey data. It must be clarified here, however, that the BAF represents total metals to evaluate exposures to herbivores eating the plants. These BAFs were calculated from plants that were not washed.
7	1-21	ARCO presents graphs showing site data vs. surface soil concentrations and the white tail deer LOAEL to show the magnitude and duration of exceedances.	ENSR toxicologists presented confusing figures in graphs 12-16 with no documentation and erroneous data presentation, preventing an adequate response by EPA.
7	1-23	BAFs do not account for the well-known relationship between the variation in bioregulated metal uptake as a function of soil concentration, and the assimilation of COCs by receptors is assumed to be 100%. Site data on gut contents versus feces could have been collected by EPA to determine the percentage of assimilation for each metal. By relying exclusively on screening assessment tools, EPA has not advanced the assessment beyond the screening level.	As presented in Appendix B of the ROD, for the re-evaluation of the food chain model, plant BAFs were recalculated using EPA's 1995 Survey data while small mammal and invertebrate BAFs were adapted from those suggested by ARCO for use at another Superfund site in Montana. Where statistical analyses indicated variability in uptake, the appropriate regression equation was used for the BAF based on the soil concentration. If uptake did not appear to be variable, the mean BAF was used. EPA disagrees that such a crude level of investigation would truly answer the question of bioavailability, and believes much more sophisticated investigative techniques would be required. For example, true control animals would have to be obtained and administered a known dose; mass balance distribution of metals throughout blood, tissues, urine and feces would then have to be calculated. Studies to this level of specificity are not required to make remedial action decisions, but will ultimately be addressed in the biomonitoring program.
Issue: Assessment of Risks to Vegetation (General)			
2	3	CDM Federal has made a good faith effort to incorporate existing data, and the effort will be more comprehensive in the BERA using the recently completed data compilation by PTI. However, use care in comparing data collected using different methods or over different areas to conditions in specific VAs.	Data collected using different methods were not used in a quantitative way. It is worth noting here that as early on as the PBERA, ARCO recognized EPA's efforts to use site-specific data which continued and was expanded upon in later drafts. However, one of the most recent ARCO reviewers (ENSR) suggested that little site-specific data was used and represents an inconsistent position taken by different contractors for ARCO and complicates EPA's ability to respond in a consistent manner to the PRP, ARCO.
2	3	Discussions of the ERA for Streamside Tailings should focus on data and conclusions specific to the reach of Silver Bow Creek within the ARWW&S OU, since that reach is significantly different from upstream reaches in tailings and vegetation distribution.	EPA recognizes that Streamside Tailings conditions are different from Anaconda riparian areas, and were therefore not extrapolated.

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2	3	Plant community effects levels should be discussed as a method of screening soil phytotoxicity in riparian areas, since these were developed using a regional data set.	EPA agrees that the PCEL information presented by ARCO in PTI's report is a valid analysis in terms of the riparian areas of Anaconda. PCEL quantification was not done, however, soil data from the PTI report was used to compare concentrations with EPA phytotoxic ECs and in the Final BERA, the results of the PCEL were qualitatively discussed. Page ES-20 of the Final BERA states: "In addition, diverse and productive plant communities are found within the portions of the riparian areas identified as potentially at risk to phytotoxic effects of COCs in soils and are believed to be the result of the positive effects caused by other soil physicochemical attributes such as high soil moisture content, organic content, and plant available nutrients". In effect, EPA's CPSA model validated PTI PCEL models in that metals and pH affect biomass and taxa richness. Also see responses in Sections IIC and E.
2	8	ARCO disagrees with EPA's interpretation of Keammerer's conclusions regarding plant growth on Mount Haggin.	EPA did not interpret Keammerer's conclusions, rather, raw data was evaluated and it was concluded that metals, low pH, and organic matter content could potentially impact plant growth.
2	9	The area east of the airport becomes more mesic, vs. more xeric, as stated in the PBERA Supplement.	Comment noted and concurred.
2	10	ARCO disagrees that soil compositing from 0-12 inches would dilute the exposure of metals from surficial soils. They point out that data from surface vs. rooting zone samples should be applied to different aspects of plant phytotoxicity. Further claim that elevated metals or low pH near the surface may not deter reproduction and success of all but shallowly rooted grasses and forbs.	Long-standing plant growth may be evaluated by 0-12 inch samples, however, to assess phytotoxicity in terms of seed germination, growth, and establishment, the 0-2 inch samples are most pertinent to reproductive parameters. EPA agrees that deep-rooted species will not necessarily be affected by surface soil contamination. ARCO's observation is consistent with EPA's conclusion, that sexually reproducing plants have limited establishment because of surface soil contamination, while well established plants may reproduce vegetatively in spite of surface contamination.
2	12	Additional data from ARCO regarding vegetation condition on north- and south-facing slopes and the southeast corner on the dikes of Anaconda Ponds should be included in the analysis.	EPA notes and agrees with ARCO that during the PBERA, data from other reclaimed areas were not identified and discussed. However, these areas help support the conclusions in the Final BERA that vegetation can exist in areas only with extreme restoration modifications to soils with pH and lowered bioavailability of metals. Future biomonitoring programs will include these reclaimed areas.
2	12	ARCO's evaluation of long-term vegetation monitoring and ARTS plots on Smelter Hill should be included in the analysis.	EPA notes and agrees with ARCO that during the PBERA, data from other reclaimed areas were not identified and discussed. However, these areas help support the conclusions in the Final BERA that vegetation can exist in areas only with extreme restoration modifications to soils with pH and lowered bioavailability of metals. Future biomonitoring programs will include these reclaimed areas.
5	vi	The bioavailability of arsenic and metals is not addressed in the Draft Final BERA.	Bioavailability is addressed indirectly as a function of ECs noted in the East Helena studies and their inherent reflection of levels of available metals exposed to plants. EPA recognized that this was not site-specific, and therefore included dosing studies conducted by state NRDA teams with Anaconda soils in an attempt to recognize factors on the site affecting bioavailability.

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7	1-11	Dialog between the risk manager and the risk assessor should have resulted in the development of more appropriate risk assessment questions under CERCLA, particularly in reference to recovery rates.	In the past, and currently, dialog with risk managers and risk assessors did occur and is occurring between EPA, EPA contractors, and ARCO managers and scientists. EPA has recognized that areas under natural recovery need to be considered. Some of the questions raised by ENSR toxicologists will need to be addressed during the biomonitoring program currently under development with ARCO input. Furthermore, this is yet another example how multiple contractors from ARCO have given inconsistent input for regulatory consideration.
6	7-8	Inappropriate soil depths were used (0-2 inches) in the State's phytotoxicity studies. Plants are exposed at greater depths, where concentrations are lower. Therefore, exposure to plants is overestimated.	EPA disagrees. The State's phytotoxicity tests were based on early seedling growth studies, conducted over a two week period, and evaluated germination, shoot height, root length, shoot mass, root mass, and total plant mass as endpoints. Germination and early seedling growth occur in surficial soil, not soil at greater depths. Also see response in Section IIA.
Issue: Assessment of Risks to Vegetation (Non-chemical Stressors)			
1	2	The PBERA does not discuss adverse effects of SO_2 emissions, logging practices, forest fires, and the resultant erosion of topsoil and subsoil as significant historical stressors. More attention should be given to the possible effects of these stressors so that impacts are not confused with potential impacts from metals in soil.	A discussion of other non-chemical stressors was included in the PBERA, the PBERA Supplement, the Draft Final BERA, and the Final BERA. Most of this discussion was based on information gathered in 1995 to fill these data gaps in response to ARCO concerns. See responses in Sections IIC, E, and G.
1	8	ARCO disagrees with the use of the 20-year-old Olson-Elliott map (completed when the smelter was in operation) of stressed vegetation likely due to SO_2 emissions.	The Olson-Elliot map was completed with data 30 years after peak SO_2 emissions (as noted in ENSR comments to EPA in January 1998) and used as weight-of-evidence that the area has not improved dramatically after nearly 20 years following the end of sulfate emissions. It could be argued that this information, in fact, supports the hypothesis that although SO_2 emissions may have initially devegetated the landscape, high metals concentrations may still be limiting germination and establishment.
1	9	Discussion of non-chemical stressors in PBERA is inadequate, and should not be deferred until evaluation of remedial alternatives.	EPA agrees with ARCO, and therefore, greater discussion of other non-chemical stressors was included in the PBERA Supplement, the Draft Final BERA, and the Final BERA. Most of this discussion was based on information gathered in 1995 to fill these data gaps in response to ARCO concerns. Also see responses in Sections IIC, E, and G.
1	9	In the discussion of historical, non-chemical stressors, there is no discussion in the PBERA of many years of SO_2 emissions and resultant soil erosion, or that this is a data gap that could be addressed by reviewing historical data on vegetative effects.	In the Final BERA, EPA did consider other factors having an adverse effect on plants and identified those factors having the major influence on plant growth (see BERA Table 5.1-6). Also see responses in Sections IIC, E, and G.
6	3	Non-COC parameters that contribute to plant stress, such as soil and landscape characteristics, should have been semi-quantitatively evaluated.	EPA disagrees. Both a quantitative (soil ECs) and semi-quantitative (CPSA model) approach was taken to an appropriate level of scientific inquiry with available techniques. Effects from soil erosion resulting from several historical factors were semiquantitatively analyzed in the CPSA model (see Table 5.1-6) by including endpoints of top soil estimates, percent organic matter, etc. Also see responses in Sections IIC, E, and G.

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6	3	pH affects bioavailability of the COCs, and hence, affects the toxicity of metals in soils. Soil pH is inadequately characterized in the BERA, and confounding results of pH studies are not considered in analysis of phytotoxicity.	In the Final BERA, EPA considered pH levels, along with other factors, in the assessment of vegetative risks. It is important to note that Dr. Menzie is uncertain about kriged estimates of pH. However, EPA used co-located measured values of pH and metals concentrations. More intensive collection of both metals concentrations and pH data is necessary to more adequately impact remedial decisions. Furthermore, most of the VAs quantified with vegetative stress were neutral to basic pH. See response in Section IIE.
2	8	ARCO requests mention of the use of broadleaf herbicides to control knapweed in the North Hills, and a discussion of grazing pressures.	Comment noted, and was addressed in Final BERA.
3	1	The assessment of risks to vegetation from metals in soil is confounded by previous operational conditions, physical disturbance, and poor soil conditions. Although the Draft Final BERA acknowledges the importance of these factors, it does not address them in a quantitative manner. Instead, the BERA presumes that risks are related to metals in soil, and proceeds to interpret observations and estimate risks on this basis.	In the Final BERA, EPA did consider other factors having an adverse effect on plants and identified those factors having the major influence on plant growth (see BERA Table 5.1-4). EPA disagrees that it is possible to address all these factors in a quantitative manner. Also see response in Section II.
5	ii	The Draft Final BERA concludes that vegetation conditions are due to phytotoxicity from metals in surface soil, based on analysis of spatial distribution of bulk metals in soil to areas of poor vegetation growth and bare ground. These spatial relationships are weak, and EPA failed to analyze relationships between other environmental factors and vegetation condition.	In the Final BERA, EPA did consider other factors having an adverse effect on plants and identified those factors having the major influence on plant growth (see BERA Table 5.1-4). EPA disagrees that it is possible to address all these factors in a quantitative manner. Also see response in Section II.
5	iii	ARCO's spatial analysis of the 1995 survey data shows that the BERA phytotoxic benchmarks are poor predictors of vegetation condition; bulk concentrations of metals are not correlated with vegetation condition; soil properties such as potassium, organic carbon content, topsoil condition, and cation exchange capacity correlate significantly with vegetation parameters; for some areas of the site, poor vegetation condition may reflect poor soil quality or grazing, rather than phytotoxicity; and in some areas, metals, poor soil moisture, and topsoil erosion coincide with poor vegetation quality.	These results are not unexpected since these parameters are some of the major soil factors that affect plant growth in general. As presented in the BERA, EPA believes that total vegetation canopy coverage and production (which are not appropriate indicators of plant community and habitat health) in some areas of the site are controlled primarily by soil factors other than COC concentrations. It should be noted that ARCO found significant and positive correlations between topsoil condition (which includes whether the topsoil has been eroded) and plant canopy coverage and production. This is important because the loss of topsoil from steeper areas of the ARWW&S OU is believed to have been caused, in part, by the elimination of vegetation through the deposition of smelter emissions. The resultant lack of topsoil, by itself, is a primary reason why some of these areas have not been able to recover floristically. The lack of topsoil continues to present a potential risk to the germination and growth of native seed from the surrounding areas. Elevated soil COC concentrations in these areas may also be contributing the stress of seedlings. This situation is acknowledged in detail in the BERA and is discussed above. Table 5.1-4 of the BERA indicates that soil COC concentrations are likely not having a negative influence of vegetation in VA2A (North Hills) and VA15 (East Hills).

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5	iii	(Continued from above)	(Continued from above) EPA acknowledges this situation in the BERA, but also believes that the soil COC concentrations in these areas are high enough to have a significant negative impact on the growth and development of the vegetation (see BERA Table 5.1-4). Each of these areas had soil COC concentrations that exceeded at least one of the high (liberal) phytotoxicity benchmark values; in some cases most of the high arsenic and metal benchmark values were exceeded (see BERA Table 5.1-5). Future biomonitoring with application of the LRES will be taking these factors into account with more spatially specific detail. Also see response in Section II.
5	2	Although the Draft Final BERA acknowledges the importance of environmental factors, other than metals, on plant growth and community structure, it does not address them quantitatively.	This comment is contradictory to comments by Dr. Menzie listed above that EPA did not recognize other environmental factors influencing plant growth and community structure.
5	29	Soil properties, such as potassium, organic carbon content, topsoil condition, and cation exchange capacity correlate significantly with vegetation parameters.	These results are not unexpected since these parameters are some of the most basic and major soil factors that affect plant growth in general. However, EPA does not recognize how this directly supports the hypothesis that metals are not having an effect because of the lack of a 2-dimensional correlation between vegetation communities and arsenic and metals.
5	29	For some areas of the site, poor vegetation condition is likely the result of poor soil quality and/or physical stressors, such as grazing.	EPA concurs that there are areas, such as the North Hills and East Hills, which have negative soil characteristics (other than metals) and physical stressors impacting vegetative growth and community structure, and as such, using the CPSA model, these areas have been removed as an area of concern for the remedial design.
5	29	In some VAs, metals, poor soil moisture, and topsoil erosion coincide with poor vegetation quality.	EPA concurs. In the CPSA, however, the relative impact of metals contamination was used to distinguish if vegetative stress was influenced by metals or other soil parameters.
5	9	ARCO's analysis of the 1995 field data indicate that soil quality is correlated with the vegetation condition at the site, and there is little evidence that a negative (i.e., phytotoxic) effect of soil metal concentration on the plant community exists.	These results are not unexpected since these parameters are some of the most basic and major soil factors that affect plant growth in general. However, EPA does not recognize how this directly supports the hypothesis that metals are not having an effect because of the lack of a 2-dimensional correlation between vegetation communities and arsenic and metals.
5	12	ARCO presents a series of tables providing their spatial comparison (by VA) of observed vegetation conditions of an area to the magnitude of chemical and non-chemical stressors, and the predictive ability of the soil ECs.	EPA agrees with the conclusion from these tables that using phytotoxic benchmarks alone are poor predictors of vegetative risk. However, EPA IS NOT basing remedial decisions solely based on phytotoxic benchmarks. Phytotoxicity benchmarks were used to provide a general indication of areas where soil concentrations may be high enough to be phytotoxic under most environmental conditions. However, because of the myriad of environmental factors influencing vegetation, an integrated (plant stress) analysis was subsequently performed in the BERA. This approach considered soil physicochemical and other environmental factors in identifying portions of the site most in need of remediation. Also see response in Section II.

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7	1-2	ARCO disagrees that current vegetation conditions are well-correlated with contaminant concentrations in soils, and claims little evidence that observed vegetation effects are caused by surface soil contaminants. ARCO further claims that EPA failed to fully consider the effects of SO_2 fumigation as a causative factor for soil conditions that influence vegetation condition and rate of recovery.	ARCO misconstrued EPA's use of the term "correlated". EPA acknowledges that no clear and significant statistical correlation occurs throughout the site between arsenic and metals and landscape level plant community effects. EPA has agreed that there are a *few* areas with high metals concentrations with decent vegetative health. However, ARCO reviewers should be reminded that *most* of the areas with high metals concentrations above the high phytotoxic benchmark are sparsely vegetated or barren. Furthermore, EPA is taking these considerations into full consideration during remedial design and in the use of the LRES. EPA does not argue that SO_2 did not significantly impact the local environment in the past, but is evaluating current effects at the site. Once SO_2 fumigation had stopped, ecological recovery would be expected to occur. Also, if SO_2 was the primary factor influencing current vegetation conditions, site soils would show reduced pH. In actuality, most site soils are within the range typically found in southwestern Montana. Also see response in Section IIG.
7	1-7	ARCO feels that we used a priori assumptions as to the stressors responsible for the effects, and that we did not evaluate all possible stressors. They remind us that EPA guidance states that risk management policy an risk assessment are to be kept distinct	EPA references ENSR toxicologists to the 1997 ERAGS Interim Final Guidance, pg. 1-9, Exhibit 1-2, which clearly delineates scientific management decision points to promote strong risk assessor and risk management communications. These communications occurred throughout the process. Again, EPA would like to point out the difference between non-program specific general *guidelines* for agency use that ENSR Toxicology cites and programmatic guidance used to develop the Final BERA. Also see response in Section II.
7	1-10	EPA fails to review the literature on the effects of smelters on vegetation, and the relative importance of SO_2 and metals effects was not evaluated. Rates of recovery at other sites could have been used to evaluate the likelihood that the hypothesized stressor has caused the observed effects.	EPA does not disagree that SO_2 emissions may have originally caused devegetation on the site. However, the assessment addresses current vegetative risk conditions in a weight-of-evidence approach with what is known about phytotoxic concentrations of metals in soils and the historic impacts to draw meaningful conclusions about risk. Also see response in Section II.
7	1-10	The BERA did not contrast the likelihood of exposure and effects from SO_2 with that of effects from surface soil metals. ARCO provides an example evaluation.	The Final BERA did not assess the loss of vegetation from past SO_2 emissions; it focuses on current stressors in the environment.
7	1-12	By focusing on whether the system is at risk from COCs in the soil, the approach is inappropriate since it doesn't answer the question of what caused the observed effects. While possible stressors are identified, their <u>likelihood</u> of causing the effects is not evaluated.	EPA disagrees with ARCO's fundamental approach that EPA is ***not*** to assess risks from COCs. The purpose of risk assessment under CERCLA is to identify contaminant sources, releases, pathways, receptors, and either observed or potential effects. The Final BERA has done just that. EPA has documented several times that there are other stressors which could have and are impacting vegetative health. It is the job of the RI/FS process to identify potential risks from COCs to receptors that occur and could occur on the site. The bulk of the phyto-toxicological literature strongly supports EPA's position that COC concentrations in soils are high enough to potentially cause phytotoxic effects. These ECs are from documents that have been peer reviewed (East Helena studies; CH2M Hill 1987a and b). These peer reviews are in the EPA Administrative Record and are therefore available for review. Furthermore, high phytotoxic concentrations (with the exception of cadmium) used in the BERA are more liberal than those used in the study.

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7	1-12	(Continued from above)	(Continued from above) The assessment addresses current vegetative risk conditions in a weight-of-evidence approach with what is known about phytotoxic concentrations of metals in soils and the historic impacts to draw meaningful conclusions about risk. See response in Section II and response to Document No. 5, pg. 12.
6	2	Provide detailed info regarding the CPSA and how it is used to identify areas of potential phytotoxicity due to COCs in soil or other factors. It appears that zones are defined by comparison of COCs to high and low soil ECs, w/o consideration of non-COC stressors. BERA relies on screening level criteria to characterize risks to habitats, and should incorporate additional lines of evidence as part of a weight-of-evidence approach.	EPA feels that the CPSA model was taken to the level of detail needed to identify general areas of phytotoxic concern. In the Remedial design process, more detailed information will be collected to make more detailed remedial decisions (LRES). See BERA Table 5.1.4 and response in Section IIC. This is yet another example of contradictory comments by ARCO contractors. Menzie-Cura acknowledges that new data was collected to address data gaps identifying non-COC stressors, while ENSR toxicologists state several times that the assessment is no more than a screening level assessment not addressing other potential stressors than the metals contaminated soils. An observant review of the Final BERA will demonstrate that non-COC stressors were adequately considered in the CPSA model. Furthermore, in the Remedial Design process, more detailed information will be collected to make more detailed remedial decisions (LRES) on nearly an acre-by-acre basis. EPA would request that ARCO identify the non-COC stressors not identified in the CPSA model (Table 5.1-6) and suggest methodology to satisfactorily quantitatively assess their relative impact. See responses in Sections I, II, and V.
6	2-3	There is insufficient rationale for basing quantitative risk estimates on soil concentrations of COCs, and there is no statistical analysis of correlation between the many stressors that may be affecting plant growth and health.	See responses in Sections IIC, D, E, and G.
6	5	Spatial variability in soil pH is not adequately characterized. Variability in pH must be analyzed to examine its role in phytotoxicity. Hand contouring of soil pH may not be sufficient to characterize the spatial variability of pH at the site. In addition, the BERA assumes that soils in upland areas are always equal to or less than pH 6.5. The BERA ignores site-specific data and overestimates phytotoxicity.	See responses in Sections IIA and E.
7	1-7	The BERA fails to describe historic emissions and probable effects of SO_2. ARCO provides a graph of estimated levels of emissions, and modeled estimates of areas of the site where historic concentrations exceeded thresholds of effects.	See response in Section IIG and response to Document No. 7, pg. 1-2.
7	1-7	Estimated and measured concentrations of SO_2 exceeded vegetation effects thresholds by orders of magnitude over large areas surrounding the smelter.	EPA agrees with this comment. See response in Section IIG and response to Document No. 7, pg. 2.

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7	1-7	The probability of acute and chronic effects to vegetation, given the duration and magnitude of SO_2 concentrations, is exceedingly high. Sensitive plant receptors were continuously fumigated by high concentrations of SO_2 for over 80 years, and the probability of exposure was 1.	See response in Section IIG and response to Document No. 7, pg. 2.
7	1-8	EPA should have evaluated if the pattern of widespread vegetation loss is more consistent with SO_2 effects or surface soil metals levels. The BERA should have applied an evaluation of Hill's factors (in Suter 1993) in assessing the likelihood that factors other than metals caused the observed effects on vegetation at the site. The pattern of historic SO_2 exposure and metals deposition are congruent, so patterns of specific effects of one may not be easily distinguished from the another.	EPA did evaluate the patterns of smelter emissions as part of the Site-Wide Fate and Transport of COCs as discussed in all phases of the BERA, Smelter Hill RI Report, Regional Soils RI Report and FS Deliverable #2. Historic emissions of SO_2 and metals do correlate. Current and future lingering physical soil effects from the SO_2 emissions are lowered pH. pH was measured and documented, and with the exception of areas directly around Smelter Hill and the tailings piles, pH was relatively neutral to basic. As stated numerous times above, EPA does not dispute that SO_2 fumigation could have had as strong, or stronger an influence on vegetation around Anaconda when compared to historic metal emissions. Phytotoxic ECs in the BERA were primarily focused on endpoints and on the ability of plants for reestablishment of vegetation communities (germination rates, root growth, etc). To that end, the question of what historically impacted the area is less of a concern for CERCLA action than as to what factors would be currently limiting the ability of plant species to reestablish themselves on the Anaconda site. Within the same book and chapter cited by ENSR toxicologists (Suter 1993), the author also uses Koch's postulates as another example of how to apply environmental epidemiology in ecorisk. Below are the four postulates followed by text, in which one could also argue quite strongly that metals are impacting vegetation on Anaconda: Koch's Postulate #1: The injury, dysfunction, or other putative effects of the toxicant must be regularly associated with exposure to the toxicant and any contributory causal factors. The author cites other scientists who have stated "consistent conjunction (between cause and effect) may be difficult to demonstrate because measurement error or variation in the way that individual units respond to exposure may obscure a true conjunction" Suter goes on to state that responses of communities and populations may not always be sensitive enough to truly state that no true dose-response relationships are occurring because of the variability of intra- and interspecific responses of members within communities. Such is the case, EPA believes, with data sets from Anaconda. We do however know that most areas of high metals contamination are populated with more metals-tolerant species as compared to areas which have less metals contamination. Koch's Postulate #2: Indicators of exposure to the toxicant must be found in the affected organisms: On Anaconda, elevated levels of arsenic and metals have been found as compared to reference sites.

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7	1-8	(Continued from above)	(Continued from above) Koch's Postulate #3: The toxic effects must be seen when normal organisms or communities are exposed to the toxicant under controlled conditions, and any contributory factors should contribute in the same way during the controlled exposures. On Anaconda, NRDA laboratory studies have indicated that contaminated site soils have effects on reproductive endpoints in plants dependent on pH and metals concentrations. Koch's Postulate #4: The same indicators of exposure and effects must be identified in the controlled exposures as in the field. On Anaconda, those species which are re-populating metals contaminated soils are rhizomatous species which reproduce vegetatively, below the relatively much more contaminated surface soils. EPA agrees, and because of this very point, the BERA focused on current and potential risks. Also, it is confusing that ENSR would assert, without reservation, in most of their text, that SO_2 exposures were the cause of vegetative loss while concurrently identifying the problem in making such a claim. In essence, where there was high SO_2 fumigation, there were also tons of metals released daily.
7	1-9	Surface soil metals concentrations do not explain the observed patterns of vegetation effects, and the absence of a dose response for soil metals is significant. The strength of spatial correlation between effects, metals in soil, and historic SO_2 should have been measured using GIS.	See response to document number 7, pg. 1-8. Also see response II. EPA encourages ARCO to pursue correlations with vegetative community endpoints with estimated releases of SO_2. Since ENSR has already successfully argued that historic SO_2 exposure and metals deposition are congruent so patterns of specific effects of one may not be easily distinguished from one another, it is anticipated that little correlation, if any, would be found.
7	1-9	EPA should have discussed the overall pattern and magnitude of effects, the impacts to deeply rooted long lived trees, pH effects on contaminant bioavailability, and inhibited recovery in acid soils.	See response to document number 7, pg. 1-8. Also see response in Section II.
7	1-9	The hypothesized cause is inconsistent with observed measures of effects.	See response to document number 7, pg. 1-8. Also see response in Section II.
7	1-10 to 1-11	The lack of correlation between measures of risk, phytotoxicity benchmarks, and plant abundance and cover is very important. There is no clear metals stressor response gradient relationship.	Since ENSR has already successfully argued that historic SO_2 exposure and metals deposition are congruent so patterns of specific effects of one may not be easily distinguished from one another, it is anticipated that little correlation, if any, would be found. Also see responses in Sections I and II.

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Issue: Assessment of Risks to Vegetation (1995 Sampling)			
2	6	ARCO disagrees with our statement that "The 1995 survey results are consistent with the State's data showing that spotted knapweed made up 27% of the plant cover on Smelter Hill". The State actually said that 27% of the sites on Smelter Hill were dominated by spotted knapweed.	What the State actually said was that spotted knapweed made up 27% of the total plant coverage on Smelter Hill. That is, the Smelter Hill plant community was composed of 27% spotted knapweed. The points being made on page 11 of the PBERA Supplement reflect an accurate representation of the plant communities on Smelter Hill, which are: 1) PTI's vegetation data was collected in 1988 and does not accurately represent current vegetation conditions on Smelter Hill. In 1988, spotted knapweed may not have invaded Smelter Hill or 1988 could have been a low production year for this biennial species. And 2) The State's and EPA's data are similar in that they show that Smelter Hill is generally dominated by weedy species such as spotted knapweed.
2	1	More detailed information is needed in the PBERA Supplement for the 1995 survey : site selection, soil sampling procedures, cover estimation, and determination of plant productivity.	Procedures for collecting and reducing vegetation and soil data are described in the sampling and analysis plan prepared by EPA. PTI provided detailed oversight of EPA vegetation procedures in the field; PTI field records will confirm that the procedures in the SAP were followed. Soil information and data were collected by PTI for ARCO.
2	1	In the discussion of the 1995 site survey, it should be discussed that sites were not randomly selected, and that detailed sampling information is available from only one or two sites within each VA. It is therefore impossible to determine if a site is representative of the entire VA. This is not a criticism, but a recognition of the limits of the study when comparing the data to other investigations.	During the survey, a reconnaissance of each VA was conducted by trained scientists who established transects using best professional judgement in areas that represented the major plant community. If major disparities in the vegetation within a VA were observed, more than one transect was used in order to collect data that would be representative of the range of plant community characteristics within that VA. EPA has repeatedly stated, and does so again in the final BERA, that vegetation results are generally representative of the major plant communities, but do not accurately represent the vegetation in all parts of every VA. The usefulness and the limitations of this approach are fully discussed in the uncertainty section of the final BERA. The commenter states that care must be exercised in comparing the 1995 EPA Survey data to that collected by other researchers at the site. This is true for any data comparison exercise. Comparisons of Anaconda data sets were carefully scrutinized by EPA prior to the release of the PBERA Supplement and the final BERA. The important points here are that 1) EPA's data are accurate characterizations of the major plant comminutes throughout the Anaconda site, 2) EPA's data are consistent (or the differences explainable) with respect to previous results collected by other researchers and, 3) other researchers will obtain similar results if they survey the plant communities in the areas evaluated by EPA.
2	2	Within the PBERA Supplement, the text and tables imply a level of precision far greater than is possible using the Daubenmire method to estimate plant cover.	Cover estimates made in the field were to the nearest percent; therefore, the results presented in the text and in Table 6 are accurate representations of the data collected in the field. They represent an average over the 10 Daubenmire quadrats on each transect.
2	5	Example of reporting cover estimates to a greater degree than method warrants.	See previous comment.

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2	2	CDM should clarify comparisons of site data from 1995 with previous data, attempting to use data from same areas for comparison, and noting factors contributing to differences.	Because CDM Federal scientists were aware of how results can vary among researchers working on large sites such as the ARWW&S OU, a thorough evaluation of the sampling methods, sampling station location, precipitation patterns and frequency prior to vegetation sampling, study objectives, and other factors was conducted before any comparisons were made between the 1995 EPA Survey data and data from other studies at this site. EPA and CDM Federal were very careful not to use the previously collected data unreasonably. To ensure this, the previously collected data and statements made by other researchers about the vegetation or habitat in any particular area were not used unless that information was consistent with results from the 1995 EPA Survey. Inconsistencies between data sets are thoroughly discussed in the PBERA Supplement and in the final BERA. As is pointed out in the comments, "CDM has made a good effort to incorporate existing data", and this effort was more comprehensive and carefully refined in the final BERA.
2	3	ARCO assumes that PTI field data will supplement the discussions of opportunistic sitings of wildlife and plants, not along the transect, but in the vicinity of the sites.	In the field the CDM Federal and PTI scientists conferred about the opportunistic wildlife sitings; this information was recorded by CDM Federal and presented in the final BERA.
2	3	Calculations of percent cover should be checked where there are two sample sites per VA. (Example provided).	The raw data from all transects were used in calculating the mean cover values for the VAs that are presented in the un-numbered tables in the text portion of the document. The figures have been re-checked and only minor discrepancies (e.g., rounding errors) found that do not affect data interpretation.
2	6	Text should be revised to reflect recalculated mean cover values, per previous comment.	EPA has re-checked calculations and they were not inaccurate. In the field, canopy coverage was estimated to the nearest percent, not within coverage classes. It is, therefore, appropriate to display the coverage values in the tables to the closest percentage.
2	6	Comparison of plant productivity between Smelter Hill and undisturbed rangelands may not be appropriate.	The PBERA Supplement and the final BERA repeatedly acknowledge that disturbances from logging, fire, grazing, and other anthropogenic sources all contributed to current ecological condition at the site. This will be abundantly clear to anyone who takes the time to thoroughly review these documents; the statements made in this paragraph are therefore not out of context as the comment suggests.
2	6	A citation is needed for the native plant species expected to occur at VA17.	The source of information on native species expected to occur and present on Smelter Hill is contained in Mueggler and Stewart (1980) and many of the other reports cited in the PBERA Supplement and in the final BERA, including reports from ARCO and their contractors.
2	6	ARCO challenges the comparison of EPA's and ARCO's assessment of barren ground in VA17.	The comparison made is between the 1995 EPA Survey results and results from PTI's Rocky Barren/Bald and Horsebrush Shrubland types. These rangeland "types" are similar to areas within VA17, even if some of these "types" happen to be found also in VA18. Therefore, these comparisons are legitimate and the comment has no merit.
2	6	ARCO disagrees that conifers in VA18 were planted.	Trees have been planted in portions of VA18 lying adjacent to VA21. These plantings may have included conifers.
2	7	A citation is needed here and in similar discussions regarding production figures for undisturbed rangeland. (i.e., Mueggler and Stewart 1980).	Unnecessary - the source of the production figures for native rangeland in southwestern Montana is presented in numerous locations in the PBERA Supplement.

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2	5	When discussing percent of each VA that is barren or exceeds phytotoxicity thresholds, use "approximately" rather than "more than", which implies a subjective bias.	EPA disagrees that the use of the terms "more than" or "less than" imply a subjective bias. Moreover, the use of these terms is more accurate since the "approximate" percentages are not known. Furthermore, substituting the term "approximate" would not change data interpretation.
2	7	In the discussion of VA22 (portion of Stucky Ridge), the discussion of State data should only focus on data from Stucky Ridge. (Also applies to comment 20 on page 8)	The discussion in the PBERA related to the phytotoxicity of Stucky Ridge soils is merely a reiteration of the results obtained by the State. The information presented in the PBERA is therefore an accurate summary of the State's beliefs regarding phytotoxicity on Stucky Ridge.
2	8	ARCO wants conclusions re: the relationships between plant conditions and soil metals concentrations in VA16 to be postponed until the results of the ecological risk analysis, including data from 1995 survey, are completed. Neither the Keammerer nor the Redente data, nor the data presented by the MNRDP, define robust phytotoxicity thresholds.	Defining "robust phytotoxicity thresholds" is not attempted in these paragraphs nor in other places in the PBERA Supplement. This text merely brings forth the results of Keammerer's and Redente's work and discusses in a balanced and rational way how those results may be related to the observed structure of the existing plant communities.
2	9	Several 1995 survey sites were misplotted on Plate 1 in the PBERA Supplement.	These have been checked and corrected for the final BERA.
2	8	There is insufficient data to support the statement that one transect is more representative of VA15. The possibility of historically high grazing pressure should also be discussed.	The discussion about the vegetation in VA15 implies that the researchers believe that the vegetation data from transect 15-2 is more indicative of the general condition of the vegetation within this VA than the data from transect 15-1. This is absolutely true. Many miles of rangeland were surveyed in traveling to and from these two sampling points and it is the researchers professional opnion that most of the land observed is in poor condition (i.e., has low composition of perennial species, high percentage of bare ground, and low plant species richness). Effects on the plant communities in VA15 from land-use practices such as intensive grazing is discussed in the final BERA as the probable major cause of poor vegetation condition in portions of this VA.
Issue: Assessment of Risks to Vegetation (Natural Resource Damage)			
2	5	ARCO provides rebuttals to State's claims that ARCO utilized methods to overestimate quality and quantity of vegetation and wildlife in impacted areas, and feels the PBERA Supplement should have evaluated these criticisms in light of the NRDP investigations.	One of the purposes of the Supplement was to present the data, results and researcher opinions on the natural environment at the Anaconda site. This was done in a balanced manner to give the reader a complete picture of current environmental conditions. The statements in the Supplement that ARCO is referring to are simply a reiteration of what the State consultants said in their report. The State believes that the ARCO consultants may have biased their sampling in a way that overestimates the quality of the habitat and the use of these areas by wildlife species. Also presented in this part of the Supplement are opinions by ARCO's consultants regarding, what they believe, are biases in the State's approaches to interpreting environmental cause and effect relationships at the site. In short, both sides of these environmental questions were presented in the Supplement.
2	7	The discussion of VA19 does not include any information from the State or ARCO NRDP surveys.	Following the initial reconnaissance of the operable unit in the summer of 1995, EPA and ARCO decided that VA19 would not be surveyed because on the great abundance data available for that area, and because it was unlikely that major reclamation work would be conducted in this area because of the very good cover of Great Basin Wildrye. Therefore, the authors of the Supplement made a conscious decision to limit the discussion of vegetation conditions in this VA.

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2	7	The concerns voiced by the State do not invalidate the use of Redente's data in the Supplement. Furthermore, Redente presents limitations with the State's phytotoxicity investigation that should be considered in the use of the State's data. Also applies to comment 24 on page 8.	Again, information from both the State's and ARCO's contractors are presented in the Supplement, in conjunction with data from the 1995 EPA Survey, to provide a balanced picture of environmental conditions at the site. EPA has not implied, as is suggested by ARCO's comment, that opinions voiced by the MNRDP "invalidate" the results of ARCO's contractor. On the contrary, many of the conclusion and opinions of ARCO's consultants were corroborated by EPA's work at the site.
2	7	ARCO wants language from the State that recovery of impacted soils would take hundreds or thousands of years, that this is a misinterpretation of the NRDP regulations.	EPA believes that the State's statement is generally true; that it will take many years (perhaps hundreds or even thousands of years) to reestablish the nutrient cycling dynamics in the soils of the Anaconda area to levels capable of supporting diverse assemblages of plants and animals unless some type of remedial intervention is taken. Some ecosystems in the Anaconda area have already shown substantial regeneration, but in other areas the natural regeneration has been very slow or is not evident. For these areas, some type of active intervention is required to prevent the continual movement of COCs. Land reclamation alternatives seek to do this by accelerating the reestablishment of plant and animal systems.
2	2	Much data collected prior to 1995 was collected to respond to allegations of natural resource damage. Questions pertaining to natural resource damage may differ from those pertaining to ecological risk. ARCO experts have pointed out limitations in the approach taken by MNRDP that were not portrayed in the PBERA Supplement (examples provided). Conversely, the supplement clearly points out criticisms against ARCO.	From the beginning of the risk assessment process EPA was aware that all previously collected data and information would have to be screened for applicability in assessing risk using EPA guidance. EPA desired to use, to the extent possible, all existing data in order to be cost effective during this process. To this end, the Supplement was used as a forum to present the existing data and information along with newly collected environmental data, and did so in a balanced and unbiased way. As pointed out in previous responses, the Supplement presents the data and conclusions by the State and ARCO that relate to environmental perturbations, current ecological risk, and the potential for the recovery of ecological systems. EPA's conclusions regarding existing and potential risks to the flora and fauna at the Anaconda site are throughly presented in the Final BERA and this Responsiveness Summary using site-specific data and EPA-approved risk assessment methodologies.
7	1-17	It is unusual that risks to wildlife are given a secondary role in an ERA. EPA's approach follows the State's NRDA injury assessment where injury to vegetation is alleged to be due solely to metals phytotoxicity.	One reason that it may appear as though the risk assessment focused on vegetation is that vegetation traditionally takes a secondary role to wildlife in risk assessments. In the case of the Anaconda risk assessment (Final BERA), vegetation and wildlife were given equal attention. As discussed, the Supplement was used to present the data and conclusions from past environmental investigations, while the Final BERA relied upon the use of EPA guidance and site-specific data.

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Issue: Assessment of Risks to Aquatic Ecosystems (General)			
1	6	The comparison of instantaneous grab samples to surface water AWQCs is uncertain, since the AWQC is based on a 96-hour average.	EPA agrees in principle that grab samples can be uncertain. This uncertainty is identified in the Final BERA on page 5-143.
2	3	ARCO reiterates their comments on the PBERA, and states that they have still not been addressed by the PBERA Supplement (i.e., concerns regarding sediment ECs; recent WERs were not used, and the ones used were applied incorrectly; risks should be based on dissolved concentrations; method for calculating dissolved AWQCs is not the current method.) Figures and conclusions will need to be revised. ARCO requests that these problems be addressed before the Final BERA.	All of ARCO's comments regarding the assessment of aquatic risks from surface water and sediments were addressed in the Final BERA. Specifically, while NOAA sediment guidelines were used as sediment ECs in the screening-level assessment and the PBERA, they were no longer considered in the Final BERA, due to limitations in their use. Instead, regional/site-specific data developed by Ingersoll et al., (1996) were used as sediment ECs in the Final BERA. Further, the BERA made an effort to use site-specific data and to provide information regarding a full range of potential effects. To this end, the WER data developed by ARCO (ENSR 1996) were used and applied correctly in the BERA. Finally, EPA did assess risks to aquatic receptors based on comparison of dissolved metals in surface water to the surface water ECs. We also chose to evaluate potential risks based on total metals in surface water, to characterize a range of potential risks. The method used to calculate dissolved AWQC is the current method, as published in the May 4, 1995 Federal Register.
7	1-17	Remediation to protect against theoretical risks to aquatic receptors is not warranted when site data document no adverse impacts under current conditions.	This is a confusing statement when the proposed plan has outlined very little remedial action directly focused on aquatic risks. The primary remedial action of revegetation is aimed at protecting site streams from overland runoff of metals in the site water bodies. Also see response in Section IV.
Issue: Assessment of Risks to Aquatic Ecosystems (Fisheries)			
1	3	Interviews do not provide quantitative data for characterizing risk. In particular, although healthy self-sustaining fisheries were reported to exist upstream of Anaconda, no data were presented to show that lower reaches do not provide conditions supportive of fish spawning and rearing.	Information obtained from interviews was used to qualitatively characterize risks, and was not used in a quantitative manner. Further, it is true that EPA did not conduct fish population or reproduction studies in lower reaches of Anaconda rivers. However, exceedances of a variety of surface water ECs in portions of these lower reaches show that some stretches would not be supportive of fish spawning and rearing.
1	8	It is inappropriate to use AWQC and sediment ECs as measurement endpoints, actual status of fish populations provides more evidence regarding whether there are adverse effects on these populations.	It is not inappropriate to use surface water and sediment ECs to evaluate the potential for risk to aquatic receptors. Information from additional studies, such as population studies or toxicity studies, can be considered in a weight of evidence approach to evaluating the potential for such risks.
2	4	Both the Supplement and the PBERA place undue emphasis on the use of sediment and water ECs as predictors of risk, but downplay the fact that the creeks support viable fish and benthic communities that do not appear to be affected by metals toxicity.	See above. In addition, ARCO's comment is misleading by stating "...while downplaying the fact that the creeks in the area support viable fish and benthic communities that do not appear to be affected by metals toxicity." This may be true for certain stretches of certain streams, but site-specific macroinvertebrate surveys have shown that certain portions of the streams in the Anaconda area demonstrate adverse impacts to benthic macroinvertebrate communities from exposures to metals.
2	11	Citation needed to support statement about decline in health of fishery in Warm Springs Creek.	The information was stated as such from a direct interview with state fisheries biologist Wayne Hadley. No data was available for quantitative analysis. The statements were made from Wayne Hadley's professional judgement.

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7	1-3	No evidence is provided in the BERA that documents that metals and arsenic are currently causing adverse impacts or pose an unacceptable risk to aquatic biota. They cite data that show that under present conditions, the streams support a diverse and abundant benthic macroinvertebrate community and a self-reproducing viable trout population that meets or exceeds conditions in other regional streams.	ARCO's comment is misleading to state that "No evidence is provided in the BERA that documents that metals and arsenic are currently causing adverse impacts or pose an unacceptable risk to aquatic biota." In fact, comparisons of surface water and sediment concentrations to nationally accepted and regionally-based effects concentrations show the potential for risk to aquatic receptors in certain stretches of streams in the Anaconda area. Further, ARCO reviewers appear to have not read the uncertainty section that explains the uncertainties associated with using a single survey for 5 of the 6 sampling stations. While conclusions may indicate that the benthic macroinvertebrate community is unimpaired, a single snapshot in time may not reflect long-term health of the macroinvertebrate community for each stream segment surveyed. It is therefore, inappropriate to make a broad-brush statement that "...the creeks support viable fish and benthic communities that do not appear to be affected by metals toxicity." While aquatic habitats are not considered to be the habitats most at risk for this site, this does not preclude the weight of evidence that supports a potential risk to aquatic receptors in certain portions of the site.
7	1-13	The weight-of-evidence overwhelmingly documents that current conditions are not having an adverse impact on aquatic biota at the site. ARCO provides tables showing brown trout data and macroinvertebrate data. ARCO provides table indicating that the macroinvertebrate community composition of Anaconda streams is not significantly different than reference streams.	See above comment. In addition, ARCO's comments using brown trout as an example are misleading. Brown trout have been shown to tolerate warmer and more turbid waters than rainbow trout, and are a little less sensitive to metals (e.g., copper) than rainbow trout. The goal is not to ensure survival and growth of brown trout, but to support a fishery habitat that is conducive to the survival of other species as well.
Issue: Assessment of Risks to Aquatic Ecosystems (Total vs. Dissolved)			
1	5	Risks are calculated using total concentrations in surface water, which is not an appropriate measure of the bioavailable fraction. Risks should only be calculated based on dissolved concentrations.	EPA calculated risks based on both total and dissolved, recognizing that dissolved is more representative of the bioavailable fraction. Total concentrations were also considered as a way to evaluate potential risks from sediment contamination and food chain exposures.
3	7	The BERA should not evaluate aquatic risks using total concentrations of metals in surface water.	EPA calculated risks based on both total and dissolved, recognizing that dissolved is more representative of the bioavailable fraction. Total concentrations were also considered as a way to evaluate potential risks from sediment contamination and food chain exposures.
Issue: Assessment of Risks to Aquatic Ecosystems (Sediments)			
1	6-7	ARCO challenges the weight-of-evidence consideration of sediment ECs used in the PBERA, in that the NOAA ERLs and Ingersoll NECs should not be given equal weight. Further, Ingersol states that the use of his values should be for screening, not for a definitive assessment of the toxicity of sediments.	Sediments, like surface water, were never found to have a magnitude of risk necessary for further study. In the Final BERA and ultimately in the proposed plan, aquatic risks were realized not to be risk drivers and responsible for remedial action.

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1	3	CDM Federal used Milltown sediment data to generate NEC values, which may be useful in screening, but are overly protective for an assessment of true ecological risks. Using the same data, PTI developed LOAELs, which may be a more appropriate predictor of true toxic effects. To evaluate the bioavailable component, ARCO suggests correcting for the acid volatile sulfides and organic carbon in the sediments to assess partitioning of metals between sediment and pore water (pore water concentrations should be used to assess risks).	Sediments, like surface water, were never found to have a magnitude of risk necessary for further study. In the Final BERA and ultimately in the proposed plan, aquatic risks were realized not to be risk drivers and responsible for remedial action.
1	8	ARCO challenges CDM Federal's use of Essig and Moore data from Clark Fork River and Silver Bow Creek to develop NECs. Inappropriate to extrapolate from conditions in Silver Bow Creek to creeks in Anaconda area, since macroinvertebrates in Silver Bow Creek are known to be affected by stressors (i.e., ammonia) other than metals. Plus, other characteristics related to spatial and temporal differences in the invertebrate and sediment chemistry samples provide very weak evidence of sediment toxicity.	Dan McGuire collected site data in an attempt to reduce the uncertainty in this data gap. Also, this comment is directly contradictory to ENSR's reassessment of aquatic risks in which data from Clark Fork River was extensively used. Again, it is an example of ARCO's contradictory positions taken by different contractors and presented to EPA. In McGuire's report, the only reach that suggested only moderate impacts from metals was from lower reaches of Warm Springs Creek. In the Final BERA, the uncertainties in using data from a single survey were discussed.
2	11	Attributing differences in the benthic community of Warm Springs Creek to "metals pollution" is purely conjectural.	EPA disagrees with this statement, and further rebuttal is not possible without further explanation of ARCO's position.
7	1-14	ARCO states that their evaluation of McGuire's data shows, by weight-of-evidence, that impacts to benthic organisms are not occurring, even though McGuire's synthetic biointegrity scores may indicate impairment.	ARCO points out that EPA guidance recommends against using synthetic indices, yet ARCO uses the biointegrity score in comparison to sediment and surface water concentrations to support their statement that impacts to benthos are not presently occurring. EPA even states that impairment seems to be diminishing. McGuire's data do not suggest severe impairment and the Final BERA never stated such.
Issue: Assessment of Risks to Wildlife (General)			
1	1	The PBERA evaluated risks in nine wildlife use areas, then the focus changed to 20 subareas based on vegetation cover and condition, where the 1995 sampling occurred. To avoid confusion, future discussions should focus on the vegetation areas.	EPA concurs, and this change was made in the BERA.
2	6	Citation needed when identifying species of special concern that could have occurred at the site.	This comment was specific to the PBERA. EPA has since completed informal Section 7.0 consultation with the USFWS and, as a result of the consultation from Mr. Bill Olsen, the Final BERA was appropriately adjusted. See Final BERA citation labeled USDI/USFWS. 1997. Letter from K. McMaster to Julie DalSoglio.

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7	1-18	The BERA wildlife risk assessment is incompletely documented, full of errors and inconsistencies, and demonstrates a fundamental lack of understanding of wildlife risk assessment. (five bullets provided as examples): - assessment endpoint doesn't specify evaluation of wildlife risk from ingestion of contaminated soil or prey, but the food chain model does this; - assessment of relative risk does not report the precise methods used or the calculated HQs or HIs. In the mapping, the class of hazard factors 0 to 1.99 includes locations where relative risk does and does not exceed background; - since the food web model includes estimation of forage tissue doses, the risks due to ingestion of forage are not in addition to food chain risk (ES-24); - the food chain risk from ingestion of plants is not compared with the screening assessment of plant ingestion, and the plant tissue data collected in 1995 are not used in the food chain; - possible risks to wildlife based on geometric mean soil concentrations indicate only nominal risks to wildlife, whereas the hazard factor approach suggests that wildlife are up to 1000 times more at risk than in background sites. HQs from which HFs are calculated are not presented. These inconsistencies should have been resolved prior to publication of the BERA. These wildly different assumptions and findings contribute to ARCO's position that the Proposed Plan is not based on a defensible finding of risk.	Some of ARCO's recommended changes have been addressed in a re-evaluation of Appendix 10 of the BERA (Appendix B of the ROD). The BERA assessment endpoint states: Protection of wildlife species by ensuring the COC levels in forage and surface water are low enough to minimize health risks. ENSR is asserting that term forage may only apply to herbivorous species eating vegetation. This is highly erroneous. It is been highly acceptable to refer to prey species by carnivores as forage items within the diet. Furthermore, incidental ingestion of soil is part of a dietary fraction and therefore part of the forage. ENSR attempts to discredit the application of an assessment endpoint through the inappropriate use of semantics. As stated in the BERA, this comment is accurate, however, the map range statement should have read >0 to 1.99. See revisions in the re-analysis of wildlife risk models included in Appendix B of the ROD. Both forage assessment via the food web modeling and comparisons of metal concentrations in vegetation were used for comparison to TRVs for two independent approaches and were NOT additive. The food chain analysis confirmed estimates of risk that were completed through only estimates of forage and water. The plant tissue data collected in 1995 was used to calculate BAFs in the additional re-analysis of wildlife risks mapping exercise. See Appendix B of the ROD. The geometric mean analysis was done early in the process when limited comprehensive soils data were available. The text in Appendix 3 of the BERA was meant to give some site history of decision making for focusing on vegetative receptors. Subsequent to this initial analysis, further soil characterization (kriging, completed in late 1996) was completed and more appropriate TRVs identified. Since the kriging process was completed at the latter end of the ERA process, EPA felt compelled in the BERA to reanalyze these endpoints and receptors in risk characterization. This represents a scientifically valid approach to using the most current and relevant site-specific data as the project progressed, not "wildly different assumptions and findings".
Issue: Assessment of Risks to Wildlife (Wildlife Health)			
1	9	Identification of areas of concern for wildlife, based on indicators of effects on plants, is unjustified. Wildlife populations on Stucky Ridge, Smelter Hill, and Mount Haggin are quite healthy.	In the PBERA Supplement, EPA has addressed the reviews of several ARCO wildlife population studies and those from the State of Montana. The Olsen-Elliot line was not used to identify areas of risk for wildlife risk in the Final PBERA Supplement.

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Issue: Assessment of Risks to Wildlife (Estimation of Risks)			
2	10	The ARCO reviewer attempts to clarify EPA's description of PTI's report. ARCO disagrees with EPA's descriptions of risks to the kestrel when a conservative 10x uncertainty factor was used in the TRV.	Comment noted.
7	1-5	The primary purpose of HQs based on NOAELs is to screen out COCs and receptors. A NOAEL HQ>1 does not quantify risk or indicate that exposures will cause effects.	EPA agrees and further descriptions of both NOAELs and LOAELs are included in the re-analysis of the food chain model. EPA clearly states in several portions of the document the modeling effort was not intended for clear quantifiable measure of absolute risk.
7	1-21	The screening level evaluation of risks from ingestion of drinking water and vegetation have not been confirmed to exist. This does not evaluate the likelihood of risk or the likelihood of exposure. EPA does not evaluate the size and seasonality of the potential wildlife drinking water sources and the likelihood of exposure.	The BERA did not assess risks from ephemeral water bodies. Furthermore, several bodies of water exceed drinking water TRVs within what could be considered a single receptor's home range. It is not necessary for EPA to document damage or effects, only that the potential for risk exists.
7	1-28	Evaluation of risk to wildlife receptors requires more than the rudimentary analysis set forth in the BERA. Thus, there is no basis for concluding current conditions pose an unacceptable risk to wildlife.	Further re-analysis of the food chain model more clearly identifies both relative and absolute estimates of risk to wildlife receptors by both describing geographic areas of concern as well as pertinent pathways of exposure. Also, future biomonitoring will confirm or contrast modeling results.
7	1-26	HIs are an inappropriate summary measure since COCs at Anaconda have separate modes of action affecting different organs and systems.	In the re-analysis of the food chain modeling, maps were produced identifying the individual additions of risk from each chemical contributing to the HI.
Issue: Assessment of Risks to Wildlife (Hazard Quotient Does Not Equal Risk)			
7	1-4	EPA's use of HQs is not equivalent to risk. Actual ecological risk is related to the probability of effects given exposure to the stressor, and the probability of exposure to the stressor. Where site data demonstrate that the current conditions of exposure are not causing adverse effects, the risks are nominal. HQs and HIs are not measures of risk, and should not be confused with measures of risk. They are indicators of potential risk and possibly severity measures.	EPA has never claimed that the HQ approach is an absolute measure of risk, but rather, relative indications of potential risk. Furthermore, the exercise is needed in order to appropriately design sampling events aimed at confirming or contrasting modeling results. Again, this was clearly stated several times in the Final BERA.
7	1-27	The HQs and HIs ignore other important probabilities, such as exposure and source. (i.e., the *probability* that the entire diet of the receptor comes from one 70-acre plot is likely to be less than one).	Currently, EPA is not interested in further defining modeled parameters. Efforts will be spent to quantifiably measure exposure and effects in wildlife species in the field during future biomonitoring programs.

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Issue: Risk Mapping			
7	1-17	The screening tool invented by EPA for this assessment, based on the so-called "hazard factor", is not properly documented, is shown to be mathematically incorrect, and is not a measure of the relative potential for risk to wildlife from food chain exposures.	The hazard factor may not have been clearly documented in the BERA, but all documentation from the mapping was entered into the administrative record and furthermore, revisions of Appendix 10 (i.e., Appendix B of the ROD) more clearly describe the documentation. EPA has checked calculations and as noted in Hoff comments above were not mathematically incorrect. EPA absolutely disagrees that this exercise is not a measure of relative risk from food-chain exposures.
7	1-21	EPA provides a crude screening level RELATIVE assessment of risk to wildlife for each kriged cell surface soil concentration versus background soil potential risk.	We agree and EPA never claimed in the BERA that is was much more than a screening level assessment for wildlife receptors. Clearly, the focus of ecological risk on the site and the majority of proposed remedial focuses on vegetative risk.
7	1-22	ARCO could not fully review the BERA since methodology or risk calculation and results of exposure model were not documented. While the components of the hazard factor approach are supposedly in the Administrative Record, it is ARCO's understanding that the Administrative Record may not have the correct assessment data. It is inappropriate for EPA to have released a final document without this information.	In the rewrite of Appendix 10 (Appendix B of the ROD), all the documentation will be provided for replication by independent investigators of the technique. Also, it is again important to note that this was meant to be a screening exercise for wildlife receptors as the focus of the assessment was vegetative risk.
7	1-22	The HQs are based on a new set of TRVs that include conservative uncertainty factors, while the same food chain model is used.	The text in Appendix 3 was meant to give some site history of decision making for focusing on vegetative receptors. Subsequent to this initials analysis, further soil characterization (i.e., kriging, completed in late 1996) was completed and more appropriate TRVs were identified. Since the kriging process was completed at the later end of ERA process, EPA felt compelled in the BERA to reanalyze these endpoints and receptors in risk characterization. In Appendix 10, kriged soil coverages were used as comparisons to the geometric mean of the entire site. In the re-analysis of Appendix 10 (i.e., Appendix B of the ROD), the food chain model was changed.
7	1-22	The BERA only maps "hazard factors" based on the NOAEL, and not on the LOAEL. The BERA misuses this index to quantifying "relative potential risk" when it infers this ratio is related to risk.	Comment noted. EPA has never claimed that the HQ approach is an absolute measure of risk, but rather relative indications of potential risk. See Appendix B of the ROD.
7	1-26	The hazard factor approach to screening risk is apparently a new assessment tool, used here for the first time, and has not been subjected to peer review.	This document uses several sources of information that has not been peer-reviewed and published in the literature. Two such examples are the WER data that were used and incorporated in the text, and Hayden-wing wildlife surveys that have not been published in peer-reviewed journals. It is not apparent to EPA why all data and techniques used in an ecological risk assessment must be peer-reviewed before they are useful in the document. It is worth noting that ENSR has previously stated that the phytotoxicity ECs are scientifically invalid, when indeed, these values, which were taken from East Helena studies were successfully peer-reviewed (see attached). Therefore, it is EPA's conclusion that even if the technique had been subjected to a high level of peer-review, ENSR commenters would have still concluded that the technique was invalid in their opinion.

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7	1-26	The calculation of the HF is mathematically incorrect, does not measure relative risk, and is ecologically meaningless. The resulting maps are invalid and do not indicate relative or potential risk.	This is not true. As noted above, the method is not mathematically incorrect. See discussion in Appendix B of the ROD.
7	1-26	As a ratio of ratios, the components responsible for the magnitude of the "risk" cannot be identified and the uncertainty is obscured.	In the re-analysis of Appendix 10 (Appendix B of the ROD), both estimates of relative risk (HI site/HI background) and absolute (HI site-HI background) are included.
7	1-26	The extent and magnitude of wildlife risk is misrepresented in the BERA. It is customary to account for naturally occurring background by subtracting hazards from a reference site of similar geochemistry.	In the re-analysis of Appendix 10 (Appendix B of the ROD), both estimates of relative risk (HI site/HI background) and absolute (HI site-HI background) are included.
7	1-27	BERA erroneously states "Assuming that the risk calculated for background conditions represents the "risk" from arsenic, cadmium, copper, lead, and zinc under uncontaminated conditions for the selected receptors, this comparison [ratio of site HI to background HI] provides an estimation of additional risks to wildlife." ARCO provides an example to show how it may be interpreted that the hazard to one receptor may appear to be greater than the risk to another receptor, when the individual HQs wouldn't show this.	In the re-analysis of the food chain modeling, maps were produced identifying the individual additions of risk from each chemical contributing to the HI. See Appendix B of the ROD.
7	1-27	The underlying mathematics used to create the HF is apparently flawed. Only the HQs for the same chemical should be ratioed, HIs cannot be ratioed.	In the re-analysis of the food chain modeling, maps were produced identifying the individual additions of risk from each chemical contributing to the HI. However, ENSR's example showing fractions is incorrect, we added products of the division (i.e., ½ = .5), and when the products are used, the same results are always achieved.
Issue: Relationship Between the Proposed Plan and the BERA			
5	1	EPA cannot justify reclamation measures at Anaconda on the basis of the Draft Final BERA's phytotoxicity benchmarks for metals in soil.	This comment indicates that ARCO reviewers do not understand the integration of the Final BERA, the Proposed Plan, and the LRES scoring system. While the phytotoxicity benchmarks for metals in soil provided the first step in the BERA to identify terrestrial areas potentially at risk, numerous additional environmental parameters and existing vegetation conditions were taken into consideration by the Comprehensive Plant Stress Analysis (CPSA) model to refine the areas identified as posing a potential risk to vegetation. These areas are identified in the Proposed Plan as High Arsenic Soils, Sparsely Vegetated Soils, and Waste Material. The preferred alternative for these areas include reclamation and limited or partial removal of waste material and soils followed by revegetation. The LRES is used as a tool to prepare a site-specific ranking of the need for reclamation and spatial delineation of the remedial units. In this way, EPA is not justifying reclamation measures at Anaconda on the basis of the BERA's phytotoxicity benchmarks for metals in soil. EPA, with ARCO's involvement, will apply the LRES to the OU July, August, and September 1998. From this, a Conceptual Remedial Design Report will be prepared.
5	2	EPA has no authority to require further remedial action to address arsenic and metals-impacted soils unless it can provide a scientifically defensible basis for doing so.	See response to Menzie-Cura comments in Section XI.

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7	1-1	The BERA is so critically flawed that any remedial actions based on the findings of this assessment (or earlier versions) would be inconsistent with CERCLA and the NCP, and would be arbitrary and capricious. The critical flaws are based on errors begun in problem formulation and propagated throughout the assessment.	EPA wholly disagrees with ARCO's statements; see Sections I and VII.
7	1-2	It is inappropriate for EPA to document a need for remedial actions based on an assessment that doesn't go beyond a screening level characterization of risks, especially when site ecological data contradict results.	See response in Section V.
7	1-2	The BERA does not support response actions described in the Proposed Plan.	See above response to Document No. 5, pg. 1.
7	1-3	Based on previous comments, ARCO feels that there is no risk to aquatic receptors, therefore, there is no basis for remediation on Stucky Ridge (proposed to minimize transport of contaminants to surface and groundwater), based on the premise of protecting aquatic receptors. Further, they state that response actions to improve habitats impacted by SO_2 is outside CERCLA remedial authority.	See response in Section IIG.
7	1-4	ARCO claims the BERA starts with an assumption that metals and arsenic have caused any observed effects, and seeks data to support this assumption, and excludes consideration of ecologically sound alternative hypotheses. Forced reclamation of habitat under CERCLA is not appropriate if the habitat loss resulted from the effect of historic SO_2 fumigation.	See response in Section V, and Appendix B to the ROD.
7	1-5	Since the streams have the capacity to produce healthy trout populations that are comparable to other streams in the region, there is no risk basis to require remediation to mitigate against theoretical risk to these receptors.	Again, this is a broad-brush statement that fails to recognize that EPA has identified the potential for risks to aquatic receptors in certain portions of certain streams at the site. These risks are usually associated with high spring run-off in which the streams receive increased loadings of metals that exceed surface water ECs and likely affect early life stages of aquatic organisms.
7	1-6	Since there is an absence of a clear stressor-response, the Proposed Plan is not based on a defensible finding that phytotoxicity from metals is responsible for the observed vegetation condition.	See response in Section II.
7	1-12	EPA has not evaluated the risks of remedial alternatives. Disturbance of surface soil and existing vegetation through proposed remedial efforts may in the short term reduce vegetative cover and habitat, increase soil loss, increase loading to surface water, while doing little to mitigate ecological threats.	This comment again suggests that ARCO reviewers do not understand the language in the Proposed Plan. EPA has repeatedly and iteratively incorporated results from ground-truthing of site conditions in the selection and recommendation of the number of acres requiring remediation. As a result, the acreages recommended for remediation are only barren or sparsely vegetated areas. There will be no disturbance of existing vegetation cover and habitat.

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7	1-17	While focusing on phytotoxicity, and following an approach congruent with the State's NRDA injury assessment, EPA has not adequately addressed potential risks to wildlife under the Proposed Plan. The Proposed Plan projects that remedial actions to reduce phytotoxicity will also be protective of wildlife.	See Appendix B of the ROD.
7	1-17	The Proposed Plan is improperly designed to improve vegetative cover and wildlife habitat by mitigating hypothetical phytotoxicity. However, data in the BERA fails to establish that the Proposed Plan will mitigate against theoretical or actual risks to wildlife.	See Appendix B of the ROD.
Issue: NRDA vs. Ecological Risk Assessment			
4		Editorial comments on two pages, regarding edits to remove language pertaining to injury, impairment, the State's conclusions regarding injury to the site, and the State's restoration goals.	Appropriate editorial changes were made in the Final BERA.

XI. RESPONSES TO ARCO'S ASSESSMENT OF IMPACTS TO VEGETATION BY MULTIPLE STRESSORS AT THE ANACONDA SMELTER NPL SITE PREPARED BY MENZIE-CURA & ASSOCIATES, INC., MARCH 3, 1997

This response to the conclusions presented in ARCO's report is prefaced by explanatory text that puts forth some of the key premises on which the BERA is based. This is provided to make EPA's position clear on: 1) the definition of phytotoxicity; 2) the selection and use of phytotoxicity benchmark values in the BERA; 3) concepts of phytotoxicity and measuring phytotoxic response in the natural environment; 4) observed differences between the existing composition of plant communities at the ARWW&S OU and plant communities on uncontaminated areas and those that would be found at the ARWW&S OU under climax conditions; 5) the use of the risk analysis to delineate areas for potential remediation (in the FS); and 6) the use of an integrated environmental (plant stress) analysis in the BERA to define areas of potential risk to vegetation from soil COCs (arsenic, cadmium, copper, lead, and zinc). This text is intended to simplify the responses to each of ARCO's conclusions in the above-referenced report, which are provided at the end of this document.

<u>Fundamental Concepts of the ARWW&S OU Ecological Risk Assessment</u>

Phytotoxicity and Phytotoxicity Benchmark Values Used at the ARWW&S OU

Phytotoxic effects due to a particular chemical can range from sub-chronic effects such as slightly reduced germination or shoot elongation to more acute effects such as limited germination, low plant density, and plant death. The concentrations of the COCs in the soil of the ARWW&S OU are just one of many soil chemical factors that are affecting the growth and development of individual plants. The chemical composition and physical attributes (i.e., texture) of the soils, landscape features (including slope angle, aspect and position), and land-use all contribute to the current assemblages of plants in a given area of the operable unit. In any environment these interactions are extremely complex. For the ARWW&S OU, which covers nearly 200 square miles and many different range sites and habitat types, the difficulty in assessing the influences of soil COCs and other soil factors on vegetation becomes more problematic. As Suter et al. (1996) points out, "an assessor must realize that these soil characteristics [pH, Eh, cation exchange capacity, moisture content] play a large part in plant toxicity and incorporate these site-specific considerations in the evaluation of the potential hazards of a chemical". EPA's solution was the use of an integrated environmental (plant stress) analysis that evaluates the primary plant growth soil characteristics and plant community attributes by comparing these to risk-based values and plant community characteristics for uncontaminated sites and for these range sites under climax conditions.

The intent of the ARWW&S OU risk assessment is to identify the relative degree of ecological risks across the site so that the FS team can prioritize areas and select appropriate remedial alternatives. To this end, the BERA compared regional soil (general relative) kriging results with site-specific phytotoxicity benchmark values and delineated areas of decreasing potential risk as distance increased outward from the Anaconda smelter complex. This analysis was used to delineate four phytotoxicity zones (Plates 2 and 3 in the BERA - CDM Federal 1997) that strongly suggest a general and positive relationship between soil COC concentrations and field observable phytotoxic effects. This premise is supported by the data, information, and opinions of other researchers working in the Anaconda area (see CDM Federal 1996).

Ecologists working in the ARWW&S OU have observed plant communities with high diversity and canopy coverage in some portions of the site having high soil COC concentrations. This includes Zone 4 where the concentration of all the COCs in the soil exceed their respective high phytotoxicity values. EPA believes that this response is due to the positive affects that other environmental factors (other than the COCs) are having on plant community composition and structure. These factors fall under the broad headings of physicochemical soil properties, microclimate, and anthropogenic influences and includes factors such as high soil moisture, abundant organic matter, non-steep north slopes, and limited grazing. Under the right circumstances, some of these other factors, working alone or in concert, are believed to be moderating, or offsetting the affects of elevated soil COC concentrations on the vegetation.

Table 5.1-7 (attached) from the BERA rates the principal soil physicochemical properties and other environmental influences from each VA at the ARWW&S OU in terms of whether they are potentially having a negative, positive, or neutral affect on plant performance. This table shows that soil COCs are potentially having a negative impact on vegetation in or near Smelter Hill and Weather Hill (i.e., VA17), in the area adjacent to Weather Hill lying south of Mill Creek (i.e., VA16), in the Southern Lowland area (i.e., VA13A and VA14), in the well-vegetated Northern Lowland area (VA1), and in areas near proposed waste management areas (WMAs) (i.e., VA4, VA6, VA7, VA9, VA11, and VASN). With the exception of VA16 and VA1, these VAs correspond to areas within the operable unit that are barren/sparsely vegetated or have poor vegetation growth/condition. The diverse and productive nature of the vegetation in VA16 and VA1 is believed to be the result of other mitigating environmental factors, especially favorable soil moisture regimes, slope aspects, and topsoil condition, that are having a strong enough compensatory influence to overcome the affects of phytotoxic COC soil concentrations.

National criteria or guidelines for soil values protective of vegetation are not available because the toxicological response varies widely for individual species, populations, and communities. Therefore, during the development of the BERA EPA used the best regional and site-specific information presented in the Terrestrial NRDA completed for the State of Montana (State of Montana 1995) and an extensive toxicological literature review completed for the assessment of arsenic and metal toxicity to plants in the Helena Valley (CH2M Hill 1987a and b) to derive phytotoxicity benchmark values for the ARWW&S OU. It is important to understand that these values were used as general (screening level) indicators of where soil concentrations may be high enough to be phytotoxic under most environmental conditions. Conversely, they were not intended to be used to delineate specific boundaries between COC-affected and COC-unaffected vegetation. Because of the myriad of environmental factors influencing vegetation, an integrated environmental (plant stress) analysis was subsequently performed in the BERA.

Integrated Analysis of Plant Stress

EPA used an integrated environmental analysis to assess the relative influence of the COCs and the other physicochemical soil component, landscape factors, and land-use history on the potential for plant stress and existing plant community composition at the ARWW&S OU. This is presented in the BERA and was accomplished using data and information gathered during field reconnaissance and sampling events conducted by EPA, data from other researchers at the site, and remote sensing data. This analysis included a comparison of the existing vegetation at the ARWW&S OU to what should be present under climax vegetation conditions and what is present in German Gulch (which was used by the State as a reference area).

The integrated environmental analysis did not rely on any one piece of data, such as phytotoxicity benchmarks, to define areas of potential risk. Rather, this analysis used the phytotoxicity benchmark values along with other physicochemical soil data and landscape characteristics in a weight of evidence manner to identify general areas where smelter and ore processing wastes may be significantly contributing to plant stress. This approach to assessing potential risks, and the data and information used to define areas of potential risks (or no risks), are discussed in detail in the BERA.

The data collected in the Vegetation Areas (VAs) during the 1995 EPA Survey provides a general representation of soil conditions and plant community characteristics for each VA. As such, these characterizations do not accurately reflect soil and vegetation conditions in all portions of each VA. Furthermore, the existing site data only approximate vegetation conditions in the Areas of Concern used in the FS and likewise do not accurately represent actual conditions in all areas. The boundaries of the Areas of Concern delineated in the FS (where remediation is proposed for implementation) will be modified following more intensive field investigation during the design phase of the ARWW&S OU project.

Climax, Reference, and Existing Vegetation Condition at the ARWW&S OU

Ross and Hunter (1976) classified the climax (i.e., uninfluenced by current human activity) vegetation in the Anaconda Smelter NPL Site into three range/forest sites.

1) **Silty Range Site (10- to 19-inch precipitation zone)** Vegetation on this range site is dominated by perennial grasses (bluebunch wheatgrass, rough and Idaho fescue, needle-and-thread, prairie junegrass, western and thickspike wheatgrass, green needlegrass, and basin wildrye), forbs (danthonia, sticky geranium, arrowleaf balsamroot, larkspur and prairie smoke), legumes, and shrubs (winterfat and big sagebrush).

2) **Saline Lowland Range Site (10- to 14-inch precipitation zone)** Vegetation on this range site is dominated by perennial grasses (basin wildrye, alkali sacaton, alkaligrass, cordgrass, slender and western wheatgrass, and inland saltgrass) and shrubs (greasewood and buffaloberry).

3) **Subalpine Fir and Douglas Fir Climax Forests (20- to 45-inch precipitation zone)** Typical overstory composition is 65% Subalpine fir, 25% Douglas fir, and 10% Engelmann spruce. Climax understory species include many grasses, forbs and shrubs such as pinegrass, basin wildrye, Idaho fescue, grouse whortleberry, arnica, huckleberry, beargrass, and serviceberry.

The primary rangeland habitat types (h.t.) found in the Anaconda Smelter NPL Site classify into either the rough fescue or Idaho fescue climax series (Mueggler and Stewart 1980).

1) **Rough Fescue Series** This series consists of either the rough fescue/bluebunch wheatgrass h.t. (needle-and-thread phase) or the rough fescue/Idaho fescue h.t. (Richardson's needlegrass phase).

2) **Idaho Fescue Series** This series consists of the Idaho fescue/bluebunch wheatgrass h.t. (western needlegrass phase).

Under climax or near climax conditions the plant communities on these range/forest sites and in these habitat types would be highly productive and composed of a variety of native perennial plant species. This is in sharp contrast to the plant communities in many areas of the Anaconda Smelter NPL Site that exhibit low canopy coverage and annual above-ground production, or are dominated (or co-dominated) by weedy, introduced plant species. Many of the plant species listed above were not observed in the ARWW&S OU during EPA's reconnaissance trips or vegetation surveys conducted in 1994 and 1995. Likewise, many of these species are absent from the reports of other ecologists who have studied the vegetation in this OU.

In general, plant canopy coverage by native perennial species, species richness, and plant community diversity within the Anaconda Smelter NPL Site increases with distance from the smelter complex. In areas not contaminated from smelting activities (in German Gulch or under climax conditions), upland forests are generally dominated by Douglas fir, lodgepole pine, and juniper, while upland shrublands are composed of willows, alders, red osier dogwood, chokecherry, buffalo berry, low bush cranberry, and silver berry (State of Montana 1995; MNRDP 1994; and Taskey 1972). Native range in uncontaminated areas is composed of perennial species of wheatgrasses, fescues, and bluegrasses. Grasslands in contaminated and disturbed areas of the site are dominated by weedy species such as spotted knapweed and Canada thistle, metal-tolerant grass such as basin wildrye, and the non-native redtop (State of Montana 1995; MNRDP 1994). Areas subjected to intense grazing typically contain a greater density of opportunistic weedy species including spotted knapweed, thistle, and dandelion (State of Montana 1995).

Plant community diversity and density vary considerably depending on the characteristics of the soil and physical environment that include the concentration of smelting-related contaminants, soil moisture, total organic carbon (TOC) content, pH, nutrient status, slope, aspect, reclamation activities, and other activities such as logging history, irrigation, and grazing. Previous investigations and field reconnaissances conducted in 1995 have noted areas of barren soil and stressed vegetation, especially in the vicinity of Stucky Ridge, Smelter Hill, Mt. Haggin, and the Anaconda and Opportunity Ponds (State of Montana 1995; Monninger 1992; Olsen-Elliott 1975).

Based on one estimate, approximately 18 square miles (11,400 acres) of uplands near Anaconda have been visibly altered by previous smelting activities (MNRDP 1994). These alterations include near total elimination of native plant communities and extensive topsoil loss from lack of vegetation. Additionally, there has been a shift in plant community structure from forests with open grasslands to predominantly bare ground or sparsely vegetated grassland having low plant species diversity and being composed of monocultures of weedy metals-tolerant species (State of Montana 1995). For example, historical photographs of the Old Works (circa 1886) indicate that Stucky Ridge was formerly vegetated by arid grassland and open steppe plant communities on exposed slopes and forest communities in the moist drainages (State of Montana 1995). Today, Stucky Ridge is either bare soil or is sparsely vegetated with predominantly metals-tolerant species. The surface of Smelter Hill presently consists of large areas of bare ground and evidence of stressed vegetation, composed primarily of metals-tolerant species (State of Montana 1995). Formerly forested slopes to the south and west of Mill Creek, as far as the Continental Divide, are currently devegetated and show extensive soil loss (State of Montana 1995). The drainages of Mill and Warm Springs Creeks, once covered by dense riparian forests and shrublands, are currently either unvegetated, or composed of stressed or metals-tolerant vegetation (Taskey 1972). Of the approximately 11,400 grossly injured acres, about 20 percent of the total (2,200 acres) are greater than 40 degrees in slope (MNRDP 1994). The devegetation in these areas exacerbated erosion and soil loss.

The aforementioned areas of the ARWW&S OU are those that demonstrate obvious and dramatic changes in the composition of the plant communities and wildlife habitat. Data collected during the 1995 EPA Survey supports this assessment of vegetation condition on Stucky Ridge and Smelter Hill, and also indicates that the soil COC concentrations in other areas of the site have likely altered plant community composition and still pose a potential risk to the germination and growth of vegetation. These other areas, some of which have abundant plant growth, are generally composed of only a few metal tolerant species. EPA believes that the surface soils in many of these areas are still toxic to seedlings and that this has hindered the recovery of these areas.

Application of Remedial Measures

The FS (CDM Federal 1997) evaluated remedial options to reduce environmental and human health risks at the ARWW&S OU. The potential application of land reclamation techniques, which in most cases would significantly disturb and thereby eliminate some of the existing vegetation, was evaluated against the potential risks to vegetation if reclamation was not implemented (i.e., under the no action alternative). A basic premise of the FS was that plant communities with adequate diversity, composition, and production would not be disturbed to implement reclamation, even though some of these areas may have soil COC concentrations that exceed the phytotoxicity benchmark values. Depending on the plant species present, sparsely vegetated areas might be interseeded, thus avoiding full tillage and the destruction of existing vegetation. This logic was also used during the calculation of the acreage within the waste management areas to which reclamation might be applied; areas having adequate vegetation were not included in the total acreage requiring reclamation.

To fully appreciate how this approach has reduced the amount of acreage to which remedial efforts might be applied, the reader should compare the FS map showing the areas slated for remediation to the phytotoxicity maps in the BERA. Such a comparison clearly shows that some areas are not recommended for reclamation even though soil COC concentrations exceed phytotoxicity benchmark values. EPA believes that other soil factors (e.g., high soil moisture) are reducing plant stress that would occur under "average" soil conditions (e.g., moderate to low soil moisture). EPA recognizes the value of these diverse plant communities and wildlife habitats and intends to keep them intact.

Response to ARCO's (Menzie-Cura & Associates, Inc.) Comments on the BERA

Section 6.0 - Summary of Results

Comment 1 ARCO states that the phytotoxicity benchmarks are poor predictors of vegetation condition and gives examples of areas having high plant canopy coverage and high soil COC concentrations, and vice versa.

Response 1 The BERA clearly discusses the intended use of the phytotoxicity benchmark values. These values were selected as the best indicators of potential phytotoxic risk under what was considered to be "typical" environmental conditions in southwestern Montana. It is important to realize that the phytotoxicity benchmark values were not chosen to account for other soil characteristics that might significantly enhance or stress site vegetation. Furthermore, the phytotoxicity benchmark values were used to identify areas of the site where the soil COCs may be high enough to be phytotoxic under most environmental conditions. These values were not intended to be used alone in defining absolute phytotoxicity or to delineate areas requiring remediation. EPA recognized at the outset of the risk assessment process that other site information, such as the other physical and chemical soil properties, landscape conditions, land-use, and the existing vegetation, would need to be assessed before the areas requiring remediation could be determined.

EPA, CDM Federal, and MSU have known from the outset of the risk assessment process that there were areas of the site where plant community condition did not correlate with the phytotoxicity benchmark values. The reasons for this lack of correlation in the areas identified by ARCO (the Northern Lowland Area, the Southern Lowland Area, the East Hills, and the North Hills) are thoroughly discussed in the BERA. In essence, the lack of correlation is due to the influences of physical and chemical soil factors (other than the COCs), landscape characteristics, and/or land-use practices that either enhance or diminish plant germination and growth, and the subsequent development of the plant communities and wildlife habitat.

Because of the multitude of physical and chemical soil parameters that can influence plant growth, EPA realized early in the assessment of potential risks at the ARWW&S OU that it would be impossible to identify an absolute phytotoxicity values for each COC and plant species under all possible environmental conditions at the site. The BERA, therefore, evaluated the primary plant growth characteristics present in the environment (e.g., soil moisture regime, topsoil condition, organic carbon content) in the context of the level of soil COCs and assessed the potential risk to vegetation in a semi-quantitative and qualitative way. Results of this analysis indicate a general relationship between the level of COCs in the soil and plant community composition. However, as discussed above there are areas of the site with good plant growth despite high soil COC levels. This is believed to be a function of the positive affects of other physicochemical soil characteristics, landscape factors, and/or past and current land-use in those specific locations. Conversely, some areas of the site demonstrate poor plant growth and community condition but have soil COCs concentrations less than the phytotoxicity values. EPA postulates that this phenomenon is due to naturally poor plant growth characteristics of the soil (e.g., low organic matter level) and the possible added stress of elevated soil COCs, even though the soil COC concentrations do not exceed the phytotoxicity benchmark values.

Specifically, the BERA demonstrated that all the soil factors evaluated for the Northern Lowland Area (CEC, K, P, organic carbon, soil moisture regime, slope; grazing, topsoil, SC, pH, aspect and stones/rock), with the exception of N and the COCs, were having either a positive or a neutral affect on the vegetation (see Table 5.1-7 of the BERA). Within this area of the site there are many soil factors that are enhancing the diverse and productive nature of the vegetation despite high soil metal concentrations. In this area the soil arsenic and metal levels are not high enough, by themselves, to negatively affect plant growth. The primary plant-growth soil factor in the Northern Lowland area is high soil moisture conditions, brought about by a seasonally high water table. If plant available soil moisture is diminished in the future through a lowering of the water table, the potential risks to vegetation due to high soil COC concentrations are expected to increase.

ARCO states that other areas of the site (e.g., VA2A, VA2B, VA24, and VA15) have poor vegetation growth or condition in the absence of **elevated** levels of soil COCs. This is an incorrect statement because even though soil concentrations do not exceed the phytotoxicity benchmark values in these areas they are significantly greater than background soil concentrations for the United States and for the Clark Fork River Basin. In some cases the soil COC concentrations are more than an order-of-magnitude greater than background. As an example, the copper concentration in the surface soils at Transect 2 at VA2A was 644 mg/kg, compared to a U.S. soil concentration of 24 mg/kg. As stated in the BERA for the North Hills (page 5-55), "concentrations of the COCs, by themselves, were considered to be having a non-negative or neutral influence on the plant communities in general. However, since the primary plant limiting factors (i.e., organic matter, soil moisture regime, nutrients) ranked low, the potential for the phytotoxicity effects of the COCs to be important factors in plant germination and growth may be high in some portions of the North Hills area. As mentioned, areas where phytotoxic effects may be particularly acute include the south-facing slopes in the southeastern portion of VA24, portions of VA2B, and the portion of VA2A that lies south of VA2B" where soil moisture may be limited.

Comment 2 Bulk soil concentrations of the COCs are not correlated with vegetation condition. ARCO found no correlations or negative correlations between the vegetation parameters (total plant cover, peak standing crop, and/or bare ground) and the soil COC concentrations.

Response 2 From field reconnaissance trips conducted in 1994 and 1995 EPA strongly suspected that there may not be simple correlations between total soil metal concentrations and plant community characteristics. As discussed above, some areas had good vegetation condition (high canopy coverage, high species richness, and diverse habitat) and high total soil COC concentrations while other area showed the opposite relationship. Therefore, EPA decided in the planning stage of the BERA that an integrated environmental (plant stress) analysis, which considers the major plant-growth parameters, would be used in a semi-quantitative and qualitative manner to identify areas of the ARWW&S OU where the concentration of COCs in the soil may be a threat to plant germination and growth.

It is inappropriate for ARCO to use gross measurements of site vegetation (e.g., total canopy coverage) in correlation tests with soil COC concentrations. A more appropriate analysis would be to compare the composition of the plant communities in the ARWW&S OU to those of similar sites in un-contaminated areas (such as German Gulch) or to climax community conditions. Plant community characteristics of canopy coverage and production are gross measures that do not, by themselves, indicate the ecological health of plant communities and wildlife habitat. As the BERA points out, the effects of smelting and ore processing to diminish plant community characteristics such as species richness and to continue to limit the potential for certain areas to recover floristically is suggested by the scarcity of many species that would typically be found on these range sites in the absence of industrial activities.

The primary rangeland habitat types found in the Anaconda area classify into either the rough fescue or Idaho fescue climax series. Under climax or near climax conditions the plant communities on these range/forest sites and in these habitat types would be very productive and dominated by native perennial plant species. As discussed above, this contrasts with the structure of plant communities in many areas of the ARWW&S OU that exhibit low canopy coverage of native, perennial species and are dominated (or co-dominated) by weedy, introduced plant species.

Comment 3 Other soil properties, such as potassium, organic carbon content, topsoil condition and cation exchange capacity, correlate significantly and positively with the vegetation parameters.

Response 3 These results are not unexpected since these parameters are some of the major soil factors that affect plant growth in general. As presented in the BERA, EPA believes that total vegetation canopy coverage and production (which are not appropriate indicators of plant community and habitat health) in some areas of the site are controlled primarily by soil factors other than COC concentrations. It should be noted that ARCO found significant and positive correlations between topsoil condition (which includes whether the topsoil has been eroded) and plant canopy coverage and production. This is important because the loss of topsoil from steeper areas of the ARWW&S OU is believed to have been caused, in part, by the elimination of vegetation through the deposition of smelter emissions. The resultant lack of topsoil, by itself, is a primary reason why some of these areas have not been able to recover floristically. The lack of topsoil continues to present a potential risk to the germination and growth of native seed from the surrounding areas. Elevated soil COC concentrations in these areas may also be contributing the stress of seedlings.

Comment 4 ARCO states that their spatial analysis suggests that for some areas of the site the poor condition of the vegetation may not be the result of phytotoxicity, but simply reflects poor soil quality and/or physical stressors such as grazing.

Response 4 This situation is acknowledged in detail in the BERA and is discussed above. Table 5.1-7 of the BERA (attached) indicates that soil COC concentrations are likely not having a negative influence of vegetation in VA2A (North Hills) and VA15 (East Hills).

Comment 5 ARCO states that the spatial analysis shows that the soil COC concentrations coincide with poor soil moisture, topsoil erosion, and vegetation quality in Smelter Hill, South Hills, and areas adjacent to the waste management areas.

Response 5 EPA acknowledges this situation in the BERA, but also believes that the soil COC concentrations in these areas are high enough to have a significant negative impact on the growth and development of the vegetation (see Table 5.1-7). Each of these areas had soil COC concentrations that exceeded at least one of the high (liberal) phytotoxicity benchmark values; in some cases most of the high arsenic and metal benchmark values were exceeded (see Table 5.1-5 of the BERA).

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FIGURES

Figure 1

Kaputska Phytoxicity Scores versus Metal Concentration and pH

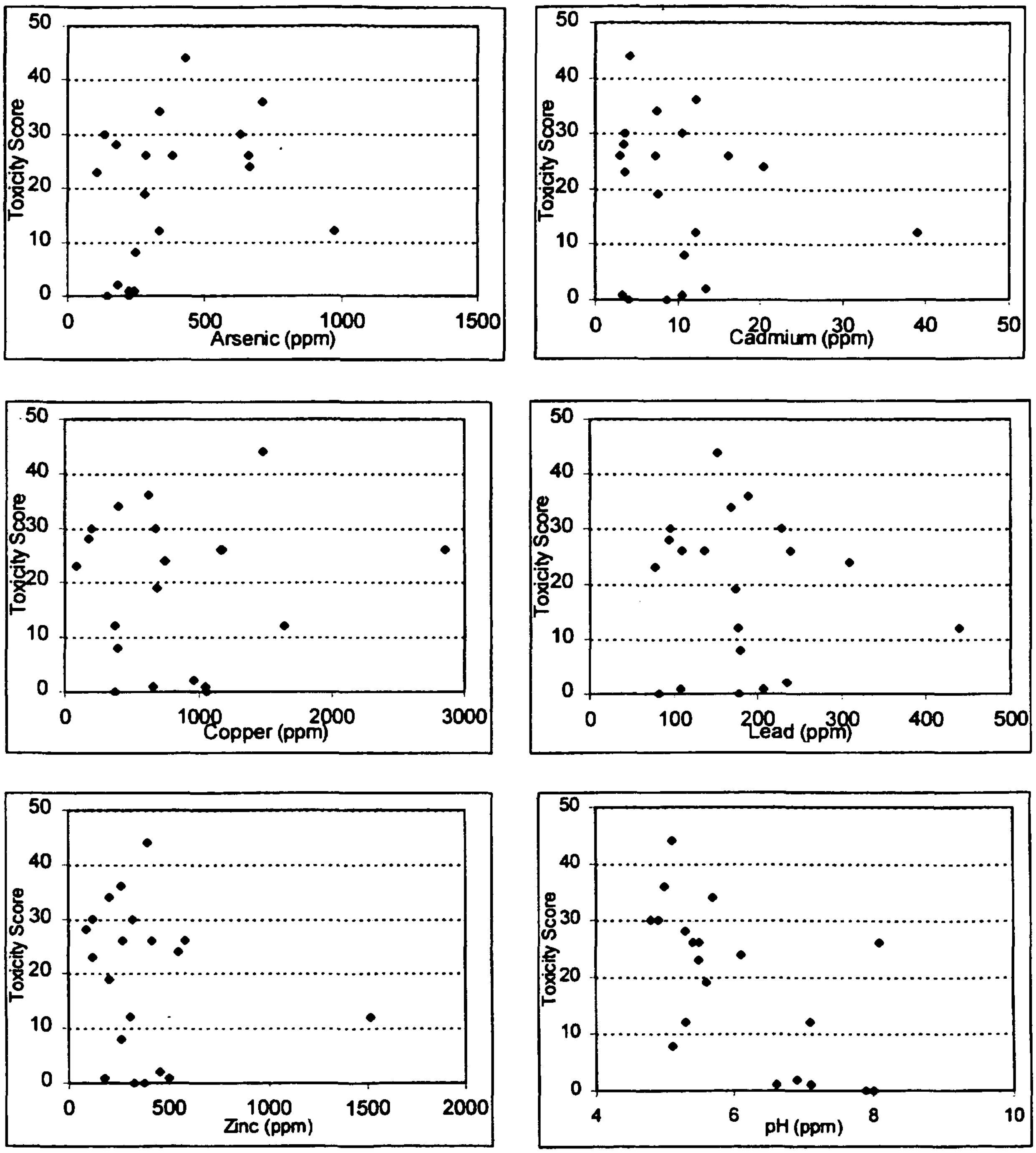


Figure 2

Bivariate Expression of Kaputska Toxicity Scores with pH and Total Metals Concentrations

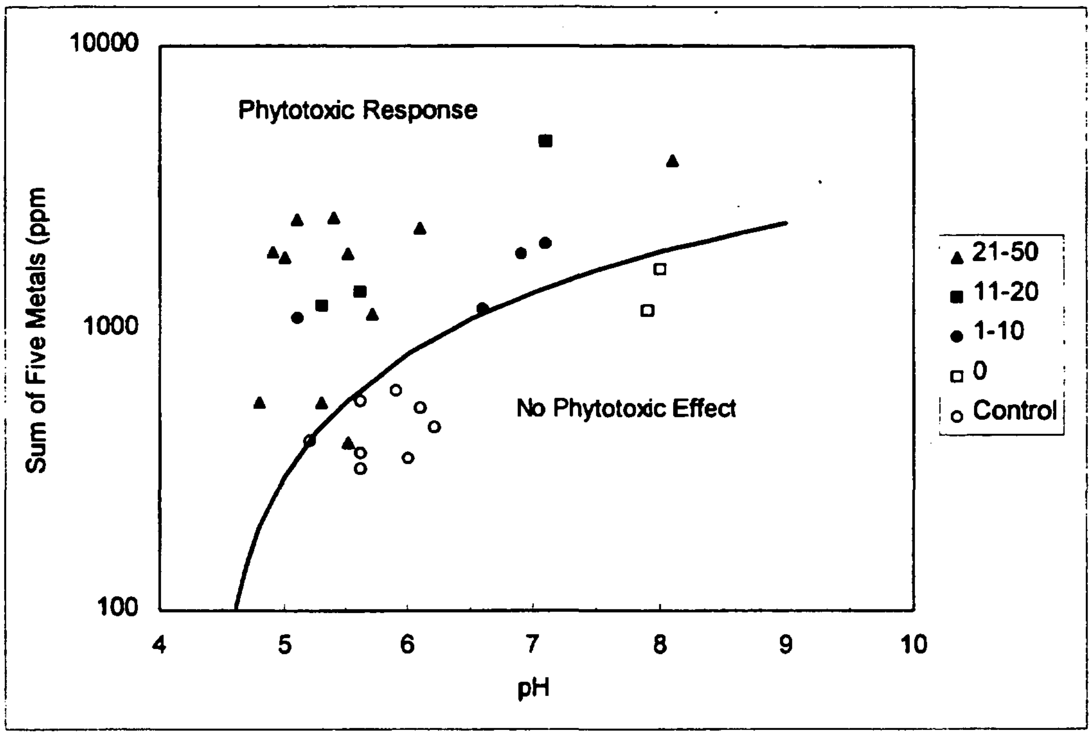
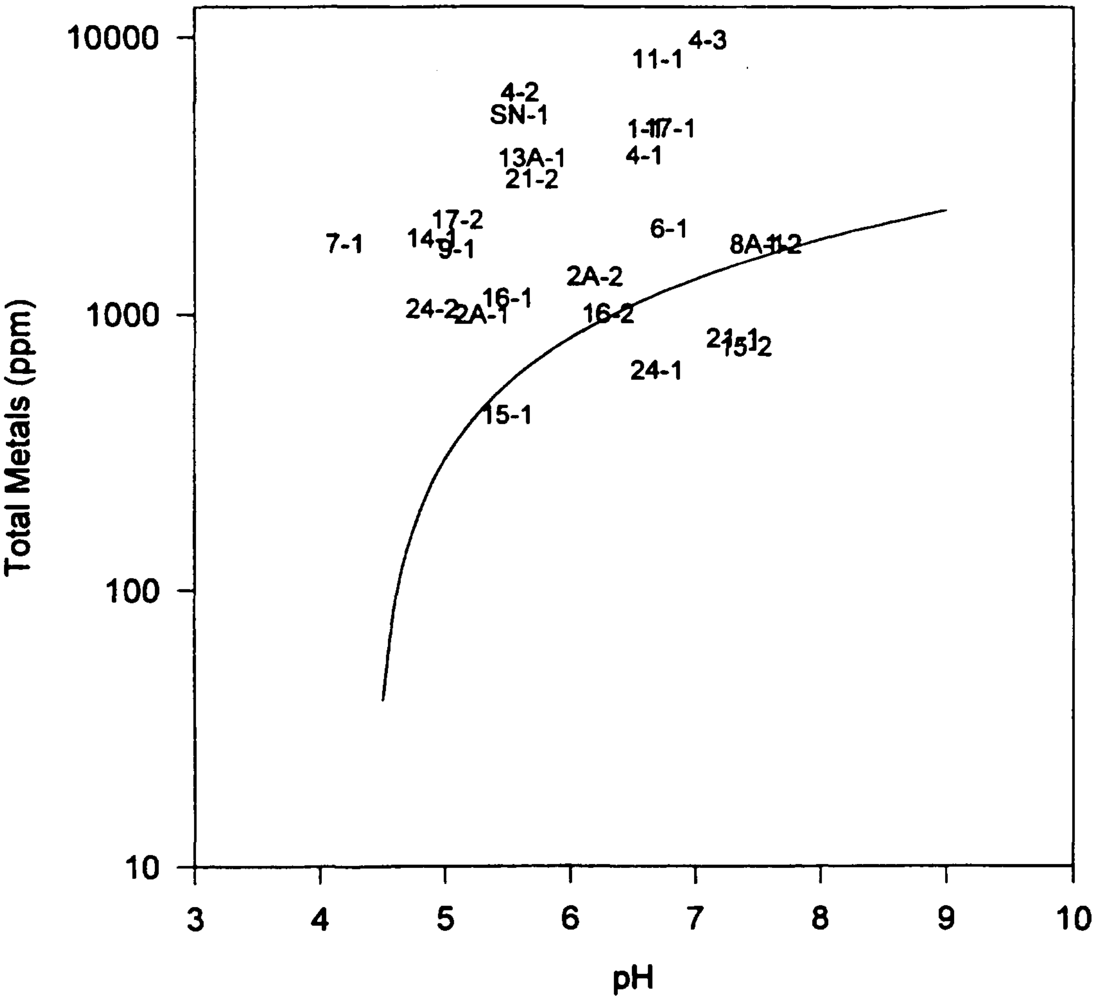


Figure 3

Kaputska et al. (1995) Toxicity Score Line in Reference to Soils Collected in EPA 1995 Survey of Vegetation Areas (VAs)



Note: Labels within the figure represent VAs.

Response to ARCO Comments in Attachment I

In discussing risk for a dirt-bike rider under the section entitled 'Results of Risk-Based Calculations' ARCO states that "soil arsenic must exceed 23,000 mg/kg before soil presents a potentially unacceptable risk." The 23,000 mg/kg figure is inconsistent with the risk-based concentration for arsenic presented in Table 1, which is 2,312 mg/kg.

Based upon ARCO's RME of 2,312 mg/kg arsenic (ARCO's Table 1), statements made by ARCO in the next section (Comparison with Site Soils) regarding the potential for human health risks are erroneous. As shown in ARCO's Table 3, some areas at the Anaconda Smelter Site have soil concentrations in excess of 2,312 mg/kg. This includes the Stack and Railroad Bed areas. Based on the standard deviations presented in Table 3, soils throughout the Smelter Hill area were found to exceed 2,312 mg/kg. Material located in the Anaconda and Opportunity Tailings Ponds do not have arsenic concentrations that exceed 2,000 mg/kg.

EPA Calculation of Arsenic Action Level for Trespasser Scenario

Introduction

This section presents the technical rationale used by EPA to develop risk-based screening action levels for a trespasser scenario at the ARWW&S OU. These screening levels apply to soils in the areas that meet the combined criteria of 1) not being readily accessible to the public due to ownership by ARCO, 2) location on steep slopes in remote areas, and 3) area having controlled entry. These screening levels do not apply to any waste material at the site. The screening levels were developed based in part on public comments by ARCO and a technical memorandum prepared by ARCO regarding potentially exposed receptors and exposure scenarios (ARCO 1997). EPA believes that the risk-based screening levels developed herein are based on more appropriate exposure assumptions than those used by ARCO. From the screening levels presented herein, EPA selected the "Steep Slope/Open Space" arsenic action level, which is presented and discussed in Section 4 (below) and Section 6.1 of the Decision Summary portion of the ROD.

Exposure Pathways and Exposure Variables

The trespasser scenario is equivalent to the recreational exposure scenario of dirt bike riding, without the dust inhalation exposure attributed to dirt bike riding. Therefore, ingestion of surface soils is the only exposure pathway of concern for trespassers. In most instances, the exposure variables used to determine the level of contact a recreational dirt bike rider would have with contaminated soil are used for the trespasser scenario. Exposure variables for the Reasonable Maximum Exposure (RME) scenario are used to calculate arsenic trespasser screening levels.

Table 1 lists the parameters used to calculate RME arsenic screening levels for the trespasser scenario. Some of these values are reasonably well established default values (e.g., body weight) while other values are based on site-specific data (e.g., arsenic bioavailability, exposure frequency for riding dirt bikes). The arsenic bioavailability factor (BAF) is site-specific for the

Community Soils OU; it is applicable to soils in other areas of the ARWWS OU due to the similar types of arsenic contamination (i.e., aerially-deposited arsenic with a spectrum of arsenic phases similar to those of the Community Soils OU). A soil ingestion rate of 50 milligrams (mg) per visit is used for the trespasser scenario (Griffin 1998). The soil ingestion rate used for trespassers is less than that used for dirt bike riders (100 mg/visit) because trespassers are assumed to have less contact with soil (Griffin 1998).

Table 1
RME Exposure Variables Used to Calculate Arsenic Screening Levels for Trespassers

Symbol	Units	Definition	Value	Source
SL	mg arsenic/kg soil	risk-based screening level	to be calculated	-
TR	(unitless)	target risk	Cancer: 1E-04 to 1E-06 Noncancer: 1	EPA 1991
AT	days	averaging time	25550	EPA 1989
BW	kg	body weight	70	EPA 1989
EF	days/year	exposure frequency	26	Life Systems 1993
ED	year	exposure duration	30	EPA 1989
IR_s	mg/visit	soil ingestion rate	50	Griffin, 1998
CF	kg/mg	conversion factor for soil	1E-06	EPA 1989
SF_o	$(mg/kg\text{-}day)^{-1}$	oral slope factor for arsenic	1.5	EPA 1998
RFD_o	mg/kg-day	arsenic oral reference dose	3.0E-04	EPA 1998
BAF_s	(unitless)	arsenic bioavailability factor in soil	0.183	EPA 1995

mg = milligrams
kg = kilogram

Arsenic Screening Levels

The following equation is used to calculate arsenic screening levels for the trespasser scenario, based on the carcinogenic potential of arsenic:

$$SL = ((TR \times AT \times BW)/(EF \times ED \times IR_s \times CF \times SF_o \times BAF_s))$$

Exposure variables used in this equation are provided in Table 1.

To calculate arsenic screening levels for the trespasser scenario based on arsenic's potential for systemic effects, the following equation is used:

$SL = ((TR \times AT \times BW \times RfD_o)/(EF \times ED \times IR_s \times CF \times BAF_s))$

Exposure variables used in this equation are provided in Table 1.

Arsenic screening levels for the RME trespasser scenario based on carcinogenic and systemic effects are presented in Table 2.

Table 2
Screening Levels for Arsenic in Soil at the ARWW&S OU
RME Trespasser Scenario

Risk (unitless)	**Screening Level for Trespasser Scenario (mg/kg)**
Carcinogenic Risk	
1E-04	16,706
1E-05	1,670
1E-06	167
Systemic Risk	
1	32,219

Arsenic Action Level

Selection of Arsenic Action Level for the Trespasser

EPA believes that the exposure assumptions presented in Table 1, considering uncertainties, are reasonable. Therefore, the range of screening levels presented in Table 2 for the trespasser scenario, for the targeted risk range of 1E-04 to 1E-06, are considered to be an appropriate range from which to select an action level for remediation of hot spots. The EPA has selected an arsenic action level for the trespasser scenario of 2,500 parts per million (ppm). This action level corresponds to an excess cancer risk of 1.5E-05. Although the risk associated with this action level is greater than EPA's 1E-06 point of departure, EPA has determined that it is protective for the following reasons:

- The action level reflects detailed site-specific studies (i.e., arsenic exposure and BAF) conducted in Anaconda that significantly reduce the uncertainty associated with calculations of exposure. These studies provide site-specific parameters to replace standard EPA default assumptions which generate a greater degree of confidence in the range of screening values;

- Conservative assumptions were used for exposure frequency and duration; and

- This action level would apply to areas where access would not be convenient due to remoteness and steep slopes. The area where the action level would most likely be applied would be the undisturbed portion of Smelter Hill that is in ARCO's ownership. The area has kriged concentrations not exceeding 1,900 ppm (best average) and 2,500 ppm (upper confidence). Individual data points are generally below 2,500 ppm. Based on kriged concentrations, application of the 2,500 ppm action level would presumably result in an overall average concentration less than 2,500 ppm and risks less than 1.5E-05.

In addition to the above, risk management considerations included the following:

- Risk levels similar to this were previously used in remedial actions taken at the Anaconda Smelter Site under the Old Works/East Anaconda Development Area (OW/EADA) and Community Soils OU; and

- The action level incorporates a balancing of the National Contingency Plan (NCP) criteria used to select remedial actions that are protective, implementable, and cost effective. Technical and cost limitations would be significant to achieve an incremental risk reduction.

Application of the Trespasser Arsenic Action Level

As described above, the 2,500 mg/kg "Steep Slope/Open Space" arsenic action level only applies to soil in steep areas where human access is inconvenient or undesirable. Specifically, these areas lie in the Smelter Hill Subarea. This action level does not apply to soils that can be remediated in the Smelter Hill Subarea, to waste source areas, or soils in other parts of the site.

Other Arsenic Action Levels Based Upon Land Use

EPA developed arsenic action levels for surface soil and wastes at the ARWW&S OU for the targeted cancer risk range of 1E-04 to 1E-06. Arsenic action levels were selected from the risk-based screening levels for comparison to arsenic concentrations in soils and waste to determine the potential for risk. The action levels, selected based on technical and risk management considerations at the ARWW&S OU, are as follows:

Land Use Designation	Media	Concentration	Risk
Residential	Soil and Waste	250 ppm	8E-05
Commercial/Industrial	Soil and Waste	500 ppm	4E-05
Recreational	Soil and Waste	1,000 ppm	4E-05
Agricultural	Soil only	1,000 ppm	1E-04
Steep Slope/Open Space	Soil only	2,500 ppm	1E-05

Please refer to Section 6.1 of the Decision Summary portion of this ROD for a thorough discussion of the human health risk assessment process and the selection of these action levels.

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ATTACHMENT J

Additional FS Comments:

These additional FS comments are provided based on EPA's proposed plan.

1) Section 2.1.4, page 2-13

High Arsenic soils are defined as areas containing arsenic greater than 1,000 ppm.. -This statement does not take into account that the areas greater than 1,000 ppm arsenic are within areas owned by ARCO, controlled by restrictive covenants or dedicated developments. Where access is restricted (i.e. trespasser scenario), arsenic concentrates would have to exceed 5,500 ppm to pose a calculated risk of greater than 10-4

Response: See EPA's response to ARCO Attachment I - Trespasser's Scenario.

2) Section 2.1.4, Page 2-13

Sparsely vegetated soils are defined as areas having "poor composition".

- Poor composition is undefined; areas can have suitable vegetation cover and provide for stable soil; plant diversity is not required by CERCLA to protect human health or the environment.

Response: No where does EPA assert that plant diversity is required to protect human health. Plant composition and diversity is an indication of ecosystem health and was assessed during the BERA and is used in the LRES scoring to determine effects of metals on plant communities (i.e., absence of metals sensitive plant species in areas with elevated metals and arsenic soils concentrations). The objective of a diverse and abundant plant community will be met through establishment of vegetation success criteria during RD.

3) Section 2.1.4, page 2-13

Groundwater areas of concern are defined as those areas exceeding WQB C-7 standards.

-WQB C-7 standards are pertinent only for those areas which are or are reasonably anticipated to be used as a potable water source, or those waters which may impact the State's surface waters. The areas of impacted groundwater underlying ARCO's land ownership, and those of lands with restrictive covenants, can not be now or in the future developed for potable water use. Certain groundwater areas can recharge into ditches which are used solely for water management. Other effected groundwater areas do not impact down gradient State surface water bodies.

Response: See EPA's responses to WQB-7 ground water standards in Attachment L.

4) Section 2.1.4, page 2-13

Surface water areas of concern are defined as those stream reaches exceeding WQB-7 standards.

-WQB-7 standards do not represent the best estimate of potential risk for the stream reaches. A water effects ratio adjusted dissolved criteria more appropriately reflects the risk status of those reaches. It must also be noted that background concentrations of arsenic were

detected above WQB C-7 standards in Willow and Mill Creeks.

Response: See EPA's response to WQB-7 standards in Attachment L.

5) Section 3. 1. 1, page 3 -4, 1 st paragraph

Land uses within the ARWW'S OU also include waste management and open space areas.

Response: Comment noted; these land uses are included in EPA's final assessments.

6) Section 3. 1. 1., page 3 -4, 1 st paragraph

Human receptors also include trespassers as an exposure scenario.

Response: See EPA's response to ARCO's Attachment I.

7) Section 3.1.2, page 3-5

Additional Ecological Risk Assessment comments are provided in Attachments G and H.

-The statement that " a positive correlation between COC concentrations and easily observed phytotoxic effects at the site" does not take into account that for almost 100 years the Smelter Hill, Old Works and Opportunity Ponds subareas were, industrial facilities with over 1,000 workers, processing millions of cubic yards of ore concentrate. These areas were cleared of vegetation and stripped of topsoil to construct these facilities. While a positive correlation between the location of operating facilities to sparse vegetation exists; this does not correlate to a CERCLA exposure to hazardous substances.

Response: See EPA's response to Attachments G and H.

8) Section 3.2.1.2, page 3-9

Relevant and appropriate (R&A) requirements are identified to provide guidance on what type of situations may occur at sites and what type of solutions may exist, not for evaluation of alternatives for ARARs compliance. If an alternative meets applicable standards, then the alternative compiles with ARARs.

Response: Comment noted.

9) Section 3.2.4, page 3-13, 2nd Paragraph

It should be noted that Red Sands has been observed and documented to extend south of the Red Sand pile to Highway I and east of the pile to Highway 48. Therefore it should be specified that the Red Sands, within the Old Works area, has a lateral extent which meets the boundaries specified above.

Response: Comment noted.

10) Section 3.3, page 3-15

The PRAGS for solid media need to include the land Designation of Trespasser, with a respective standard of 5,500 ppm Arsenic (for 10-4 risk), based on the extensive privately held land holdings within the waste management areas.

Response: EPA disagrees. See response to Attachment I.

11) Section 3.3, page 3-15

PRAGS for surface waters do not take into account the site-specific scientific data for determination of potential risks. Both Federal and State regulations allow for risk-based alternative standards to be utilized as PRAGS.

Response: The State of Montana has not adopted site-specific criteria for streams in the Anaconda area. See response to Attachment L.

12) Section 3.3 3. 1, page 3-16

The point of compliance for the Opportunity Ponds should be located "at and beyond the edge of WMAs when waste is left in place". (1990 NCP Preamble). In some cases, such as where several distinct sources are in close proximity, it may be appropriate to move the point of compliance to encompass the sources of release." In such cases, the point of compliance may be defined to address the problem as a whole, rather than source by source. (1990 NCP Preamble at 55 Federal Regulation 8753).

Response: Comment noted. The final point of compliance for the Opportunity Ponds area is at the edge of the ponds.

13) Section 3.3. 1, page 3-16

Establishment of wildlife habitat and accelerating successional processes are not required to minimize potential environmental and human health risks from alleged releases of hazardous substances. Therefore these two objectives go beyond EPA's mandate for remediation under CERCLA and should be deleted as PRAOs for each subarea. The PRAOs should also be modified to state that soils containing surficial soils COCS greater than applicable exposure scenarios should be stabilized to minimize wind & water erosion. How an area is stabilized is to be evaluated as an alternative, not mandated as a PRAO.

Response: Comment noted. See EPA's response to comments on PRAOs in Attachment L.

14) Section 3.3. 1, page 3 -16, Waste Sources

The Opportunity Ponds are not required to be closed as mine waste facility. Mine reclamation standards are not applicable to the Opportunity and Anaconda Ponds and should not be deemed relevant and appropriate. Mine reclamation requirements are not "well-suited" to the Opportunity and Anaconda Ponds and should not be identified as ARARs for these areas. It should also be reinforced that the end land use for the privately held ponds is a waste management area, with defined restrictive covenants.

Response: See EPA's response to comments on mine reclamation ARARs in Attachment L.

The toe wastes can be stabilized in-place. These materials do not present a risk to ground and surface *water following this stabilization. This consolidation should be deleted as a* ***PRAO, and alternatives*** *should be evaluated to determine the appropriate remedy. The PRAO of stabilization of soils against wind and surface water erosion can be accomplished by utilization of different alternatives, one of whi*[illegible] *is revegetation. Therefore, the PRAO should be modified to include only stabilization and not presume* [illegible] *treatment alternative as part of the PRAO.*

Response: See EPA's response to comment on PRAOs in Attachment L.

15) Section 3.3.2, page 3-17, High Arsenic Soils and Sparsely vegetated

See comments #13.

Response: See response to #13.

16) Section 3.3.2, page 3-18, Groundwater

"Elimination of loading sources of cadmium" should be deleted as a PRAO. The PRAO should be modified to return groundwater to its beneficial use. There are no current or reasonably anticipated future potable use of groundwater in the vicinity of the drag strip.

Response: Just because there is no current use of ground water in the vicinity of the Drag Strip does not eliminate the need to restore a ground water resource. Cadmium is significantly elevated above the WQB-7 standard. The plume has not been fully characterized and has been noted to extend beyond the Old Works OU boundary. The PRAO is a valid and necessary objective.

17) Section 3.3.3, page 3-18, Sparsely Vegetated Soils

- *See comments #13.*

Response: See response to comment #13.

18) Section 3.3.3, page 3-19, Blue Lagoon

- *See comments #13.*

Response: See response to comment #13.

19) Section 3.3.4, page 3-19, High Arsenic and Sparsely Vegetated Soils

See comments #13.

Response: See response to comment #13.

20) Section 3.3.5, page 3-20

The main granulated slag pile will be sold as a product to a viable entity (s).

Response: Comment noted. The final remedy requires appropriate legal contracts for long-term use of the slag.

21) Section 3.3.5, page 3-21

The NCP expressly allows for wastes that are of similar quality and close proximity to be grouped and managed as one WMA. Since there are no current or potential future ground water users between each subarea WMA, and they meet the intent of the regulations, a down gradient edge of the single, grouped WMA is appropriate. (See comment #12)

Response: See EPA's responses on WMAs and POCs in Attachment L.

22) Section 3.3.5, page 3 -2 1, Waste Source
See comments #14.

Response: See response to comments #14.

23) Section 3.3.5, page 3-22, High Arsenic and Sparsely Vegetated Soils

See comments #13.

Response: See response to comments #13.

24) Section 3.3.5, page 3-22, Surface Water

The PRAO should be modified to reflect that the objective for Mill Creek is to return surface water to its beneficial use. The around water seep located in Cabbage Gulch can exceed WQB C-7 while not effecting surface water receptors.

Response: The fact that water seeps in Cabbage Gulch exceed WQB-7 means that there is a violation of ground water and surface water standards. The PRAO is appropriately set to require remediation of surface water to the state standards.

25) Sections 4. 1. 1, page 4-2

A discussion and recognition of the extent of natural recovery of all subareas should be included. As can be seen in Attachment A, a substantial amount of revegetation has occurred between 1988 to 1997.

Response: EPA disagrees that there has been "substantial amount of revegetation" occurring within the areas of concern between 1988 and 1997. The LRES system is designed to assess where natural succession is occurring and set up to monitor those areas. Vegetation performance criteria will be set in the RD process.

26) Section 4.1.2, page 4-2

The monitoring alternative should include a discussion of the potential of natural recovery to continue to reclaim areas over time. As can be seen in Attachment A extensive areas of revegetation have occurred within 10 years. Natural recovery should be included as a component of monitoring as part of a remedial alternative, so as, over time sparsely vegetated areas may with appropriate management meet applicable success criteria or receive lower levels of reclamation.

Response: EPA agrees that some areas may have success in meeting applicable criteria or receive lower levels of reclamation. See Appendix C, LRES, and response to comments Attachment A. EPA disagrees that extensive areas of revegetation have occurred in the last 10 years.

27) Section 4.1.3, page 4-2

The Institutional Controls alternative should include the use of BMPs.

Response: BMPs have been included, as appropriate, in the final remedy.

28) Section 5.2. 1, page 5-5

Monitoring and natural recovery should be added to the list of alternatives for solid media. This alternative would also include ICs, particularly the use of BMPs and weed control.

Response: Elements of monitoring, BMPs, and weed control have been included in the LRES and remedial design process.

29) Section 5.2. 1, page 5-6, Soil Cover

The soil cover alternative can utilize less material that 2 feet of soil and/or rocks and cobble to stabilize the underlying soil and provide for sufficient seed bed as appropriate.

Response: Soil cover criteria was adjusted to a minimum of 18 inches, with other appropriate design parameters, to provide good growth media for plants.

30) Section 5.2. 1, page 5-6, Reclamation

- *The level I Reclamation alternative should also include the aerial application of fertilizer.*
- *All amendment application would be as determined through data collection as necessary.*

Response: Comments noted. Aerial application of fertilizer is a remedial action implementation question.

31) Section 5.2. 1, page 5-7, Level III

The objective of establishing grazing and wildlife habitat is beyond that which is authorized under CERCLA for minimizing risk to human health and the environment from release of hazardous substances.

Response: The establishment of grazing and wildlife habitat will be an outcome of reducing COC concentrations in soils and allowing plant to re-establish. This reduces risk to the environment.

32) Section 5.2. 1, page 5-8, Rock

Pit run and coarse slag should be included as acceptable materials use as a rock cover.

Response: An industrial cover is allow for certain dedicated developments on the site (e.g., active railroad beds). During remedial design, appropriate covers will be determined.

33) Section 5.2.2, page 5-9

Point of compliance's for ground water are determined based on ground water quality, current and potential future ground water users, land ownership and groundwater flow paths.

Response: POCs are not set based on land ownership. POCs are appropriately set for this site.

34) Section 5.2.2, page 5-11

The potential for additional remedial action for groundwater would need to be based on a consistent, significant degradation above primary MCLs beyond the established single points of compliance boundary below the Opportunity Ponds. At this time additional source controls and the potential for treatment would be reviewed.

Response: EPA agrees that the need for additional remedial action will be based upon degradation, but above the State of Montana WQB-7 standards. The performance criteria will be established in the remedial design. The point of compliance monitoring will be applied to all three points of compliance, not just at the Opportunity Ponds.

35) Section 5.2.2, page 5-12, Stormwater

An overview of the conceptual stormwater plan is provided in Attachment C.

Response: Comment noted.

36) Section 5.3.3, page 5-17

A point of compliance is not necessary for this subarea. Monitoring will continue and sources of irrigation have been eliminated.

Response: EPA agrees. The entire alluvial aquifer in the South Opportunity Subarea will have to attain the ground water standard.

37) Section 5.3.5, page 5-19

A point of compliance for the TI area is not necessary.

Response: EPA agrees. The boundaries of the TI zones will be monitored and a single point of compliance is not established.

38) Section 5.5.7, page 5-23), Cost

Add present worth discussion.

Response: An explanation of how present worth is calculated is included in Appendix E.

39) Section 5.5.8, page 5-23, State Acceptance

EPA states that "Assessment of state concerns will not be completed until comments on FS No.5 are received." ARCO is requesting a copy of the state comments, since this is one of the 9 criteria which EPA used to develop it's proposed plan.

Response: Comment noted. Copies of the State of Montana's comments will be sent to ARCO.

40) Section 6. 1. 1, page 6-1

Monitoring, ICs and natural recovery should be included as an additional alternative to be evaluated for each area of concern.

Response: Monitoring and ICs were included as part of the No Further Action scenario in FS Deliverable No. 5.

41) Section 6. 1. 1. 1, page 6-1

Restrictive covenants are also included on all ARCO owned land.

Response: Comment noted. Deed restrictions may become part of the site-wide Institutional Controls Plan.

42) Section 6. 1. 1. 1, page 6- 1, Effectiveness

- *The human health exposure scenario should also include analysis of a trespasser scenario. As such, no high arsenic soils would be defined in this subarea. Therefore, 356 acres as defined here as an area of concern should be deleted.*

Response: See EPA's response to Attachment I; and Section 6 of the Decision Summary. No acres were deleted from the total areas of concern at this point.

- *The PRAO of wildlife habitat and successional reclamation is not a CERCLA authorized objective for protection of human health and the environment, and therefore should be deleted and the conclusion modified accordingly.*

Response: PRAO were modified as noted in Section 9 of the Decision Summary; see EPA's response to comments Attachment L.

43) Section 6.1.1.2, page 6-3 Implementability

It is not required for superfund activities to obtain permits.

Response: Comment noted; substantive requirements of permits must be met if the action is specific to a CERCLA required remedy implementation.

44) Section 6.1.1.2, page 6-4, Cost

Cost comments will be provided to Appendix C for each alternative as appropriate.

Response: See Appendix E, Revised Cost Assumptions.

45) Section 6.1.1.4, page 6-6

See comment #42

Response: See response to comment #42

46) Section 6.1.2. 1, page 6-8

The PRAO of wildlife habitat and successional reclamation is not a CERCLA authorized objective for protection of human health and the environment, and therefore should be deleted and the conclusion modified accordingly.

Response: The PRAO has been modified per Section 9; see additional EPA's response to comments on Attachment L.

47) Section 6.1.2. 1, page 6-10

See comment #46.

Response: The PRAO has been modified per Section 9; see additional EPA's response to comments on Attachment L.

48) Section 6.1.3. 1, page 6-11

The restrictive covenants which are placed on this subarea should be included in the alternative description. General comment. It should be acknowledged the variable chemical and physical nature of the ponds and the constructability concerns of working on unstable material.

Response: These are both remedial design issues and will be addressed during that phase of the project.

49) Section 6.1.3. 1, page 6-12, Effectiveness

The PRAO of wildlife habitat and successional reclamation is not a CERCLA authorized objective for protection of human health and the environment, and therefore should be deleted and the conclusion modified accordingly.

Response: See response to comment #46 and #47.

The PRAO of consolidation of the Toe Wastes, is inappropriate. The Toe Waste material should be evaluated separately for selection of an appropriate remedy.

Response: Removal and consolidation of the Toe Wastes are an appropriate alternative to assess in the final Feasibility Study. This alternative was selected as the final remedy.

50) Section 6.1.3.2, page 6-13

See comment #49. Two feet of soil cover is not required to stabilize the soils from wind and water erosion and to provide for dust suppression, See comment #43.

Response: See response to comment #49 and #43.

51) Section 6.1.3,4, page 6-17

See comment #49.

Response: See response to #49.

52) Section 6.1.3.6, page 6-20

See comment #32. See comment #49. Rock amendment would meet the R and A Montana State mine waste reclamation objectives.

Response: See response to comments #32, #49; Rock amendments do not meet the relevant and appropriate requirements of the Montana State mine reclamation objectives (see responses to Attachment L).

53) Section 6.1.3.7, page 6-22

Alternatives should be rescreened based on the revised PRAOs and cost assumptions.

Response: Alternatives were not rescreened. The alternatives were appropriately selected and carried forward into the detailed analysis of alternatives.

54) Section 6.1.4. 1, page 6-22

The South Lime ditch includes land which has restrictive covenants on the deed. It should also be noted that trail development in this area has been deleted from the recent Master Plan update. See comment #46.

Response: Restrictive covenants are not a replacement for active remediation of a site to reduce risk to human health and the environment; trails development is included in the Master Plan updates; see response to #46.

55) Section 6.1.4.2, page 6-25

General comment. Many of these technologies, due to the extent of remediation, are not easy to implement. Care should be taken to avoid gross simplification of major construction activities.

Response: EPA does not imply that major construction activities are "simple" to implement. "Easy" to implement is used in the context of CERCLA defined "implementability" meaning the technologies use standard engineering and construction practices.

Restoration of groundwater within the Opportunity Ponds subarea is not a PRAO, and as such the conclusions should be modified.

Response: Comment noted.

56) Section 6.1.4.3, page 6-27

See comment #55

Response: See response to comment #55.

57) Section 6.1.4.4, page 6-28

o*See comment #55.*

Response: See response to comment #55.

58) Section 6.1.5. 1, page 6-3 2

o*See comment #13.*

Response: See response to comment #13.

59) Section 6.1.6.2, page 6-40, Effectiveness

o*Based on comment #13 the Rock Amendment alternative meets PRAOs.*

Response: Based on response to comment #13, Rock Amendment does not meet all PRAOs.

60) Section 6.2. 1, page 6-47, High Arsenic Soils

Rock cover, reclamation and soil cover each meet the PRAOs and ARARs for the site.

Response: Rock cover does not meet all PRAOs and ARARs for the site.

61) Section 6.2.2, Page 6-50

See comment #13.

Response: See response to comment #13.

62) Section 6.2.3, page 6-50

See comment #58.
Of remaining alternatives, soil cover, reclamation and rock cover each provide for a permanent remedy. Each of these alternatives may be utilized to an extent for remediation of the opportunity ponds. Rock cover is the most cost effective of the three alternatives.

Response: See response to comment #58. Rock cover clearly does not meet ARARs and PRAOs and therefore is not the most cost effective remedy.

63) Section 6.2.4, page 6-53

Costs are commented on in Appendix C.
Multiple alternatives may be most appropriate for individual polygons within each subarea.
Of all alternatives, removal is not the most cost effective.

Response: Comments on Costs are responded to in Appendix E; the LRES provides the basic set of alternatives for individual types of polygons within each subarea; EPA agrees that removal may not be the most cost effective but may provide superior attainment of ARARs and reduction of risk.

64) Section 6.2.5, page 6-55

Each of the three alternatives provide for protection of human health and environment. Each alternative meets the appropriate PRAOs. The reclamation alternative is the most cost effective option.

Response: EPA agrees with ARCO's conclusion on the three alternatives for Triangle Waste (soil cover, reclamation, and removal).

65) Section 6.2.7, page 6-57

Utilization of the existing interception trenches or enhanced wetlands areas for groundwater management were not evaluated in the FS.

Response: Comment noted. These will be evaluated in the remedial design.

Prior to selecting treatment, an additional evaluation of source control would be required.

Response: EPA agrees.

66) Section 7. 1. 1. 1, page 7-1

Monitoring, ICs and natural recovery should be included as an alternative.

Response: Monitoring and ICs were included in the No Further Action Alternative.

67) Section 7. 1. 1. 1, page 7-1

o See Comment #13.

Response: See response to comment #13.

68) Section 7.1.1.4, page 7-7

o See comment #13.

Response: See response to comment #13.

69) Section 7.1.2. 1, page 7-9

See comment #13

Response: See response to comment #13.

70) Section 7.1.3 3, page 7-16

The need for an upgraded bridge on Warm Springs Creek would be evaluated during RD.

Response: EPA agrees.

71) Section 7.2. 1, page 7-21

Reclamation reduces surfical concentrations of arsenic, therefore both soil cover and reclamation result in sufficient risk reductions to have equal protectiveness. Costs are addressed in Appendix C.

Response: EPA agrees; response to Costs are found in Appendix E.

72) Section 8. 1. 1. 1, page 8-1

o See comment #13.

Response: See response to comment #13.

73) Section 8.1.1.2, page 8-2

General comment; the soils should not be consolidated as required - this should be modified to graded as required.

Response: Comment noted.

74) Section 8.1.2.6, page 8-11

Suggest modifying sentence to read "All alternatives would require consolidation of unvegetated tailings located on the banks".

Response: Comment noted.

75) Section 8.1.3.3, page 8-15

Soil cover should be modified to low-maintenance trail surface (approximately 6 inches cover).

Response: The appropriate soil cover to accommodate trails will be decided during remedial design.

76) Section 8.1.4. 1, page 8-19

oSee comment #13.

Response: See response to comment #13.

77) Section 8.1.4, page 8-19

Reclamation should have been included as an alternative. The Blue Lagoon can be stabilized to meet appropriate PRAOs and be cost effective through implementation of reclamation.

Response: EPA believes the copper precipitation concentrations are too high to allow for reclamation.

78) Section 8.1.4.3, page 8-20

Instead of a soil cover and geo cells, the railroad embankment should receive rock cover as appropriate. Rock cover is more appropriate for use on a railroad grade, since the railroads' do not want vegetation on their embankments.

Response: Comment noted.

79) Section 9. 1. 1. 1, page 9-1

It should be noted that portions of this subarea are included within the Old Works Historic District.

Response: Comment noted.

See Comment #13.

Response: See response to comment #13.

80) Section 9. 1. 1. 1, page 9-1

An alternative should be included which looks at tree and shrub planting as an additional stabilization alternative.

Response: This alternative was included in the LRES system; see Appendix C.

81) Section 9.1.2. 1, page 9-8

oSee comment #13.

Response: See response to comment #13.

82) Section 9.1.2.3 3, page 9-11

oSee comment #13.

Response: See response to comment #13.

83) Section 9.1.3. 1, page 9-12

The Drag Strip area is currently being remediated under the OW/EADA OU. No additional work in this area is anticipated.

Response: Comment noted; EPA did not include further work in the Drag Strip area as part of the final remedy.

84) Section 9.1.3.3, page 9-15

There is no defined high Cd waste source located within the Drag Strip area. Therefore, this alternative should be eliminated.

Response: No specific waste sources have been identified in the Drag Strip area which may be contributing to the identified cadmium plume. The ground water will have to be monitored and a loading source may be identified in the future.

85) Section 9.1.3.1

Natural attenuation was not included as an alternative. Several actions have occurred on or in close proximity to the Drag Strip. The benefits of these actions have not been fully accounted for.

Response: The final remedy calls for completion of the source controls measures outlined in the OW/EADA ROD, natural attenuation and compliance monitoring.

86) Section 9.1.4. 1, page 9-16

Monitoring, at the toe of the Red Sands cap does not account for the Red Sands located downgradient of the pile, or the results of the tailings and Arbiter removal action.

Response: EPA acknowledges that additional waste material is located down gradient of the Red Sands cap. The agency believes that the remedy selected in the OW/EADA ROD, after full implementation, and in conjunction with natural attenuation, will lead to improvements in the ground water and eventual attainment of the ground water standards. See Section 9 for further information.

Containment of the plume is not required at the Red Sands pile since downgradient areas have also been shown to periodically exceed PRAGs.

Response: Containment may be required in the future to further reductions of cadmium loading to ground water from the Main Deposit of the Red Sands.

It should also be noted that this area has restrictive covenants placed on the properties to preclude groundwater use.

Response: These restrictive covenants will be used until ground water standards are attained in the area.

87) Section 9.1.5. 1, page 9-22

See comment #13.

Response: See response to comment #13.

A conceptual stormwater management plan has been submitted and reviewed by EPA. This plan is summarized in Attachment C to the proposed plan comments.

Response: Comment noted. The final site-wide conceptual storm water management plan will be approved under the RD/RA process at ARWW&S OU.

88) Section 9.2. 1, page 9-24

See comments #13 and #1.

Response: See response to comment #13 and #1.

89) Section 9.2.2, page 9-26

General comment; monitoring, ICs and natural recovery alternative should be included in all soils alternative evaluations.

Response: Monitoring and ICs were included in all No Further Action alternatives.

90) Section 9.2.3, page 9-29

Reclamation should be included as an alternative to be evaluated.

Response: Storm water BMPs (e.g., reclamation) has been included in the final remedy.

91) Section 9.2.5, page 9-29

oSee comment #land #13.

Response: See response to comment #13 and #1.

92) Section 10.1.1.1, page 10-1

oSee comment# I and# 13.

Response: See response to comment #13 and #1.

93) Section 10. 1. 1.4, page 10-6

oSee comment#1 and #13.

Response: See response to comment #13 and #1.

94) Section 10. 1. 2. 1, page 10-8

See comment # 13.

Response: See response to comment #13.

Should include tree and shrub planting as a soil stabilization alternative.

Response: This alternative was included in the final set of applicable reclamation techniques for the site.

95) Section 10. 1.2.3, page 10-11

o*See comment #13.*

Response: See response to comment #13.

96) Section 10.1.4.1, page 10-23

o*See comment #13 and #14.*

Response: See response to comment #13 and #14.

97) Section 10. 1.4.2, page 10-24

Surface water drainage would be managed, but it is infeasible and unnecessary to route water off the ponds.

Response: EPA agrees.

98) Section 10. 1.4.4, page 10-28

o*See comment # 13 and # 14.*

Response: See response to comment #13 and #14.

99) Section 10.1.4.6, page 10-30

o*See comments # 13, # 14 and #32.*

Response: See response to comment #13,#14 and #32..

100) Section 10.1.4.6, page 10-31

o*See comments #13 and #14.*

Response: See response to comment #13 and #14.

101) Section 10. 1. 5. 1, page 10-33

o*See comment #13.*

Response: See response to comment #13.

102) Section 10. 1. 6. 1, page 10-36

o*See comments #13 and #14.*

Response: See response to comment #13 and #14.

103) Section 10.1.6.4, page 10-41

oSee comments #13 and #14.

Response: See response to comment #13 and #14.

104) Section 10.1.7, page 10-42

oSee comment #12.

Response: See response to comment #12.

105) Section 10. 1. 8, page 10-46

Reclamation to reduce infiltration and runoff should have been included as an alternative to be evaluated.

Response: Reclamation included the objective to reduce infiltration and runoff, in addition to reduction of risk to the environment.

106) Section 10. 1.9. 1, page 10-50

• See comment #13.

Response: See response to comment #13.

107) Section 10.1.9.2, page 10-51

oSee comment #13.

Response: See response to comment #13.

108) Section 10.1.9.3, page 10-52

oSee comment #13.

Response: See response to comment #13.

109) Section 10.2. 1, page 10-55

oSee comment #1 and #13.

Response: See response to comment #1 and #13.

110) Section 10.2.2, page 10-55

oSee comment #13.

Response: See response to comment #13.

111) Section 10.2.3, page 10-57

The No Further Action does not recognize the restrictive covenants in place.

Response: EPA disagrees; ICs were included in the No Further Action alternatives; ICs are not considered a replacement of protection of human health and the environment or attainment of ARARs.

112) Section 10.2.3, page 10-60

The No Further Action does not recognize the ICs and soil covers that are already in place within the EAY. Therefore, the conclusion should be modified.

Response: EPA disagrees; existing soil covers and ICs were evaluated in this alternative. The final remedy selected this alternative.

113) Section 10.2.4, page 10-60

See comment # 13. Rock amendment provides similar long-term effectiveness as the revegetation alternatives.

Response: See response to comment #13. Rock amendment does not provide similar long-term effectiveness for reduction of risk to the environment or attainment of ARARs.

114) Section 10.2.6, page 10-63

oSee comment #13.

Response: See response to comment #13.

Reclamation and soil cover provide equal degrees of protection as each provide for comparable revegetation success.

Response: EPA agrees and modified the ROD to reflect this.

115) Section 10.2.9, page 10-69

See comment #1 and # 13.

Response: See response to comment #1 and #13.

116) *Costing Assumption*

RESPONSE: EPA responded to all cost changes in Appendix E.

Appendix G - Best Management

This document provides an overall good first step to attempt to bridge between the FS, the Stucky Ride Work Plan and the Remedial Design. Attachment A of ARCO's proposed plan comments attempts to further the approach suggested within MSU's BMP document.

RESPONSE: EPA notes the comments attached to this section.

Response to ARCO Comments in Attachment L

ARCO's Previously Submitted Comments on the ARWW&S RI/FS	Response
1 Letter to Julie DalSoglio, EPA Montana Office, from Stephen E. Dole, ARCO, Re: Review of Final Preliminary Baseline Ecological Risk Assessment, Anaconda Regional Water and Waste Operable Unit, November 15, 1995.	1 See response to ARCO's Comments in Attachment G/H, Ecological Risk Assessments, matrix of responses to combined ecological risk comments.
2 Letter to Julie DalSoglio, EPA Montana Office, and Andy Lensink, EPA, from Phyllis Flack, ARCO, Re: ARCO Disclaimer Anaconda Regional Water and Waste Operable Unit, Final Remedial Investigation Report, May 22, 1996.	2 On March 15, 1996, ARCO submitted the Final Anaconda Regional Water and Waste Remedial Investigation Report, Volumes 1 through 4, to the EPA and MDEQ. These documents were approved by EPA on May 2, 1996 (see letter from Julie DalSoglio, EPA Montana Office to Phyllis Flack, ARCO, *Final Approval of Anaconda Regional Water and Waste Operable Unit Final Remedial Investigation Report February 1996*). ARCO subsequently submitted the "disclaimer letter" on May 22, 1996. At the time of receipt of the letter, EPA considered issues raised by ARCO as insignificant and minor to the overall interpretation of ground water and surface water contamination across the southern Anaconda-Deer Lodge Valley.
2a Issue 1 (Stream Classification): "All streams in the ARWW OU were classified as B-1 by the State of Montana....Because of the sizes, locations, population density, and diversity of streams in the ARWW, ARCO believes it is not appropriate to categorize all streams in the ARWW OU as B-1. As such B-1 stream classification standards should be reviewed and modified for specific stream reaches..."	2a Response: The beneficial uses for surface water are defined by the B-1 classification of all tributaries to the Upper Clark Fork River (with the exception of Silver Bow Creek, designated by the I classification) found in ARM § 17.30.623. The stated goal of the State of Montana is to have B-1 streams fully support a number of beneficial uses, including drinking, swimming, growth and propagation of fishes and other aquatic species, and agricultural and industrial water supply. The beneficial uses are considered supported when the applicable standards for ambient water quality, contained in department Circular WQB-7, are met. The Clean Water Act, 33 U.S.C. § 1251, <u>et seq.</u>, provides the authority for each state to adopt water quality standards designed to protect beneficial uses of each water body and requires each state to designate uses for each water body. The State of Montana has appropriately followed implementation of this legal requirement, therefore, the B-1 classification and standards and designation of beneficial use of the Anaconda streams are applicable to this site.
2b Issue 2 (Recharge - Vadose Zone Flow): ARCO and the Agencies agree with the overall concepts and methodologies involved in estimating and presenting a range of net infiltration of precipitation through the tailings in the Anaconda and Opportunity Ponds. However, ARCO maintains that it is not accurate to refer to net infiltration or deep drainage as ground water recharge. Various factors such as stratification, clay layers within the tailings or water vapor flow may limit or reduce the final amount of net infiltration reaching ground water on an average annual basis.	2b "Recharge" is generally defined as the replenishment of water beneath the earth's surface, usually through percolation through soils or connection to surface water bodies. [1] The Southern Deer Lodge Valley hydrologic model appropriately assessed net infiltration and/or deep drainage as part of the Final ARWW RI report. EPA does not disagree that factors such as clay layers may limit or reduce the final amount of net infiltration, however, in the absence of data from underneath the ponds (data which ARCO refused to collect as part of the RI investigations), it was appropriate to conservatively estimate net infiltration as part of the numeric model calculations.

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[1] Committee on Ground Water Cleanup Alternatives, Water Science and Technology Board, Board on Radioactive Water Management, Commission on Geosciences, Environment, and Resources, National Research Council, *Alternatives for Ground Water Cleanup*, 1994, p. 294.

ARCO's Previously Submitted Comments on the ARWW&S RI/FS	Response
2c Issue 3 (Acid Neutralization Potential for the Opportunity Ponds): Although ARCO and the Agencies agree in general with the general method for estimating acid neutralization...This estimate does not account for other attenuating factors such as mechanical dispersion or adsorption to clays. Therefore, ARCO believes that these estimates...are an overestimate of future site conditions.	2c The Final ARWW RI report notes, "...it is not possible to know precisely the amount of acid that will enter the alluvium or the amount of carbonate that will actually be available to neutralize the acid." (page 6-61.) Without further hydrogeological and geochemical studies of the area underneath the ponds or of the tailings materials itself, EPA and MDEQ cannot determine whether the acid neutralization potential calculated in this report is either an over- or under-estimate. This ROD requires continual monitoring of the bedrock/alluvial aquifer systems in the Smelter Hill/Anaconda Ponds area and the alluvial aquifer system in the Opportunity Ponds area and the agencies may therefore require further site characterization in the future.
2d Issue 4 (Ground Water Concentration Isopleth Maps and Cross-Sections - Subarea Characterizations - Section 4.0 (Old Works/Stucky Ridge Subarea), 5.0 (Smelter Hill Subarea), 6.0 (Opportunity Ponds Subarea) and 7.0 (South Opportunity Subarea)): ARCO would have preferred the simple posting of ground water quality values next to data sites rather than creating isopleth maps and cross-sections in the RI....This style of presentation leads the reader to believe that the shape and chemical gradients within a particular ground water contaminant plume have been defined...the wide variability on such a local scale should preclude widespread interpolation.	2d ARCO's final comment on the requirement to use isopleth mapping for the ARWW site is interesting. EPA rejected ARCO's proposal that the RI use posting of water quality values next to data sites because this kind of analysis could not help define the origin of contaminant source areas and/or predict the downgradient zone of dissolved contaminants. Determination of contaminant sources was a key objective of the RI investigations in order to develop feasibility study options and select an appropriate remedial action. EPA and MDEQ fully understand the uncertainty of applying interpolation of few data points across widespread areas, however, over 150 monitoring wells were installed and sampled during 1991 - 1994, additional wells were installed as part of the 1996 FS Supplemental Field Investigation, and TI Zone wells and springs/seeps were used as part of continuing site characterization in 1997. With a large site, relatively limited data points, and expansion of ground water use for domestic purposes into previously uninvestigated areas, EPA and MDEQ will require continued monitoring and site characterization as part of this final remedy to assure that human health is protected.
2e Issue 5 (Numeric Modeling): ...ARCO agrees that additional information may have been helpful in refining certain aspects of the numeric model. But, refinement of certain components of the numeric model may not have been practical or add any significant beneficial insight to that which is currently know... Overall, the final model represents an excellent tool for describing the general ground water flow directions and quantities (on a regional scale) within the ARWW OU.	2e In a previous comment ARCO argues that the agencies should not call net infiltration "recharge" because we do not understand the extent of stratification, clay layers within the tailings or water vapor flow which may limit or reduce the amount of net infiltration. This is an example of a data gap which would have influenced the numeric hydrologic model outputs for the Southern Deer Lodge Valley. Because of the size of the site, the amount of area contaminated by acid mine drainage into alluvial and bedrock aquifers, and transport of dissolved arsenic from aerially contaminated soils into bedrock aquifers, the agencies have continued to direct ARCO to collect additional site data during 1996, 1997 and 1998 to further decision making on the ability to minimize ground water contamination and protect human health. This site will continue to require data collection and analysis for long-term management of the ground water plumes.
2f Issue 6 (Pore Water Chemistry Beneath Main Slag Pile): In Section 5.7, the pore water chemistry in the vadose zone within and beneath the main slag pile has been identified as a data gap...there is no reason to believe that the slag pile itself is a source of arsenic in Monitor Well 211 given the relatively low concentrations of arsenic detected in pore water samples, the extremely low flow rates typically found in the vadose zone, the thickness of the vadose zone, and relatively high flow rates that have been calculated for the underlying aquifer...ARCO is in agreement with the statement on page 5-85, that "it does not seem likely that the slag is a source of arsenic."	2f At the direction of EPA and MDEQ, ARCO installed three lysimeters in the Main Slag Pile in 1995 to collect pore water samples from granulated slag and the underlying alluvium. Concentrations of arsenic in pore water samples collected at the Main Granulated Slag Pile range from less than 20 *ug/L* at SLAGLY1 and SLAGLY2S to 80 *ug/L* at SLAGLY2D. During drilling operations at SLAGLY2, composite samples of drill cutting material were collected and analyzed. Results indicate material penetrated in boring SLAGLY2 below a depth of 70 feet contains little slag, and is dominated by quartz suggesting the material is not a smelting byproduct. The material is presumed to be a low-grade ore which was stockpiled but never fully processed, or tailing material from early mineral processing due to its poor metal recovery characteristics. The extent of this material underlying the Main Slag Pile is unknown at this time.

2f *(Continued from above)*
EPA and MDEQ stand by their initial interpretation that the slag itself may not be a significant source of arsenic to the aquifer, but that the area on which the Main Slag Pile sits is probably a source of some arsenic loading to the aquifer. EPA and MDEQ have determined to leave the slag waste in place, as part of the Smelter Hill WMA, and allow the material to be appropriately processed for certain products (e.g., roofing shingles). However, any materials or surface soils remaining after the slag material is removed will have to be sampled and the area remediated to applicable cleanup action levels.

3 Letter to Andrew Lensink, EPA and Mary Capdeville, MDEQ, from Pamela Sbar, ARCO, Re: ARCO's Position on Use of Montana Water Quality Standards as ARARs for Ditches Within the Regional Water, Waste and Soils Operable Unit, September 12, 1996.

A. Montana Water Quality *Standards* Are Not Legally Applicable to the ARWW&S OU Ditches.

1. The ditches do not qualify as "state waters."
2. The ditches do not qualify as "surface waters."
3. Return flows from irrigated agricultural storm water runoff in the ditches are not "point sources."
4. Montana surface water quality regulations are more stringent than federal standards and therefore are not applicable.

B. Montana Water Quality Standards are not Relevant and Appropriate.

1. EPA should grant a waiver if the Montana water quality standards are ARARs for the ditches in the ARWW&S OU.

3 A1. ARCO argues that irrigation waters in the Yellow Ditch are not "state waters" as they are used up in the irrigation process and do not discharge to other "state waters." See § 75-5-25(a) and (b)(ii), M.C.A. Montana water quality standards therefore do not apply to the Yellow Ditch. EPA does not agree. Investigation shows that Yellow Ditch waters flow to Old Lime Ditch, which discharges to the Mill-Willow Bypass, both of which are considered "state waters." The Yellow Ditch is therefore itself a "state water" and Montana water quality standards apply. Additionally, Gardner Ditch is a state water because it discharges to Lost Creek..

A2. ARCO argues that only the Gardiner, Old Lime and North Drain ditches are "surface waters" because they discharge "directly into a stream, lake, pond, reservoir or other surface water." See definition of "surface water" at ARM 17.30.602(25). Further, ARCO argues that the surface water standards set forth in title 17, see ARM 17.30.603, therefore apply to those ditches only, and not to the other five ditches within the ARWW&S OU. EPA agrees that only "surface waters" are regulated under the "surface water" requirements. Investigation shows that the following ditches do discharge into "state waters" and "surface waters" and are therefore regulated under the surface water standards:

Ditch	State Water
Opportunity Ponds Unnamed Ditch	Silver Bow Creek
North Drain	Warm Springs Creek
Yellow Ditch/Old Lime Ditch	Mill-Willow Bypass
Gardiner Ditch	Lost Creek

Of these drainages, exceedances of total and/or dissolved arsenic in surface water are observed in Yellow Ditch. An exceedance of total copper standards is also observed in surface water of Gardiner Ditch and Yellow Ditch on an occasional basis. Therefore, the Circular WQB-7 standards for arsenic and copper apply to Yellow Ditch and Gardiner Ditch.

A3. EPA agrees that agricultural storm water discharges and return flows from agricultural runoff are not point sources under either the Clean Water Act, 33 U.S.C. § 1362(14), or the Administrative Rules of Montana at ARM § 17.30.1304(41). However, EPA disagrees that Montana's surface water quality standards do not apply to the ditches wherever they contain agricultural runoff. First, the ditches noted in point number 2 above are both "state" and "surface" waters. The surface water quality standards set forth at Title 17 of Montana's administrative rules therefore apply. These rules are not *discharge* standards meant to apply to point sources. Rather, they are *ambient* requirements which apply to all "state" and "surface" water bodies as provided under Montana statute and administrative rule. They are requirements that the water bodies themselves, not discharges to those water bodies, must meet. Thus, they are ARARs under CERCLA. See CERCLA section 121(d), 33 U.S.C. § 1321(d).

ARCO's Previously Submitted Comments on the ARWW&S RI/FS	Response
	3 A4. This issue is discussed in more detail in EPA's response to ARCO's comment letter of November 1, 1996. B. Because EPA has determined that the Montana water quality requirements are applicable to ditches which discharge to state waters (Gardiner and Yellow Ditches), there is no need to determine whether the same requirements are "relevant and appropriate." B1. ARCO argues there is no evidence that Montana has consistently applied its water quality standards to irrigation ditches in other remedial actions within the State, and therefore, a waiver from the water quality standards should be granted. See CERCLA section 121(d)(4)(E), 42 U.S.C. § 121(d)(4)(E). EPA disagrees. First, ARCO has presented no evidence at all that there has been some sort of inconsistent application. ARCO should have provided evidence of other situations where the State *should* have applied the water quality requirements but failed to do so. Second, CERCLA section 121(d)(4)(E) does not *require* EPA to grant a waiver if the State fails to apply the requirement consistently. It simply *allows* EPA to do so. Under the clear wording of CERCLA, EPA may choose to apply the State standards as ARARs even if the State itself does not consistently apply them. EPA may reconsider this position if ARCO provides evidence of situations where the ARARs should have been applied by the State, but were not.
4 Letter to Andrew Lensink, EPA, and Mary Capdeville, MDEQ, from Pamela Sbar, ARCO, Re: ARWW&S OU Point of Compliance for Ground water ARARs, September 17, 1996; *and* 16 Letter to Julie DalSoglio, EPA, Andy Young, MDEQ, Andrew Lensink, EPA, and Mary Capdeville, MDEQ, from Phyllis Flack, ARCO, Re: EPA's Proposed Ground water Point of Compliance for the ARWW&S OU, January 27, 1997.	
4a ARCO argues that EPA should adopt a single compliance point for determining whether ground water ARARs are being met. This compliance point should be downgradient of a line circumscribing a single waste management area which would include the Smelter Hill/East Anaconda, Old Works, Opportunity Ponds, and South Opportunity subareas.	4a EPA agrees that it is generally sensible to group distinct sources of contamination together as one unit if they are geographically near to each other. However, as ARCO points out at page 2 of its letter of September 17, 1996, "EPA has significant latitude to determine an 'appropriate location' for measuring ground water compliance with ARARs... ." In this case, EPA believes that 3 points of compliance (POCs) are more appropriate. One of these points is similar to the one ARCO describes, downgradient of a line around the toe of the Opportunity Ponds. EPA adds 2 additional POCs: at a location immediately downgradient of the Smelter Hill WMA at the toe of the Anaconda Ponds, and within the Old Works Subarea immediately downgradient of the Red Sands Main Deposit. A POC located at the toe of the Anaconda Ponds is justified because below this point is a large area of uncontaminated ground water between one and two square miles, underlying the Triangle Waste area. This area of ground water is between the Anaconda Ponds and the Opportunity Ponds, which are about a mile apart. Given this large quantity of uncontaminated ground water, the requirements of the Montana non-degradation standards, and the one mile of separation between the Anaconda and the Opportunity Ponds, EPA believes that a POC at the toe of the Anaconda Ponds is warranted. Furthermore, given the large and distinct volumes of tailings overlying large areas of valley alluvial aquifer, separate POCs will help determine which areas are providing specific contaminant inputs into the aquifer system. The agencies' position on this matter is in direct opposition to ARCO's statement that, "...any release from these areas would impact the same aquifer of concern." (Page 3, first full paragraph.) EPA cannot fathom how ARCO believes a POC at the toe of the Opportunity

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	(Continued from above) Ponds would accurately detect new or increased source loading of contamination from the fractured bedrock aquifer located within the Disturbed Portion of Smelter Hill located six miles away. EPA disagrees with ARCO's conclusion that one POC would be an appropriate location in the ground water for measuring the performance of the ARWW&S OU remedy. ARCO also argues that their proposed single POC is comparable to the RCRA CAMU designation and is therefore appropriate for the ARWW&S OU. EPA acknowledges that, "EPA generally equates the CERCLA area of contamination with a single RCRA land-based unit, usually a landfill. 54 FR 41444 (December 21, 1988)." (See NCP, page 8760.) However, EPA also states that, "...since the definition of "landfill" would not include discrete, widely separated areas of contamination, the RCRA "unit" would not always encompass an entire CERCLA unit." (Ibid.) The ARWW&S OU clearly has discrete, widely separated areas of disposal. EPA has been reasonable in circumscribing disposal units near each other into three separate WMAs (i.e., Disturbed Area, Main Granulated Slag and Anaconda Ponds = Smelter Hill WMA; Opportunity Ponds, South Lime Ditch = Opportunity Ponds WMA.) In the January 27, 1997 letter, ARCO continues to argue the position that a separate POC located at the toe of the Anaconda Ponds is not warranted because ARCO owns the property underlying the Triangle Waste area and would continue to prohibit ground water use in the area, thereby protecting future human health through an institutional controls action. Property ownership is irrelevant to the State of Montana laws which protect existing water quality in state waters, whether surface or ground water. M.C.A. § 75-5-605 (prohibits the causing of pollution of any state waters) and § 75-5-303 (existing uses of state waters and the level of water quality necessary to protect the uses must be maintained and protected) are applicable requirements to the ARWW&S OU and, therefore, it is appropriate to establish a ground water POC at the edge of the Smelter Hill WMA for long-term protection of the ground water resources in the Triangle Waste area. CERCLA also does not recognize property ownership as a basis for not requiring ground water cleanup. For the Old Works WMA, a POC has been located downgradient of the Red Sands/Arbiter Plant complex, at which source controls and natural attenuation is projected to restore a portion of the alluvial aquifer contaminated with cadmium and copper. The POC was set at this location, rather than ARCO's proposed location at the edge of the Old Works/East Anaconda Development Area (OW/EADA) OU boundary, to maximize the goal of ground water restoration in an area of the community where land development is projected and the need for additional water resources may develop in the future. Additional sources of potable ground water for the community is necessary given the agencies' determination that large areas of ground water resources cannot be restored (e.g., WMAs and TI Zones).
4b ARCO argues that one ground water POC is appropriate for the ARWW&S OU, and would satisfy the requirements of the NCP, RCRA Subtitle C, the new CAMU rule, and the Montana solid waste regulations.	4b Applicable law allows one POC for the ARWW&S OU, but doesn't mandate it. The law allows EPA to do what makes sense. In this case, EPA believes that 3 points of compliance (see response 4a), are what make sense and best meet the factors outlined in the NCP preamble (55 Red.Reg.8666, 8753 (March 8, 1990)). The NCP recognizes that a number of factors will affect the POC. In determining where to draw the POC in such situations, the lead agency will consider factors such as the proximity of the sources, the technical practicability of ground water remediation at that specific site, the vulnerability of the ground water and its possible uses, exposure and likelihood of exposure, and similar considerations. While ARCO's position has some merit, it ignores the fact that there is significant uncontaminated ground water in the vicinity of the triangle waste area.

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5 Letter to Julie DalSoglio, EPA, and Andy Young, MDEQ, Re: Disclaimer of EPA's Rewrite of the ARWW&S OU Draft Preliminary Remedial Action Objectives, General Response Actions, Technology and Process Option Scoping Report, Waste Management Area Evaluation, and Preliminary Points of Compliance Identification, September 23, 1996.	5 EPA reviewed the December 1995 *Draft Preliminary Remedial Action Objectives, General Response Actions, Technology and Process Option Scoping Report, Waste Management Area Evaluation, and Preliminary Points of Compliance Identification* and provided an EPA and MDEQ rewrite in February 1996. ARCO completed the rewrite at EPA's direction, which was approved in May 1996. ARCO subsequently submitted the above referenced "disclaimer" to this document in September 1996.
5a Issue 1: ARCO generally objects to the Preliminary Remedial Action Objectives and Goals (PRAOs and PRAGs) to the extent that they vary from those identified for the same media in the Old Works/East Anaconda Development Area (OW/EADA) OU.	5a As noted in the OW/EADA ROD (1994), EPA and MDEQ clearly stated, "...final remediation requirements for surface and ground water at the OW/EADA OU are not within the scope of this action, but rather will be determined under the ARWW OU." (Page DS-56, OW/EADA ROD, March 1994.) The ARWW&S PRAOs and PRAGs were established after completion of the ARWW RI investigations, use legally applicable State of Montana water quality standards, and incorporate preliminary surface and ground water objectives used in the OW/EADA ROD.
5b Issue 2: ARCO objects to EPA's site characterization of the Anaconda Smelter Site (100 square miles of affected soils and 327,000 acre-feet of contaminated ground water) as a significant over-estimate of the aerial extent and volume of affected media.	5b EPA and MDEQ do not believe that the site characterization for the ARWW&S OU is an over-estimate of media affected by 100 years of milling, smelting and disposal activities. In fact, witnesses for the U.S. Department of Justice identified 300 square miles of aerially contaminated soils, with the EPA focusing site investigations on approximately 100 square miles. During the Regional Soils RI and Baseline Ecological Risk Assessment EPA and MDEQ further reduced the area of concern to approximately 20,000 acres. The FS analysis and this ROD delineate a more detailed process to apply the final reclamation remedy which will further reduce the areas of concern for the aerially contaminated soils. EPA and MDEQ have consistently acknowledged some uncertainty about the total acre-feet of contaminated ground water in the ARWW&S OU. This uncertainty is inherent in a site of this size and the level of data collection needed to reduce the uncertainty. In fact, ARCO also admits that it is difficult to better define the total area of concern for ground water based on the data collected to date (see ARCO's disclaimer to the ARWW OU RI, May 22, 1996 and EPA and MDEQ's responses to letter number 2 above). EPA and MDEQ have, in fact, attempted to better define bedrock aquifer contamination by directing ARCO to collect additional data in 1996, 1997, and 1998. The data analyses expanded the known area of contamination, rather than reduced the areas of concern, in contrast to ARCO's assertion that the agencies have over-estimated volumes of ground water contamination. (See the TI Evaluation presented in Appendix D of this ROD.) Finally, EPA and MDEQ are requiring long-term monitoring of these ground water contamination areas to sharpen and refine the known ground water areas of concern.
5c Issue 3: ARCO objects to EPA and MDEQ's determination to use the State of Montana's ground water classification system of Class I ground waters (suitable for drinking water) based on the premise that ground water in the ARWW&S OU has not been, is not currently, and is not reasonably anticipated to be used in the future as a drinking water supply.	5c The NCP is perfectly clear in EPA's position on protection and restoration of ground water: • The goal of EPA's Superfund approach is to return usable ground waters to their beneficial uses within a time frame that is reasonable given the particular circumstances of the site....A determination is made as to whether the contaminated ground water falls within Class I, II, or III. (NCP, page 8732.) • For Class I and II ground waters, preliminary remediation goals are generally set at maximum contaminant levels, and non-zero MCLGs where relevant and appropriate, promulgated under the Safe Drinking Water Act or *more stringent state standards* ... (Emphasis added, NCP, page 8732.)

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	5c *(Continued from above)* • If ground water *can be* used for drinking water, CERCLA remedies should, where practicable, restore the ground water to such levels. Such restoration may be achieved by attaining MCLs or non-zero MCLGs in the ground water itself, excluding the area underneath any waste left in place. (Emphasis added, NCP, page 8753.) EPA and MDEQ appropriately set the PRAOs and PRAGs for the ARWW&S OU ground water based on the NCP and compliance with ARARs. See the discussion of ground water ARARs in Appendix A.
5d Issue 4: ARCO opposes a PRAO to prevent ground water discharge containing arsenic or metals that would degrade any surface water on the basis that there is only insignificant ground water loading to surface water within the OU.	5d Site investigations determined that large portions of the Southern Deer Lodge Valley are affected by ground water discharge to the surface; however, EPA and MDEQ agree that there is a minor amount of ground water discharge to surface waters in which arsenic and/or metals may be transported. The only area identified on site are the Opportunity Ponds D-1 and D-2 Drain Ditches which capture ground water discharge to a conveyance ditch and in which surface water flow is transported to the Warm Springs Ponds. EPA has revised the final Remedial Action Objectives for surface water as follows: Minimize source contamination to surface waters that would result in exceedances of State of Montana water quality standards.
5e Issue 5: ARCO disagrees with the identification of State of Montana water quality standards from the Montana Circular WQB-7 that are more stringent than primary MCLs as PRAGs.	5e As noted in response to Issue 3 above, the NCP clearly allows use of state water quality standards that are more stringent than federal MCLs as appropriate ground water clean up standards for aquifers. (NCP, p. 8732.) The state timely identified Montana Circular WQB-7 standards as applicable standards and EPA has identified them as such. See 40 CFR 300.5. See also response 8b below. The State standards are ARARs as there are no other standards to consider.
5f Issue 6: ARCO contests the use of total recoverable metals concentrations as PRAGs on the ARWW&S OU and further asserts that EPA should adopt ARCO's proposed Site-Specific Water Quality Standards for Mill, Willow and Warm Springs Creeks.	5f See response to ARCO's comment letter 8, below.
5g Issue 7: ARCO requests revisions to surface water PRAOs to read as follows: "Minimize source contamination to surface water that would result in an exceedance of federal or site-specific ambient water quality criteria, and minimize significant degradation to downstream surface water beyond an appropriate mixing zone."	5g The final Remedial Action Objectives for surface waters at the ARWW&S OU are to minimize source contamination that would result in exceedance of State of Montana water quality standards. As noted in response to Issue 5 above, and to ARCO's comment letter 8 below, the State of Montana WQB-7 water quality criteria are the applicable standards to the site, not ARCO's calculation of site-specific water quality criteria. EPA and MDEQ have not designated any mixing zones for surface waters within the OU. Point-source storm water discharges to the surface water bodies will comply with identified storm water regulations and much of the COC transport into the water column from wide-spread non-point sources, such as overland run-off from aerially contaminated soils, which will be remedied by the actions set forth in the ROD for contaminated soils. EPA and MDEQ's final Remedial Action Objective is to return surface water to its beneficial use by reducing loading sources of COCs. This ROD calls for an appropriately designed remedial actions and O&M plans to assess reduction of the non-point source loading sources, attainment of the water quality criteria, and establishment of the appropriate points of compliance.

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5h Issue 8: ARCO argues that streams and creeks within the site should not be maintained to support B-1 classification uses because of the varying size, locations, population density, flow and diversity of the streams which could not sustain drinking, culinary, food processing, bathing swimming or recreational purposes.	5h The State of Montana has properly promulgated stream classifications according to the Clean Water Act. These classifications for streams in Anaconda are applicable to this Remedial Action.
5i Issue 9: ARCO incorporates by reference its prior comment regarding State of Montana WQB-7 levels that are more stringent than primary MCLs; notes that aquatic standards for these constituents are hardness-based and thus not directly comparable to health-based standards; that metals concentrations for protection of aquatic life should be measured on the basis of dissolved methods, rather than total recoverable; and that water quality criteria should be adjusted by a water effect ratio.	5i See EPA and MDEQ response 3 and 8b.
5j Issue 10: ARCO refutes the identification of ground water as a "receptor" of contaminants from waste sources and tailings, but rather a media of concern.	5j As described in the ARWW RI Report (February 1996) and Feasibility Study Deliverable No. 2 (Conceptual Model of Fate & Transport, Pathway Assessment, and Areas and/or Media of Concern, February 1997), ground water is a "receptor" of arsenic, cadmium, copper and zinc from waste and tailings materials on the site. EPA's use of the term "receptor" throughout the ROD refers to a media receptor or biological receptor.
5k Issue 11: PRAOs should be revised from "prevent" releases of soils or sediments that would cause an exceedance of ground water and/or surface water quality standards to "minimize" releases that would result in significant unacceptable adverse impacts to ground and surface water.	5k The final Remedial Action Objectives for soils and sediments are to provide a permanent vegetative cover over contaminated soil material to minimize transport of COC to ground and surface water receptors.
5l Issue 12: ARCO takes the position that it is not feasible, or necessary to protect human health and the environment, to "prevent" exposures to waste sources, but rather to "minimize" exposures. Furthermore, minimization of exposure should be tied to current or reasonable anticipated future land use. The PRAO for waste material should be rewritten to reflect these changes.	5l The final Remedial Action Objectives for waste material reflect both these proposed changes.
5m Issue 13: Waste Sources and Tailings PRAOs should be revised to state: "Minimize the release from waste sources and tailings to the extent such release results in significant unacceptable adverse impacts to the environment."	5m Final Remedial Action Objectives for waste sources is to reduce COC levels in waste and highly contaminated soils to allow re-establishment of vegetation, thus reducing rick to upland terrestrial wildlife and allow re-establishment of wildlife habitat.
5n Issue 14: ARCO further objects to the use of the word "prevent" releases as applied to regionally contaminated soils for COC transport to ground water and surface water; and "prevention" of human ingestion, inhalation, or contact with soils that would result in unacceptable risk to human health, vegetation, wildlife and/or terrestrial ecosystems. PRAOs should be revised to say, "minimize" releases. ARCO also disagrees with the statement that site-wide terrestrial ecosystems may be at risk via direct soils toxicity, plant uptake and food chain effects of metals and arsenic.	5n EPA revised the final Remedial Action Objectives to require a permanent vegetative cover through land reclamation which will minimize potential risk of human exposure, transport of COCs to surface and ground waters, and wildlife exposures. See EPA response to comments on the Baseline Ecological Risk Assessment, Attachment G/H of the Responsiveness Summary, for the agencies' position on soils toxicity, plant uptake, and food chain effects of metals and arsenic.

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5o Issue 15: Soil clean up action levels of 1,000 ppm recreational land use and 500 ppm commercial/industrial land use are overly conservative and only applicable to areas in the OW/EADA OU.	5o See *Final Baseline Human Health Risk Assessment, Anaconda Smelter NPL Site, Anaconda, Montana* (EPA 1996) for applicable human health risk assessment for aerially contaminated soils. These action levels fall within EPA's risk range, are consistent with action levels established for the Old Works ROD, and were applied to the most recent update on land use designations within Anaconda-Deer Lodge County.
5p Issue 16: ARCO disagrees with an implied emphasis by EPA that the NCP established a different expectation for remediation of contaminated ground water, and notes that the NCP contemplates use of institutional controls for ground water as well as other media.	5p ARCO's quote that EPA expects to return usable ground water to their beneficial uses wherever practicable, within a time frame that is reasonable is the exact wording finalized in FS Deliverable No. 1. (See Section 2.1.1, page 3, and Appendix A).
5q Issue 17: ARCO disagreed with EPA's definition of a waste management area as "an area of continuous contamination in a discrete and manageable unit which will be left in place as part of EPA's response action at a given site." Proposed alternative definition is, "area where waste is left in place, including the area encompassing more than one such distinct area when such areas are in close geographic proximity." *and* Issue 18: ARCO requests establishment of two WMAs: Northern WMA to include Red Sands, Heap Roast Slag Pile, floodplain tailings, ADLC sewage lagoons, and ADLC closed municipal landfill; and Southern Waste Management Area encompassing Opportunity Ponds, Cell A, South Lime Ditch, Triangle Waste, Anaconda Ponds, Main Slag Pile, and Disturbed Areas.	5q The WMA concept spelled out in FS Deliverable No. 1 was to assist in the screening and application of feasibility study alternatives and to help develop a long-term management strategy for the waste materials left on site. EPA and ARCO are in general agreement about the need to define areas where waste will be left in place, ground water will not be remediated to State of Montana standards, and the need to develop long-term management strategies as part of the final ROD. ARCO's point is taken that a waste management area is not limited to a single discrete area of continuous material; in fact EPA has determined that several separate waste sources should be combined to form the three waste management areas on the site (e.g., Opportunity WMA = Opportunity Ponds, South Lime Ditch; Smelter Hill WMA = Disturbed Area, Anaconda Ponds, Main Granulated Slag, East Anaconda Yards; and Old Works WMA = Heap Roast, Floodplain Tailings and Red Sands). However, ARCO takes this concept to the extreme and later argues that there should only be two separate WMAs, generally circumscribing wastes from the top of Smelter Hill to the edge of ARCO owned property along the I-90 frontage road below the Opportunity Ponds. The NCP clearly allows EPA to establish appropriate waste-left-in-place POC boundaries to protect uncontaminated resources, such as the clean ground water located between Anaconda and Opportunity Ponds, and to remedy ground water resources where those resources can be remediated, such as the area below the Red Sands. This ROD appropriately established three distinct WMAs.
6 Letter to Max Dodson, EPA, from Sandra Stash, ARCO, RE: ARCO's Response to EPA's July 30, 1996 Letter Terminating ARCO's Obligations to Perform the Regional Water, Waste, and Soils RI/FS and ARCO's Invocation of Dispute Resolution, September 24, 1996.	6 EPA responded to this letter on November 25, 1996 from Robert L. Fox, EPA, to Sandra Stash, ARCO. In this letter, EPA further expanded on specific problems with ARCO's performance to conduct the ARWW&S FS and the agency concluded, "These various problems and ARCO's failure to correct them amount to noncompliance with AOC CERCLA VIII-88-16 and are the basis for EPA's decision to terminate the portion of Amendment Eight requiring the work. Under AOC CERCLA VIII-88-16, Section IX.M.2., page 52, whenever ARCO has "fail(ed) to remedy noncompliance with this Consent Order in a timely manner...," EPA may "initiate Federally funded response actions and pursue cost recovery." EPA also clarified that ARCO was not formally invoking dispute resolution, yet reserved the right to do so.

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7 Letter to Andrew Lensink, EPA, and Mary Capdeville, MDEQ, from Pamela Sbar, ARCO, Re: ARWW&S OU Storm water Discharge ARARs, October 16, 1996.	
7a The use of BMPs as effluent limitations for storm water discharges is consistent with the Clean Water Act.	7a EPA agrees that the use of BMPs *may* be consistent with the Clean Water Act so long as the conditions set forth at 40 C.F.R. § 122.44(k) are met. In essence, *all* NPDES permits, including storm water permits, must at a minimum meet the requirements of 40 C.F.R. §§ 122.41, 122.42, and 122.43(a). In addition, BMPs will be required as provided under § 122.44(k) where they are "(1) authorized under section 304(e) of the Clean Water Act (CWA) for the control of toxic pollutants, and hazardous substances from ancillary industrial activities; (2) Numeric effluent limitations are infeasible, or (3) The practices are reasonably necessary to achieve effluent limitations and standards or to carry out the purposes and intent of CWA.
7b EPA's current policy is to use BMP's rather than numeric water quality standards for purposes of controlling storm water discharges.	7b EPA's current policy regarding BMPs is outlined in a memorandum entitled *Interim Permitting Approach for Water Quality-based Effluent Limitations in Storm Water Permits*, 61 Fed. Reg. 43761 (August 26, 1996), and *Qs & As for Interim Permitting Approach for Water Quality-based Effluent Limitations in Storm Water Permits*, August 1, 1996 ("*Qs & As*"). EPA does agree that BMPs will be used in first round storm water permits. EPA may require more controls where necessary in order to attain water quality standards. EPA does not agree that it has generally "rejected" numeric limitations for storm water permits. EPA has recognized, however, that numeric standards may be difficult to derive. If such BMPs, plus the standard permit requirements of § 122.43(a), provide for attainment of water quality standards, nothing further will be required. See *Qs & As*, Question 7, page 6. However, if the standard permit requirements plus BMPs do not result in compliance with water quality standards, more controls may and will be required.
7c Montana recognizes BMPs as satisfying State storm water requirements.	7c a. ARCO seems to argue that compliance with BMPs *alone* is full compliance with the Montana storm water requirements. This is not true. ARCO refers to three general permits issued by the State of Montana, the general discharge permits for storm water discharges associated with 1) mining activity and oil and gas exploration, 2) industrial activity, and 3) construction activity. ARCO indicates that all three permits require BMPs as opposed to numeric standards and argues that compliance with the BMPs is full compliance with all water quality requirements. EPA does not agree. Full compliance with BMPs is not necessarily full compliance with all water quality requirements. All three permits provide that storm water discharges may not violate the Clean Water Act or State of Montana non-degradation standards. The permits contain monitoring and other requirements. Most important, the re-opened clauses in the three permits provide that if discharges actually or potentially impact water quality, then individual or alternate general permits may be required. The State could therefore require conditions *beyond* BMPs in order to protect water quality. Thus, ARCO's argument is incorrect. BMPs may be required under State law. However, if these are insufficient to provide for compliance with water quality standards, additional requirements may be imposed. b. ARCO argues also that 75-5-401(5)(g), M.C.A. provides that storm water dischargers are not required to get individual permits. This is true. However, 75-5-605, M.C.A. still provides that it is unlawful to "pollute" State waters beyond water quality standards (presently set forth in WQB-7) while 75-5-303, M.C.A. makes it unlawful to degrade State waters below their existing quality. Even if there is no individual permit requirement for storm water discharges, it is still illegal under both the above referenced statutory requirements to degrade the quality of State waters. These provisions are ARARs for this project and these provisions must be complied with.

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8 Letter to Andrew Lensink, EPA, Mary Capdeville, MDEQ, Julie DalSoglio, EPA, and Andy Young, MDEQ, from Pamela Sbar, ARCO, Re: Site-Specific Water Quality Standards as ARARs for the ARWW&S OU, Anaconda Smelter NPL Site, November 1, 1996; *and*	
11 Letter to Andrew Lensink, EPA, Julie DalSoglio, EPA, Mary Capdeville, MDEQ, and Andy Young, MDEQ, from Pamela Sbar, ARCO, Re: Use of Montana Environmental Regulations That Are "More Stringent Than" Comparable Federal Provisions as ARARs for the ARWW&S OU, Anaconda Smelter NPL Site, November 11, 1996.	
8a Issue (Site-specific water quality standards): ARCO argues that Montana's WQB-7 standards are not applicable standards for the ARWW&S OU cleanup since 1) Montana law mandates that the Montana Board of Environmental Review (Board) adopt site specific water quality standards at the OU instead of the WQB-7 requirements, 2) EPA has the authority to adopt site specific water quality standards where the Board has failed to do so, 3) the WQB-7 standards are "more stringent" than federal requirements since they are based upon "total recoverable metals" and therefore, the federal requirements, based upon "dissolved metals" should be applied, and 4) EPA should apply dissolved metals standards for the ARWW&S OU instead of the total recoverable metals requirements set forth in Montana's WQB-7, since the dissolved metals standards are less stringent.	8a EPA does not agree that M.C.A. § 75-5-310(1) *mandates* the adoption of site specific water quality standards instead of the WQB-7 standards (see Appendix A, page A-6). Adoption of such standards is clearly discretionary. First, M.C.A. § 75-5-310(2) requires the Board to determine whether the proposed site specific standards are protective of beneficial uses. ARM 17.30.623(2)(h)(iii) sets forth additional factors for the Board to consider. The Board clearly has discretion concerning those findings. Second, since rulings of the Board will affect the public, Montana's Administrative Procedure Act, M.C.A. § 2-4-302 provides for public comment on any proposed Board rulings. Clearly, the Board is not required to adopt site specific water quality standards, but may in some case decide not to do so as a result of public comment. It follows that if the State has not adopted ARARs which supplant the WQB-7 requirements, the WQB-7 requirements continue to be the applicable ARARs. EPA does not agree that it has authority to adopt and then apply as ARARs site specific standards where the State has not yet promulgated them. Under the NCP, EPA may include as ARARs those "cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under...state environmental or facility siting laws... ." See 40 C.F.R. § 300.5. The State of Montana has not yet promulgated any site specific requirements. Therefore, there is nothing for EPA to adopt as an ARAR other than the WQB-7 standards. The requirement for "site specific standards" is a product of State of Montana law. Federal regulations do not require site specific standards. See 40 C.F.R. § 131.11(b)(1)(ii). EPA does not have authority to promulgate requirements under state law and declines to attempt to do so here.
8b Issue ("more stringent than" considerations): ARCO argues that State standards which are "more stringent" must be modified to conform to corresponding federal standards which are "less stringent," that WQB-7 standards are "more stringent" than federal requirements since they are based upon "total recoverable metals" and that therefore, EPA should apply the federal requirements, based upon "dissolved metals," supposedly less stringent, as ARARs for this cleanup.	8b The provisions which limit the adoption of State requirements which are "more stringent" than federal requirements, M.C.A. §§ 75-5-203 and 309 M.C.A. § 75-5-203, providing, in part, that "the board may not adopt a rule...that is more stringent than the comparable federal regulations or guidelines that address the same circumstances..." and M.C.A. § 75-5-309, providing in part that "the board may rules that are more stringent than corresponding draft or final federal regulations... if the board makes written findings, based on sound scientific or technical evidence...which state that rules that are more stringent than corresponding federal regulations...are necessary to protect the public health, beneficial use of water, or the environment of the state...," are not themselves ARARs, and cannot be implemented by EPA. As mentioned above, ARARs are "*substantive* requirements, criteria, or limitations promulgated under...state environmental or facility siting laws... ." See 40 C.F.R. § 300.5 (emphasis added). The provisions at issue are not substantive requirements. Rather, they are administrative guidelines which govern decisions by the Board. Until the Board acts according to these guidelines, the WQB-7 requirements are the *only* Montana water quality ARARs there are. Only if the Board follows the guidelines, eases the WQB-7 standards, and in effect, adopts new requirements, would those new regulations be enforceable by EPA under CERCLA as ARARs.

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	8b *(Continued from above)* EPA does not agree that the "total recoverable" metal criteria set forth in WQB-7 are "more stringent" than the "dissolved" metal criteria set forth at 40 C.F.R. § 131.36(c)(4)(iii). This is because the State requirement, WQB-7, does not "compare with" or "correspond to" the federal requirement at 40 C.F.R. §131.36(c)(4)(iii) as required under M.C.A. § 75-5-203 or 309. These provide that the board may not adopt State provisions more stringent than "comparable" or "corresponding" federal regulations or guidelines. This is because the WQB-7 requirements, as ambient requirements, do not correspond to those set forth at 40 C.F.R. 131.36(c)(4)(iii).
9 Letter to Julie DalSoglio, EPA, Andrew Lensink, EPA, Andy Young, MDEQ, and Mary Capdeville, MDEQ, from Phyllis Flack, ARCO, Re: ARCO's Preliminary Comment on EPA's Draft Final Baseline Ecological Risk Assessment for the ARWW&S OU, Anaconda Smelter NPL Site *and* letter to Julie DalSoglio, EPA, Andrew Lensink, EPA, Andy Young, MDEQ, and Mary Capdeville, ARCO, from Robin Bullock, ARCO, Re: Editorial comment on EPA's Draft Final Baseline Ecological Risk Assessment for the ARWW&S OU, Anaconda Smelter NPL Site.	9 See Response to ARCO's Comment on the ARWW&S OU Proposed Plan, Attachment G/H, included in this Responsiveness Summary.
10 Letter to Julie DalSoglio, EPA, Andy Young, MDEQ, Andrew Lensink, EPA, and Mary Capdeville, MDEQ, from Phyllis Flack, ARCO, Re: Comments on the Waste Removal Evaluation for Final Feasibility Study Deliverable No. 3b, ARWW&S OU, November 6, 1996. **GENERAL COMMENTS**	
10a 1. ARCO requests that the removal option be eliminated for all waste sources, with the exception of Warm Springs Creek and Willow Creek tailings, rather than just the waste sources which will remain in place as noted in this report.	10a EPA appropriately carried forward the removal option for the South Lime Ditch, Cell A, Triangle Waste, East Anaconda Yards, Yellow Ditch, Blue Lagoon, and Opportunity Ponds Toe Wastes. The final remedy outlined in this ROD calls for waste consolidation (i.e., removal) for the Opportunity Ponds Toe Waste and partial removal of the contaminated material found in the Blue Lagoon. These alternatives are protective of human health and the environment, eliminate aquatic ecological risk, and are cost effective.
10b 2. EPA used the screening criteria identified in its guidance in the area-by-area discussion of the waste removal alternative rather than the detailed analysis criteria. Sections 4.0 and 4.1 of this document should be modified for consistency with later discussions in the report.	10b The waste removal evaluation was a screening of an alternative, and the screening criteria was appropriately applied. No revisions to the document were made.

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10c 3. ARCO argues that the following identified ARARs are neither applicable nor relevant and appropriate: (1) requirements that are more stringent than comparable federal requirements; (2) numeric effluent limitations for storm water discharges under the Clean Water Act or the Montana Water Quality Act; (3) permit requirements for industrial point source discharges; (4) solid waste requirements; (5) Water Quality Bureau-7 water quality standards, to the extent that there are site-specific water quality standards available or that these standards use total recoverable metals to measure compliance; (6) certain mining reclamation requirements; and (7) surface water quality requirements to the extent that EPA identifies them as ARARs for ditches within the ARWW&S OU.	10c See attached responses for each of these issues outlined in EPA's response to ARCO's comment letters in Appendix L.
10d 4, 5, 6, 7, 8. ARCO provides a series of comments on costing assumptions used in FS Deliverable No. 3b. Generally the comments requested a 7% discount rate for inflation to calculate unit costs; that costs for backfill and placement and costs for revegetation are lower than can be reasonably be expected; and that units and quantities on cost estimate tables are confusing.	10d EPA thoroughly reviewed costing assumptions and made specific revisions to the tables that were presented in FS Deliverable No. 5 for the detailed analysis of alternatives. EPA also presented a detailed list of costing assumptions used in an appendix to that document. ARCO again provided more detailed comments on costing assumptions found in Attachment J to their Comments on the Proposed Plan, January 31, 1998. EPA further revised costing assumptions, updating the costs based on latest and best available information, and have presented revised tables in Appendix E of this ROD.
10e 9. ARCO disagrees with the methodology used by EPA to ascertain the phytotoxic risks on the site; and therefore, with EPA's position that a potential reduction in the phytotoxic effects to local habitats is sufficient reason to consider removal for South Lime Ditch, Triangle Waste Area, Warm Springs Creek Tailings and Willow Creek Tailings.	10e EPA presents a detailed response in defense of the methodology used for ascertaining phytotoxic effects of metals and arsenic in soils and tailings in the ARCO Response to Comments Attachments G/H. EPA therefore stands by its conclusion that removal of tailings in these areas of concern would eliminate phytotoxic effects to the vegetation communities.
SPECIFIC COMMENTS	
South Lime Ditch	
The partial removal alternative should not be evaluated during the Detailed Analysis phase of the FS for the following reasons:	
10f 1. FS Deliverable No. 2 does not identify surface water as a receptor of concern.	10f ARCO is correct in stating that EPA has not identified the South Lime Ditch as a surface water receptor of concern. The partial removal alternative was not chosen in the final ROD.
10g Partial removal may negatively impact proposed land use.	10g Proposed trails development is not an insurmountable problem with the partial removal scenario.
10h Control of surface water runoff can be achieved by less costly means; control of suspended particulate matter may be achieved through less costly alternatives; soils and wastes in the South Lime Ditch may not be the sole source of arsenic and cadmium in the alluvial aquifer; and the effectiveness of waste removal to reduce loading of arsenic to ground water is considered to be low.	10h EPA considered these points during the detailed analysis and chose a more cost effective remedy of revegetation for the final ROD.

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10i Implementation of the remedy would result in significant community impacts.	10i EPA believes that impacts to the local community would not be significant and some of the impacts would be mitigated during construction. The South Lime Ditch is located solely on ARCO owned property, would be consolidated into the Opportunity Ponds (located adjacent to the South Lime Ditch), and backfill material borrowed from locations around the ponds.
Triangle Waste Area	
The removal alternative should not be evaluated in the Detailed Analysis for the following reasons:	
10j ARCO agrees with EPA's assessment that additional alternatives exist to address phytotoxic habitat effects and impacted soils human health risks which would achieve an equal level of protectiveness at a lower cost and that addresses suspended particulate matter.	10j The detailed analysis of alternatives, FS No. 5, did show that the soil cover and in situ reclamation alternatives were equally protective remedies at a lower cost. These alternative remedies were chosen in the final remedy.
10k The site was previously utilized as a solid waste landfill and therefore additional materials handling would be necessary.	10k This information would have been important if removal had been chosen as the final remedy. The ROD calls for soil cover or in situ reclamation and location of the closed landfill will be noted in Remedial Design.
10l Implementation of this remedy would result in significant community impacts.	10l The response to this comment is similar to the response on South Lime Ditch. The Triangle Waste Area is located next to the Opportunity Ponds on ARCO owned property. Minimal impacts to road traffic, noise and dust abatement, and on-site safety could all be addressed or mitigated.
Warm Springs Creek Tailings	
Although ARCO acknowledges that removal of Warm Springs Creek tailings would be carried forward into the detailed analysis, ARCO had the following comments:	
10m ARCO disagrees with EPA's assertion that the Warm Springs Creek tailings are the primary source of metals to surface water and in-stream sediment of Warm Springs Creek.	10m During writing of FS Deliverable No. 2 and 3a, EPA believed that there were potentially other sources of metals to surface water receptors, including overland run-off from aerially contaminated soils. During the Proposed Plan Public Comment Period, the Montana Department of Fish, Wildlife and Park initiated a stream re-naturalization project and uncovered significantly more buried tailings within the floodplain than identified during the RI/FS. This is additional evidence of loading from fluvially deposited tailings, and EPA stands by it's initial assessment that tailings probably play the primary source of metals loading to Warm Springs Creek, causing the periodic and seasonally exceedances of AWQC.
10n Removal of tailings may have serious short-term adverse impacts on the water quality and aquatic habitat of Warm Springs Creek.	10n EPA recognizes the risk of short-term impacts inherent during removal of stream bank material, however, several steps can be taken to minimize those impacts, such as removal during low-flow water, use of appropriately sized equipment, water diversion and sediment erosion controls structures. EPA also believes that any minor short-term impacts are overshadowed by long-term environmental gains.
10o Costs associated with stream bank stabilization and revegetation for riparian and pasture areas are not accounted for.	10o These cost factors were added to FS Deliverable No. 5 and updated in the final cost sheets found in Appendix E of the ROD.

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Willow Creek Tailings	
Although ARCO anticipated that removal of Willow Creek Tailings will be carried forward into the Detailed Analysis, the following comments were presented:	
10p Removal of the tailings may have serious short-term, adverse impacts to water quality.	10p EPA recognizes the risk of short-term impacts inherent during removal of stream bank material, however, several steps can be taken to minimize those impacts, such as removal during low-flow water, use of appropriately sized equipment, water diversion and sediment erosion controls structures. EPA also believes that any minor short-term impacts are overshadowed by long-term environmental gains.
10q Costs to maintain and repair Highway 1 to be used for hauling excavated material, for stream bank stabilization, and for revegetation of riparian areas are not accounted for.	10q These cost factors were added to FS Deliverable No. 5 and updated in the final cost sheets found in Appendix E of the ROD.
10r Implementation of this remedy would result in significant community impacts.	10r Minimal impacts to road traffic, noise and dust abatement, and on-site safety could all be addressed or mitigated.
Yellow Ditch	
The removal alternative should not be evaluated during the Detailed Analysis for the following reasons:	
10s The cause of elevated arsenic levels in the alluvial aquifer in the South Opportunity Area appears to be primarily related to land-use practices of flood irrigation with arsenic-impacted surface waters.	10s Removal of the Yellow Ditch was deliberately assessed to determine if arsenic could be reduced in the surface waters flowing through the irrigation ditch.
10t ARCO acquired property in the South Opportunity for the purpose of reducing flows through the head gates at diversions to Yellow Ditch. A small quantity of water is required to fulfill the appropriation of a downstream water-right holder. Elimination of flood irrigation is anticipated to improve ground water quality in the South Opportunity Area.	10t Comment is noted and incorporated into the final ROD. EPA chose reduction of flood irrigation and natural attenuation as the final remedy.
10u Removal of Yellow Ditch is not compatible with proposed land use which is anticipated to include the possible construction of a cap and development of a hiking trail along the berm of the ditch. In addition, the ditch must remain in place to convey irrigation water to a downstream water-right holder.	10u These factors were assessed in FS Deliverable No. 5. EPA believes removal of the ditch would not have been incompatible with the land use designation as a hiking trail; however, EPA agrees that the water conveyance structure (e.g., ditch) would either need to be maintained or replaced.
10v Implementation of the remedy would result in significant community impacts.	10v Minimal impacts to road traffic, noise and dust abatement, and on-site safety could all be addressed or mitigated.

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Blue Lagoon and Railroad Fill	
Removal of the Blue Lagoon material and Railroad Fill near Blue Lagoon should not be carried forward into the detailed analysis of alternatives for the following reasons:	
10w Impacted pore water in the vadose zone downgradient of Blue Lagoon was not identified as a "potential media of concern" or "potential area of concern" in FS Deliverable No. 2. The removal action is being cited as a potential remedial alternative for an area which may not require remediation.	10w EPA identified contaminated ground water and a downgradient outwash of material from the lagoon as a secondary waste source to downgradient ground water and surface water. The vadose zone in this downgradient area is more than likely also contaminated with high levels of copper and cadmium.
10x The removal scenario assumed that the railroad line will be abandoned after completion of the Lower Area One Project (Silver Bow Creek/Butte Addition NPL Site). ARCO anticipates that Rarus will continue maintenance of the line and require compensation for any revenue lost during the construction time frame.	10x This information was assessed during the detailed analysis of alternatives. EPA chose a partial removal in the Blue Lagoon (e.g., removal of the contaminated sediments and outwash material; use of a culvert through the railroad bed material to route upgradient waters through contaminated railroad fill) as the final remedy.
10y Control of surface water run-off over and through the railroad grade material can be achieved through less costly means than removal.	10y Agreed; see above response.
10z Implementation of this remedy would result in significant community impacts.	10z Minimal impacts to road traffic, noise and dust abatement, and on-site safety could all be addressed or mitigated.
East Anaconda Yard Wastes	
10aa Removal alternative should not be evaluated during the detailed analysis.	10aa EPA conducted an extensive analysis of the removal option as part of the Technical Impracticability (TI Evaluation) Evaluation to assess the likelihood of attaining ground water standards for arsenic in the East Anaconda Yard. EPA determined that removal of buried wastes in the area would not lead to remediation of the aquifer due to arsenic loading from the valley side-wall recharge off of the bedrock aquifer on Smelter Hill. The reader is referred to a detailed discussion of this analysis found the Appendix D of this ROD. The Montana solid waste requirements at MCA § 75-10-201, et seq. and implementing regulations are applicable requirements for the mining waste at the Opportunity and Anaconda Ponds. This position was originally established in the Record of Decision for the Streamside Tailings Operable Unit, Silver Bow Creek/Butte Addition NPL Site. See Appendix A to the Streamside Tailings OU ROD, Identification and Description of Applicable or Relevant and Appropriate Requirements, footnotes 35 and 36. Since the ARWW&S OU waste is a "historic" waste which was disposed of decades ago, it is not currently regulated under Montana's metal mine reclamation requirements, See MCA § 82-4-304, and therefore is not within any of the mine waste exceptions to the definition of solid waste. See MCA § 75-10-203(11)(b) and 75-10-214(1)(b). The mining wastes will therefore be considered "solid wastes" under the Montana Solid Waste Management Act, MCA § 75-10-201, et seq., if they are "actively managed" as part of the ARWW&S remedial action. See footnote 36, id.

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	10aa *(Continued from above)* Some of the actions EPA will require under this ROD will be considered "active management." For example, excavation and placement of any or all the wastes in a new disposal facility would be considered active management. Tilling of the wastes would be considered active management, while construction of covers on top of the waste would not. Though the State solid waste requirements listed in Appendix A may be applicable to certain actions to be taken under the ROD, EPA intends to invoke the variance provision at MCA § 75-10-206 and will not require strict compliance with these requirements.
11 See responses to comment letter 8.	
12 Letter to Andrew Lensink, EPA, Julie DalSoglio, EPA, Mary Capdeville, MDEQ, and Andy Young, MDEQ, from Pamela Sbar, ARCO, Re: Use of State Solid Waste and Related Requirements as ARARs for the ARWW&S OU, Anaconda Smelter NPL Site, November 11, 1996.	12 Section 75-10-206, MCA, allows variances from solid waste regulations to be granted if failure to comply with the rules does not result in a danger to public health or safety, or if compliance with specific rules would produce hardship without producing benefits to the health and safety of the public that outweigh the hardship. In light of the nature of the wastes at issue and the likelihood that any repository would contain only a single type of waste, i.e. tailings and related materials, considering the volume of wastes involved (1.5 to 2.5 million cubic yards) and the cost of full compliance with all solid waste requirements, and considering available Superfund procedures for the maintenance of remedies and the ability of the agencies, within the Superfund process, to consider the characteristics of the particular wastes at issue in appropriately determining and designing repositories, certain of the Solid Waste Regulations regarding design of landfills, specifically ARM §§ 17.50.505(1) and (2); 17.50.506; 17.50.513; and 17.50.530, may appropriately be subject to a variance in implementing the remedy at the WMA within this OU. The scope and manner of applying the variance will be determined in finalizing and approving of the remedial design by EPA and MDEQ. EPA thus invokes the variance with respect to the provisions listed above and finds that such variance from these requirements does not result in danger to public health or safety.
13 Letter to Andrew Lensink, EPA, Mary Capdeville, MDEQ, Julie DalSoglio, EPA, and Andy Young, MDEQ, from Pamela Sbar, ARCO, Re: Mine Reclamation Requirements as ARARs for the ARWW&S OU, Anaconda Smelter NPL Site, December 18, 1996	
13a RARs must be "well-suited."	13a EPA agrees.
13b EPA may eliminate early identified requirements.	13b EPA agrees.
13c MCA § 82-4-231 ARCO argues that this provision should not be a RAR because it requires the most "modern" technology, in conflict with the NCP criteria, which include effectiveness, implementability and cost. This analysis is flawed.	13c ARCO is incorrect in its statements that effectiveness, implementability and cost are used to determine the appropriate technologies. These three criteria are used to *screen out* technologies that do not meet these criteria. *see* 300.430(e)(7). Rather, alternatives are evaluated against the nine evaluation criteria, with overall protection of human health and the environment and compliance of ARARs as threshold criteria. As an ARAR, the technologies in the feasibility study will be evaluated on whether this reclamation standard, as well as all other ARARs, is attained.

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13d ARCO argues that specific reclamation requirements are for strip mining, not for historic metals mining sites, and therefore, should not be RAR for our site.	13d The specific provision is found in the Montana Strip and Underground Mine Reclamation Act, applicable to permitted coal and uranium mine reclamation sites. ARCO argues that most of the reclamation tasks identified in the provision are not necessary to address the contaminants of concern at this operable unit. This argument is responded to in the first part of the response. Additionally, EPA generally disagrees with ARCO's comment. The fact that the reclamation requirements listed in Appendix A are mostly from coal mining reclamation provisions does not mean they are not relevant and appropriate for the reclamation of a historic metal mining site. The factors EPA is to consider when determining whether a provision is relevant and appropriate are set forth at 40 CFR § 300.400(g)(2). These include a comparison of the following factors for the provision and the CERCLA action 1) the purpose; 2) the medium regulated or affected; 3) the substances regulated; 4) the actions or activities regulated; 5) variances, waivers, or exemptions; 6) type of place; 7) size of structure or facility; and 8) use or potential use of affected resources. It should be noted that similarity for all 8 factors is not required in the determination whether a particular provision is relevant and appropriate at a given site. NCP at 8743. EPA finds enough similarity in the 8 factors as applied to the coal reclamation requirements that it has decided those requirements should be considered relevant and appropriate at the ARWW&S OU. First, the purpose of the reclamation requirements is to stabilize the surface soils after they have been disturbed by coal mining activities. Stabilization of the surface is among the goals of the ARWW&S remedial action. Surface soils at the ARWW&S OU have been disturbed by disposal of tailings and be aerial deposition of contamination. Second, both coal strip mining and metal mining are activities which disturb the surface, and tend to destroy or damage vegetation, leaving the surface vulnerable to erosion from wind and runoff, and causing adverse impacts to the environment. Third, the strip mine regulations do not regulate substances per se. Rather, they regulate *conditions* at strip mines. The conditions at metal mines, i.e., severely disturbed surface soils, are quite similar. Fourth, the activities regulated are similar. The *activities* in both cases severely impact surface soils and vegetation. Fifth, this factor is not applicable at this site. Sixth, the "places" regulated at strip mines are similar to the "place" to be remediated at the ARWW&S OU. "Places" in both cases are so heavily impacted by mining activity, vegetation is so damaged, that further damage to human health or the environment from erosion from wind and runoff may occur. Seventh, the size of facility is similar for coal mining and for metal mining. Both types of activities result in adverse impacts to very large areas of surface soils and vegetation unless reclamation activities are implemented. Eighth, some of the resources at the ARWW&S probably will be used extensively. For example, waters running through the OU will enter State waters downstream. These waters must all meet surface water requirements. Water resources would also be protected at coal mining operations through implementation of reclamation procedures. Given these factors, EPA finds that the coal mine reclamation requirements are relevant and appropriate for this remedial action.

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13e **MCA § 82-4-233** ARCO argues that the provision requires revegetation with species native to the area.	13e The implementing regulations of § 82-4-233 state, "Vegetative cover is considered of the same seasonal variety if it consists of a mixture of species of equal or superior utility when compared with the natural vegetation during each season of the year." (See ARM 26.4.711(1).) Second, there is no basis for ARCO's statement that a designation of land use should somehow preempt the utilization of diverse, effective, and permanent vegetative cover of the same seasonal variety native to the area. § 82-4-233(1) specifically states that introduced species may be used in the revegetation process where desirable and necessary to achieve the approved post-mining land use plan. As set forth in § 82-4-232(8): If alternate revegetation is proposed, a management plan must be submitted showing how the area will be utilized and any data necessary to show that the alternate post-mining land use can be achieved. Any plan must require the operation as a minimum to: (a) restore the land affected to a condition capable of supporting the use which it was capable of supporting prior to any mining operation or to a higher or better use of which there is a reasonable likelihood, if the use or uses do not present any actual or probable threat of water diminution or pollution, and if the permit applicant's proposed land use following reclamation is not deemed to be impractical, unreasonable, or inconsistent with applicable land use policies and plans, would not involve unreasonable delay in implementation, and would not violate federal, state, or local law; and (b) prevent soil erosion to the extent achieved prior to mining.
13f **MCA § 82-4-336** ARCO argues that the provision requires revegetation with species native to the area.	13f Here ARCO repeats its argument for § 82-4-233, MCA; see response to 13 e.
13g **ARM 26.4.633** ARCO argues that BMPs under the storm water regulations are more suited to the site than the requirements of this provision, which requires BCTA (best technology currently available).	13g ARCO first confuses BTCA and BMP. BTCA and BMP are similar in that both require the attainment of water quality standards. Storm water regulations require compliance with all state water quality standards, including total suspended solids, with BMPs as the first preference to achieving compliance. BTCA also requires compliance with applicable federal and state statutes and regulations. *see* 26.4.631. Management practices under BTCA includes other components such as to "minimize, to the extent possible, disturbances and adverse impacts on fish, wildlife and related environmental values, and achieve enhancement of those resources where practicable." (See ARM 26.4.301(20)(b).) In addition, the regulations list management practices specific to mining and reclamation activities which EPA may use to augment those deemed relevant and appropriate under the storm water regulations. For example, ARM 26.4.631 states: (b) practices to control and minimize pollution include, but are not limited to, stabilizing disturbed areas through land shaping, diverting runoff, achieving quickly germinating and growing stands of temporary vegetation, regulating channel velocity of water, lining drainage channels with rock or vegetation, mulching, selectively placing and sealing acid-forming and toxic-forming materials, and selectively placing waste materials in backfill areas. In addition, the NCP does not require, as ARCO seems to imply, that only the most relevant and appropriate requirement remains standing. The determination is made as to weather a specific requirement is relevant and appropriate. Although the preamble states that "*in some situations*, the availability of certain requirements that more fully match the circumstances of the site may result in a decision that another requirement is not relevant and appropriate," in this case, the two provision work well together with complimentary portions in each of the regulations.

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13h **A.R.M. 26.4.635-7** ARCO argues that since no diversions are planned, this should not be a RAR.	13h Remedial design may require diversions of drainages on Smelter Hill, in Cabbage Gulch, or around the perimeter of Opportunity Ponds. If so, this ARAR should be identified and a mitigation plan proposed.
13i **A.R.M. 26.4.643-7** Requires monitoring of pre-mining ground water conditions, conditions of ground water during mining, and control of impact upon ground water through reclamation design and method of mining. ARCO argues this provision seems to apply to active mining facilities and therefore is not appropriate for the cleanup of a historic mining site.	13i As stated above in the response to § 82-4-231, MCA, protection of the environment (this would include groundwater) is one of the purposes of proper reclamation. The reclamation groundwater requirements are not appropriate for requiring aquifer restoration in an aquifer waived for ambient water quality standards based on technical impracticability from an engineering perspective. However, the standards will be relevant and appropriate for proper reclamation in order to prevent further migration of the plume, and minimize further degradation of the ground water through source reduction. These standards are also relevant and appropriate for reclamation in an area above an aquifer that is uncontaminated, will be treated, or will meet standards through natural attenuation within a reasonable time. ARM 26.4.643 states that reclamation must "prevent or control discharge of acid, toxic, or otherwise harmful mine drainage waters into groundwater flow systems ..."
13j **A.R.M. 26.703, 713, 716, 718, and 719** These prescribe soil amendment, revegetation and other requirements. ARCO argues they're not really properly applied at the OU because they may conflict with our remedial requirements and the requirements of ADLC's land use plan.	13j The County's land use is not as specific as the identified standards, and do not satisfy reclamation and protective requirements. The standards are not generic, but establish criteria that must be met in order for the reclamation to involve effective and permanent vegetation. The standards remain well-suited to revegetation in order to assure proper reclamation.
13k **A.R.M. 26.4.723-733** These set requirements for monitoring and evaluating the success of revegetation under a mine reclamation plan.	13k The NCP states that monitoring requirements are ARARs. ARCO's citation to the NCP is consistent with the reclamation requirements, as the performance standards will assist the agencies in the regulatory determinations that the remedy is "functioning properly and is performing as designed," as required under 40 CFR 300.435(f).
14 Letter to Andrew Lensink, EPA, Mary Capdeville, MDEQ, Julie DalSoglio, EPA, and Andy Young, MDEQ, from Phyllis Flack, ARCO, Re: "No Further Action" Alternative for the ARWW&S OU, Anaconda Smelter Site, January 3, 1997. ARCO's main premise of this position paper is that EPA must consider the remedial and reclamation actions already completed at the site, as well as the cost of those actions as part of the "No Further Action" alternative for purposes of remedy evaluation and selection for the ARWW&S OU. ARCO presents a technical summary of response actions taken to date on the Anaconda Smelter NPL Site presented on a subarea-by-subarea basis. ARCO includes all work completed under previous orders which addressed principle threat wastes (flue dust, beryllium) and immediate human health threats (Mill Creek relocation), voluntary reclamation work completed on Smelter Hill and as demonstration projects (ARTs), reclamation work completed as part of the OW/EADA ROD (including construction of the Old Works Golf Course), and other actions taken outside of CERCLA directed response actions (Anaconda County Landfill Closure). ARCO presents an estimate of approximately $90 million dollars spent on the site through 1996. ARCO further argues that "No Further Action" is appropriate for large areas of the site based on the Anaconda-Deer Lodge County's Comprehensive Master Plan, Development Permit System, and private-property land ownership by ARCO.	14 ARCO provides a good litany of response actions taken on the site up to 1996. These response actions, however, are separate distinct actions from the remaining media and areas of concern addressed under the ARWW&OU. The "No Further Action" scenario assessed whether unremediated soils and wastes-left-in-place could be protective of human health and the environment and would meet ARARs without further actions than the ICs already in place. The conclusion of the detailed FS (FS Deliverable No. 5) was an unqualified no. Therefore this ROD calls for full remediation of these contaminated media. EPA recognizes that a small number of reclaimed acres located on Smelter Hill, Stucky Ridge and along Highway 1 (an estimated 1350 acres as compared to the OU areas of concern approximating 20,000) fall within the mapped boundaries of the ARWW&S areas of concern. These acres will be delineated in the LRES process and highlighted as separate distinct units requiring monitoring and a determination of whether they meet the performance standards of the final remedy. ARCO is also reminded that EPA and MDEQ have consistently stated that all previous actions taken at the site would be assessed against the final site-wide ROD criteria and a determination made whether the previously approved actions were consistent with the final remedy (see specifically the OW/EADA OU ROD and Community Soils ROD). Furthermore, all ground water and surface water decisions and results of the ecological risk assessment, including the final remedial action objectives and goals, were deferred to the final remedy. Much of the actions required under this remedy are specifically designed to reduce risk to ecological receptors, minimize on-going contamination to ground water and surface water, and prevent further degradation of water resources.

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	14 *(Continued from above)* Finally, ARCO correctly cites the provisions of the NCP which require an evaluation of the "No Further Action" alternative as part of the feasibility study analysis. The NCP requires, "The no-action alternative, which may be no further action if some removal or remedial action has already occurred at the site, shall be developed" while, "The costs of construction and any long-term costs to operate and maintain the alternatives shall be considered." (55 Fed. Reg. 8849, March 8, 1990.) EPA correctly applied the no further action scenario to the remaining areas of concern at the site and estimated the O&M costs of these acreages in the costing summaries. No where does CERCLA or the NCP state, as ARCO asserts in their position paper, that the "... "No Further Action" alternative should take into account the response measures already implemented at the site, *as well as the cost of those measures.*" (Emphasis added.) Just because ARCO has spent close to $90 million on the site to date does not mean that the goals of reduction of risk to human health and the environment and attainment of ARARs for the entire site has been met.
15 Letter to Julie DalSoglio, EPA, Andy Young, MDEQ, Andrew J. Lensink, EPA, and Mary Capdeville, MDEQ, from Phyllis E. Flack, ARCO, Re: November 14, 1996 meeting in Helena, MT ARWW&S OU, Anaconda Smelter NPL Site, January 6, 1997. This letter outlines ARCO's positions in regards to EPA's screening of alternatives (FS Deliverable No. 3b) for the detailed analysis (FS Deliverable No. 5). ARCO raises specific issues around alternatives selected for Cabbage Gulch, Opportunity Ponds Toe Wastes, Triangle Waste Area, Blue Lagoon/Railroad Fill, and Willow Creek Tailings.	15 1. Cabbage Gulch: ARCO argues that since EPA cannot find a potential waste-related source of contamination for contributions of arsenic to surface water contamination, EPA should not look at active surface water treatments for "naturally occurring substance in its unaltered form.." EPA refers ARCO to FS Deliverable No. 2, Revised Final Conceptual Model of Fate & Transport, Pathway Assessment and Areas and/or Media of Concern (1997) and the Regional Soils Remedial Investigation Report (1997) for a full description of the aerially contaminated soils as the source of arsenic contamination in the surface waters of Cabbage Gulch. 2. Opportunity Ponds Toe Wastes: ARCO argues that there is no regulatory requirement to identify the point of compliance at the edge of the Opportunity Ponds such that it would require removal of toe wastes located outside the berms and that consolidation would provide no benefit to ground water quality. EPA notes that the requirement to consolidate toe wastes are based on three reasons: 1) remediation of surface water quality in the D-2 drain ditch; 2) reduction of risk to ecological receptors; and 3) consolidation will reduce long-term management costs of the area. 3. Triangle Waste: EPA retained the capping alternative for this alternative in FS Deliverable 3b for prevention of ground water contamination; ARCO points out that EPA has not identified ground water contamination as a problem in this area. EPA agrees with this point of clarification from ARCO. 4. Blue Lagoon/Railroad Fill: ARCO asserts that the most probable source of elevated copper concentrations in the Blue Lagoon is pooled water that collects behind the railroad bed as a result of a clogged drainage culvert; therefore, the final remedy should be replacement of the culvert to eliminate contact of surface waters with bed material and pooling behind the existing culvert which would be less costly than removing and replacing the railroad bed material. EPA agreed with this assessment and chose this alternative for the final remedy. 5. Willow Creek Tailings: ARCO rejects the complete removal alternative for this area of concern by pointing out the final remedy for tailings located in Subarea 4 of the Streamside Tailings Operable Unit (located adjacent to the Willow Creek floodplain) is in situ treatment. EPA notes that this final remedy calls for a partial removal alternative which the agency feels is as protective as the full removal option assessed in FS Deliverable No. 5 and would minimize impacts to existing vegetation as noted by ARCO.

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16 See responses to comment letter 4.	
17 Letter to Julie DalSoglio, EPA, and Andrew Lensink, EPA, from Phyllis Flack, ARCO, Re: Submittal to the Environmental Protection Agency's National Remedy Review Board for the Anaconda Regional Water, Waste & Soils Operable Unit, Anaconda NPL Site, January 30, 1997. ARCO presents an initial preferred alternative for the final remedy at the Anaconda Smelter NPL Site. The remedy would rely primarily on local governmental institutional controls, private property ownership rights, minimal engineering controls for storm water management, and reclamation of about 1200 acres for a cost of $12 - $24 million to address the final 64,000 acre site. ARCO argues that this remedy is protective because principal threat wastes have already been addressed by prior response actions at the site; existing institutional controls control inappropriate land use, protect against remaining human health risks and limit environmental risk; risk-based calculations for unauthorized land uses indicate that remaining soils metals levels pose no unacceptable risk; source materials remaining at the site do not threaten the environment; therefore in light of the insignificant human health and environmental risks posed by remaining source materials, ARCO's preferred remedy presents the only cost-effective approach to remediating any remaining potential risk. For each of these arguments, ARCO references a position paper that is reproduced in their Comments on EPA's Proposed Plan (January 1998) Attachment L, included in this list of responses.	17 EPA has thoroughly refuted each of these arguments as outlined in the detailed Responsiveness Summary, Volume II, ARWW&S OU ROD. Furthermore, EPA stands behind the Administrative Record for this OU which fully supports all positions of the agency on the human health and environmental risks posed by remaining wastes, aerially contaminated soils, contaminated surface water and ground water. ARCO's proposal in 1997, as outlined to the National Remedy Review Board, does not match new proposals outlined in the Comments on the Proposed Plan found in their Attachments A (Reclamation Plan), B (Revegetation Success Criteria), C (Storm Water Management Plan), F (Site Management Plan), and K (Conceptual Operations and Maintenance Plan Framework). These submittals outline a much more aggressive program for final remediation on the site and imply that the final clean up necessary for the site is more extensive and costly than ARCO initial proposal of $12 - $24 million.
18 Letter to Andrew Lensink, EPA, Mary Capdeville, MDEQ, Julie DalSoglio, EPA, and Andy Young, MDEQ, from Phyllis Flack, ARCO, Re: Proposed Source Controls in TI Zones, ARWW&S OU, Anaconda Smelter NPL Site, February 21, 1997. In this position paper ARCO disagrees that source control measures are required or appropriate under the NCP or EPA guidance for recommended ground water TI zones as outlined in Draft FS Deliverable No. 3a (EPA 1996). Specific comments and EPA's responses are outlined below:	
18a Issue 1: Alternative remedial strategies involving source controls are inappropriate in the ARWW& S OU because the strategy requires that sources be located and treated or removed <u>only</u> where "feasible and when significant risk reduction will result...identification and treatment of specific source areas would be difficult, if not infeasible...cost associated with identifying and treating these soils would be disproportionate to any improvement in ground water quality...other possible mechanisms and pathways by which arsenic may be transported to ground water such as geothermal loading...and institutional controls have already been implemented which prevent the use of ground water impacted by these potential sources as a present or future drinking water supply.	18a The NCP and EPA policy and guidance are very clear about actions when the agency expects that ground water cannot be restored. Where ground water ARARs are waived at a Superfund site due to technical impracticability, EPA's general expectations are to prevent further migration of the contaminated ground water plume, prevent exposure to the contaminated ground water, and evaluate further risk reduction measures as appropriate. (NCP §300.430(a)(1)(iii)(F)). These expectations should be evaluated along with the nine remedy selection criteria to determine the most appropriate remedial strategy for the site. The TI guidance that ARCO quotes has an entire section devoted to the alternative remedial strategy approach which addressed three types of problems at contaminated ground water sites: prevention of exposure to contaminated ground water; remediation of contamination sources; and remediation of aqueous contaminant plumes. Specifically the guidance states, "Sources should be located and treated or removed where feasible and where significant risk

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	18a *(Continued from above)* reduction will result, regardless of whether EPA has determined that ground-water restoration is technically impracticable." ARCO proposes in this letter that EPA should ignore this guidance by not assessing source control measures during the detailed FS and immediately concludes that remediation of aerially contaminated soils is cost prohibitive and will not significantly reduce loading of arsenic to the aquifer. In fact, the detailed FS showed that remediation of the soils is implementable, effective in reducing COCs surface soils, capable of re-establishing plant life and reducing surface water and wind erosion, provides for reduction of risk to wildlife, and is cost effective. EPA further believes that reducing COC concentrations in surface soils will help improve water quality in the ground water in the TI zones. EPA has addressed the question of geothermal loading of arsenic in the region bedrock aquifer system and concluded that geothermal sources are not wide-spread but only contribute minor amounts of arsenic loading on a localized basis. Furthermore, the TI addendum, presented in Appendix D of this ROD, shows a much wider TI zone than originally identified. Institutional controls protecting potential users of ground water do not currently exist in the Aspen Hills/Clear Creek areas or on other private property lands up the Mill Creek drainage.
18b Issue 2: Factors favoring a more aggressive remedial strategy do not apply...source controls do not meet the criteria of resulting in a significantly shorter remediation time frame, reduction of potential for human exposure, or reduction of ongoing and potential impacts to environmental receptors because human and environmental exposure to ground water is limited or non-existent.	18b EPA will evaluate and determine the objectives and relative aggressiveness of the alternative remedy on a site-specific basis, based on the applicable regulatory requirements and considering the factors of the site. EPA has determined that reclamation of the aerially contaminated soils will achieve multiple objectives within the TI zones, including providing an alternative remedial strategy of addressing source loading of arsenic to the regional bedrock aquifer system. The aggressiveness of implementation of this strategy will be based on a number of factors. Many of these factors are outlined in the LRES system presented as "modifying criteria." EPA expects to target land reclamation on those lands which are privately owned and in which ground water resources are being used as potable water on an earlier time frame. Conversely, lands which have strong institutional controls, are currently not used for residential use, and located on the outer fringes of the TI zones may be reclaimed later.
18c Issue 3: Source control measures are not necessary to meet NCP requirements because the source control measures in the TI zone will not address plume migration and existing ICs prevent exposure to contaminated ground water.	18c Site characterization to date has not conclusively defined the extent of the TI zones and whether they are migrating or not. At the direction of EPA, ARCO conducted additional data collection and monitoring in 1997 and 1998 to better define the extent of the arsenic ground water problem. The TI zone boundaries were expanded from approximately 11,000 acres to 28,600 acres. Source control measures are implementable and will help reduce loadings in the TI zones. Existing institutional controls do not cover the entire area of concern and will need to be expanded. The NCP also requires evaluation of further risk reduction measures; these measures were assessed as part of the detailed FS and presented in EPA's Proposed Plan and this final ROD.

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19 Letter to Julie DalSoglio, EPA, Andy Young, MDEQ, Andrew J. Lensink, EPA, and Mary Capdeville, MDEQ, from Phyllis E. Flack, ARCO, Re: Revised Final Conceptual Model of Fate and Transport, Pathway Assessment, and Areas and/or Media of Concern, Anaconda NPL Site, ARWW&S OU, February 27, 1997. ARCO finalized this document at the direction of EPA and provided copies of replacement pages and full documents. ARCO had specific responses to EPA's editorial changes.	
19a Issues 1, 2, and 5 are in response to EPA's Draft Final BERA. ARCO objects to use of the effects concentrations for wildlife (#1), use of fish as an aquatic receptor in drainage ditch network (#2), and in general to the draft final BERA (#5).	19a EPA has provided detailed responses to all issues raised by ARCO on the BERA. These responses are found in EPA's Response to Attachments G and H.
19b Issue 3 addresses EPA's note that the alluvial aquifer located immediately down gradient of contaminated ground water underneath the Opportunity Ponds is a receptor of concern. ARCO states that ground water data collected since 1985 does not support the hypothesis that impacted ground water is actively migrating beyond the down gradient end of the Ponds.	19b EPA strongly disagrees with this position and has consistently noted that impacted ground waters are migrating out from underneath the Opportunity Ponds. Elevated levels of iron, manganese and sulfate monitored in all downgradient wells are a clear indicator that ground waters are being impacted from mine tailings in the area below the Opportunity Ponds. EPA does agree that the monitoring data collected from 1985 to 1994 shows no movement of the Superfund COCs, arsenic and cadmium. One geochemical study completed by Tetra-Tech in 1985 shows that sometime in the future (their estimate of hundreds of years) arsenic is expected to move out from beyond the tailings. This is why the ROD calls for a POC at the edge of the waste-left-in-place, long-term ground water monitoring, and for a contingency (ground water capture and treatment) if arsenic is seen to move. EPA stands by their assessment that the ground water located downgradient of the ponds is a receptor of concern.
19d Issue 4 is addressed to Blue Lagoon. ARCO notes that the concentrate spill to which EPA refers has never been located. Railroad bed materials are the most likely source of any elevated metals in Blue Lagoon.	19d EPA agrees with ARCO's conclusion. The final remedy outlined in this ROD calls for placement of a drainage pipe through the railroad bed and removal of contaminated sediments and outwash of the Blue Lagoon.
20 Letter to Andrew Lensink, EPA, Julie DalSoglio, EPA, Mary Capdeville, MDEQ, and Andy Young, MDEQ, from Phyllis Flack, ARCO Re: Menzie-Cura & Associates' Assessment of Impacts to Vegetation by Multiple Stressors at the ARWW&S OU, Anaconda Smelter NPL Site, March 4, 1997.	20 See response to ARCO's Comments in Attachment G/H, Ecological Risk Assessments, matrix of responses to combined ecological risk comments.

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21 Letter to Julie DalSoglio, EPA, Andrew Lensink, EPA, Andy Young, MDEQ, and Mary Capdeville, MDEQ, from Phyllis Flack, ARCO, Re: Remedy for the Opportunity and Anaconda Ponds, ARWW&S OU, Anaconda Smelter NPL Site, March 18, 1997. ARCO's primary position outlined in this paper is that the reclamation measures that EPA has identified in the Draft FS Deliverable No. 5, Detailed Analysis of Alternatives (February 1997), are not cost-effective, do not wholly incorporate current or reasonably anticipated future land uses, and extend beyond protection of the environment. Conversely, ARCO has proposed reclamation measures for the Opportunity and Anaconda Ponds that are protective, ARAR-compliance and are the most cost-effective approach to remediating the Ponds.	
21a 1. ARCO's proposed remedy as outlined in ARCO's submittal to EPA's National Remedy Review Board meets the threshold requirements for remedy selection, ARCO's proposed remedy achieves protection of human health and the environment, and ARCO's proposed alternative complies with ARARs.	21a See EPA's response to ARCO's letter #17 - Letter to the National Remedy Review Board, and ARCO's letter #24 - Wildlife Habitat As a Remedial Objective and EPA Authority to Require Remedial Action Under CERCLA to Address Ecological Risk on Privately Held Land. ARCO spends considerable time arguing that EPA cannot require remediation of the Ponds because the County has designated post-mining land use at the Ponds to be waste management under the Anaconda-Deer Lodge County Comprehensive Master Plan and thus is the "reasonably anticipated future land use." EPA has accurately included this land use planning into the determination of risk and analysis of feasibility study alternative for protection of human health and the environment. As ARCO further notes, Montana regulations provide: "If the land cannot be reclaimed to the use that existed prior to any mining because of the mined condition, the post-mining land use must be judged on the basis of the highest and best use that can be achieved and is compatible with surrounding areas." ARM 26.4.824(2)(a). The 1997 Master Plan Update for Anaconda-Deer Lodge County recognizes that the Ponds will have limited human activity due to the nature of mine waste remaining. The entire area of the Ponds cannot possibly be used for future mine waste disposal as hinted by ARCO. In fact, the Lower Area One (LAO) removal from the Butte site and active disposal into the Ponds was halted by ARCO in favor of a closer location. EPA anticipates minimal acreage needed for future removals in the Anaconda Smelter NPL site. Therefore, vast areas of the Ponds would remain open or minimally addressed under ARCO's proposal to the National Remedy Review Board. As noted elsewhere in these responses, ARCO's proposal would not reduce risk to the environment or meet mine reclamation ARARs.
21b 2. ARCO's targeted reclamation measures in conjunction with existing institutional controls satisfies the CERCLA preference for treatment of principal threat wastes and is consistent with EPA policy for remediation of low-level threat wastes.	21b EPA agrees that ARCO has placed institutional controls on their property of the Ponds through use of deed restrictions which may be protective of human health. However, EPA has no guarantee that ARCO will remain the property owner of these lands perpetually. Furthermore, by virtue of the fact that ARCO has restricted human activities, the lands will be inhabited by wildlife. Additionally, as noted in the County's Master Plan, the Ponds are surrounded by open space (historic smelting districts and wildlife management areas). These factors make environmental risk reduction the primary driver on these lands. ARCO's proposal to the National Remedy Review Board does not address this risk reduction, does not meet the mine reclamation closure requirements of the State of Montana by providing a long-term, permanent vegetative cover (the State rejects 6 inches of rock as a cover for the ponds), and does not reduce COC transport to ground water underneath the mine waste materials.

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21c 3. Extensive reclamation of the Ponds is not cost-effective in comparison to ARCO's proposed remedy and therefore may not be selected as a remedial alternative.	21c ARCO's proposed remedy does not meet the thresh hold criteria of reduction of risk and attainment of ARARs. EPA rejects ARCO's conclusion that there is minimal risk posed at the Ponds. The question of whether ARCO's proposal is more cost-effective is moot.
21d 4. EPA does not have authority to require extensive reclamation of the Ponds because this remedy is inconsistent with reasonable anticipated future land use.	21d See EPA's response to issue number S1 above.
21e 5. EPA does not have authority to require extensive reclamation of the Ponds because this remedy is above and beyond that required for protection of the human health and the environment and therefore is not authorized under CERCLA.	21e EPA disagrees and relies upon the extensive Administrative Record for this site and as summarized in this Responsiveness Summary. See response 24a.
22 Letter to Julie DalSoglio, EPA, Andrew Lensink, EPA, Andy Young, MDEQ, and Mary Capdeville, MDEQ, from Phyllis Flack, ARCO, Re: Feasibility Study Deliverable No. 5, ARWW&S OU, Anaconda Smelter NPL Site, May 12, 1997. ARCO summarizes the following issues based on the other position papers found in their Attachment L to the Comments on the Proposed Plan:	
22a 1. EPA's analysis does not consider current and reasonably anticipated future land use.	22a EPA disagrees. See response in Attachment L Letter # 21.
22b 2. EPA's assessment of human health risk does not include or acknowledge risk calculations prepared by ARCO for unauthorized access scenarios.	22b See response in Attachment I.
22c 3. EPA relies on the Draft Final Baseline Ecological Risk Assessment ("BERA") for its characterization of risk despite weaknesses in the analysis that EPA is currently attempting to correct.	22c See response in Attachments G/H.
22d 4. In particular, remedial alternatives for sparsely vegetated soils are not supported by the current BERA analysis	22d See response in Attachments G/H; see Stucky Ridge Pilot Project (August 1997); and see description of LRES process, Appendix C of the Decision Summary.
22e 5. EPA incorrectly assumes that "partial" reclamation alternatives can only achieve PRAOs "partially."	22e ARCO proposed use of limited reclamation across the site was limited to visual corridors along road into the community of Anaconda. Their reclamation plan as presented to the National Remedy Review Board did not address risk reduction, prevention of COC transport via wind or surface water, minimization of storm water run off, or attainment of ARARs. EPA FS Deliverable No. 5 showed that the partial reclamation remedy proposed by ARCO was not acceptable in meeting the thresh hold criteria of the NCP. EPA further evaluated how to address the sparsely vegetated soils initially in the Stucky Ridge Pilot Project (summer 1997) and more fully in development of the LRES system as presented in Appendix C of the ROD Decision Summary. ARCO and the readers are referred to these documents for further explanation of reclamation of sparsely vegetated soils.

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22f 6. Alternatives that are intended to restore or improve conditions, rather than to prevent further risk, are beyond EPA's remediation authority under CERCLA Section 104.	22f EPA disagrees with ARCO's conclusion that revegetation that is not necessary to control exposure to or migration of COCs, such as revegetation to provide wildlife habitat, or to improve ground water quality when ground water is neither threatening surface water quality nor migrating, is outside EPA's authority. See responses to Attachment L letters.
22g 7. The analysis ignores critical implementability issues.	22g EPA has not ignored implementability issues on availability of services and materials and schedule delays. In fact, during Summer 1998 ARCO agreed under an Administrative Order on Consent to conduct field work looking at available borrow material and to address the sparsely vegetated soils. ARCO has shown through additional sampling that there is plenty of available materials to provide reclamation of the Ponds and surrounding sparsely vegetated soils. ARCO proposed Site Management Plan, Attachment F, to the comments on the proposed plan further shows that implementation of the proposed remedy is feasible, cost-effective and timely.
22h 8. The No Further Action alternative analysis frequently ignores measures ARCO has already taken.	22h See response to Attachment L Letter 14.
22i 9. EPA proposes ground water remedies in areas where (a) ground water is not subject to use; (b) the remedy is upgradient of areas where waste is left in place; and/or (c) other sources of alleged contamination such as geothermal sources impact ground water quality.	22i See response to Attachment L Letters 4, 16, and 18.
22j 10. EPA incorrectly states that the partial reclamation and rock amendment alternatives will not meet State mine reclamation ARARs for areas where mining-related materials will be left in place.	22j See response to Attachment L Letter 13.
22k 11. Remedial alternatives have not been selected for the ARWW&S OU. Therefore, EPA's Operation and Maintenance Plan, FS Deliverable No. 4 (Appendix F of FS Deliverable No. 5) remains conceptual only.	22k EPA agrees. The purpose of the O&M Plan was to outline the level of work that will be expected as part of the final remedy and potential costs associated with the remedy. The FS Deliverable No. 5 O&M Plan provides a list of ground water wells and a schedule for their sampling. For the monitoring and maintenance of revegetated areas, the O&M Plan provides a schedule for the type and frequency of data to collect. EPA intends to prepare a revised version of the FS Deliverable No. 5 O&M Plan for the ARWW&S OU during the remedial design phase. In addition, as noted above, ARCO and EPA are in agreement that vast majority of mine waste is to be left in place and large areas of ground water will not be remediated. Both of these media will need long-term O&M.
22l 12. EPA's analysis does not adequately address the cost-effectiveness of its proposed remedial alternatives.	22l EPA provides a cost analysis among the FS alternatives which are relative to each other. Once an alternative has met the thresh hold criteria, the alternative must be cost-effective. ARCO presents alternatives that do not meet thresh hold criteria and then argues that their proposal is more cost effective than EPA's alternatives. This is ludicrous. EPA has continued to refine our initial cost estimates and presents revisions to the costs as found in the Appendix E of the ROD.
22m 13. EPA's cost estimates set out in Appendix C of FS Deliverable No. 5 may not be accurate for many remedial alternatives.	22m EPA has revised cost estimates per comments received from ARCO and MDEQ. The cost assumptions that were revised and the updated cost tables are presented in Appendix E of the ROD. In fact, estimated costs have been reduced from the FS Deliverable No. 5.

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23 Letter to Julie DalSoglio, EPA, Andrew Lensink, EPA, Andy Young, MDEQ, and Mary Capdeville, MDEQ, from Phyllis Flack, ARCO, Re: Scope and Methods of Reclamation Appropriate for "Sparsely Vegetated Soils" in the ARWW&S OU, Anaconda Smelter NPL Site, May 15, 1997. ARCO presents a position that in many sparsely vegetated areas of the ARWW&S OU, reclamation is beyond EPA's legal authority.	
23a 1. EPA may require reclamation to address phytotoxicity only in areas where vegetation condition is adversely impacted by "hazardous substances." CERCLA provides no authority for EPA to require reclamation where vegetation condition is or has been adversely impacted by land use practices or other substances or conditions, such as SO2 or soil quality.	23a See response to Attachment G and H; LRES system Appendix C.
23b 2. Reclamation measures designed to introduce vegetation or improve vegetation condition or diversity in areas where existing conditions support reasonably anticipated current and future land use are beyond the statutory scope of a remedial action.	23b See response to Attachment G and H; LRES system Appendix C.
23c 3. Where EPA's assessment of vegetation condition is flawed, EPA may not require reclamation.	23c EPA's assessment of vegetation conditions is not flawed; See response to Attachment G and H; LRES system Appendix C.
23d 4. Monitored natural attenuation is an appropriate remedy in areas of the ARWW&S OU where migration of contaminants to surface and ground water is not a risk or can be controlled adequately through storm water management. 5. Best management practices (BMPs) are appropriate in many areas and should be utilized as part of EPA's reclamation alternatives. 6. Only by refining extent and methods of reclamation currently under consideration can EPA achieve a cost effective remedy for sparsely vegetated soils.	23d EPA has continued to refine the extent and depth of the problem through initiating the Stucky Ridge Pilot Project and implementation of the LRES system. EPA agrees that these efforts will further refine the costs for the site.
24 Letter to Julie DalSoglio, EPA, Andrew Lensink, EPA, Andy Young, MDEQ, and Mary Capdeville, MDEQ, from Phyllis Flack, ARCO, Re: Wildlife Habitat As a Remedial Objective, ARWW&S OU, Anaconda Smelter NPL Site, May 27, 1997.	
24a It is not reasonable to designate wildlife and plants as ecological receptors at the waste management areas including the Anaconda Smelter disturbed area, the Anaconda Ponds, the Opportunity Ponds, and the main granulated slag pile.	24a ARCO argues essentially that there can be no ecological risk at an area designated for waste management. ARCO assumes further that any such risk could occur only at an area designated for "wildlife management." EPA strongly disagrees. ARCO fails to support its assertions with any explanation, information, or study other than simply to assert that it is unreasonable to designate wildlife and plants as ecological receptors at a waste management area. The fact is, hazardous substances may well present a threat to plants and wildlife at and adjacent to waste management areas. As explained below, EPA has documented the existence of ecological risk at each of the waste management areas ("WMAs") at the ARWW&S OU, including the Anaconda Smelter disturbed area, the Anaconda Ponds, the Opportunity Ponds, and the main granulated slag pile.

24a *(Continued from above)*

EPA risk assessors are not allowed to eliminate the possibility of ecological risk at a given cleanup area based simply upon that area's particular current or future land use. Rather, EPA must evaluate a number of factors as provided for under the National Oil and Hazardous Substances Pollution Contingency Plan, 40 C.F.R. Part 300 ("NCP"), and ecological risk assessment guidance, See *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final,* June 5, 1997 ("ERAGS") in deciding whether there may be actual ecological risk at a given cleanup area. While the NCP and EPA guidance do require EPA to consider current and future land use, this occurs in the context of the baseline risk assessment performed as part of the Remedial Investigation. See NCP Preamble, 55 Fed. Reg. 8666 at 8710. The baseline risk assessment evaluates the extent of contamination at a site, as necessary, and the existence or extent of risks to human health and/or the environment. Land use assumptions are necessary in order for EPA to assess the degree of "exposure" presented by a site and allow the risk assessment to focus on realistic exposures. See ERAGS at 6. The focus on land use assumptions, however, is not intended to replace the risk assessment process, which is what ARCO seems to suggest.

The ecological risk assessment guidance requires that EPA consider the possibility of ecological risk at all sites, including industrial sites. "[A]ll sites should be evaluated by qualified personnel to determine whether [remediation to reduce ecological risk is appropriate]." ERAGS at 1-3. If EPA finds plants and animals at a given site when it performs the ecological risk assessment, it ought to designate them as receptors. That is exactly what EPA has done at the WMAs. EPA evaluated the ARWW&S OU using the 8 step process outlined in the ERAGS and in October of 1997 EPA issued the Final Baseline Ecological Risk Assessment for the ARWW&S OU ("FBERA"). EPA concluded that animals and plants are at risk across the ARWW&S OU, including the WMAs, and areas adjacent to the WMAs. Vegetation is generally stressed in these areas. There are many areas of bare soil and depressed plant populations. Animals do visit the WMAs and areas adjacent to the WMAs, are at risk from the contamination there, and are affected by the stressed plant systems. FBERA at 5-129 to 5-141.

ARCO's claim that it is unreasonable to designate plant and animal receptors at the WMAs is itself unreasonable. EPA is required to assess the possibility of ecological risk and the existence of plant and animal receptors at all cleanup sites, including industrial sites. When EPA evaluated the WMAs at the ARWW&S OU, it discovered that there were indeed plant and animal receptors and a threat of harm to animals and plants in and adjacent to the WMAs. Remedial action at and near the WMAs as set forth in this ROD is therefore well justified.

ARCO's Previously Submitted Comments on the ARWW&S RI/FS	Response
24b EPA cannot require restoration of natural resources on private land under the guise of a CERCLA remedial action.	24b ARCO argues that EPA does not have authority under CERCLA to "require affirmative "restoration" of "natural resources" on private lands as part of a remedial action."[2] Restoration of "natural resources" may only be undertaken in the context of a natural resource damage action under CERCLA § 107(f). "Remedial actions" may only address the protection of the environment and "restoration" of "natural resources" goes *beyond* protection of the environment. EPA agrees that it does not have jurisdictional authority to file actions for damages or to explicitly "restore" "natural resources" on private land or even on public land. However, EPA may take "remedial action" under CERCLA which may coincidentally result in the restoration of natural resources. EPA may take or may require remedial action to protect the "environment" anywhere, including private land. This remedial action may coincidentally result in the restoration of some natural resources. EPA's authority to take or require remedial action is *not* limited by the definition of "restoration," "natural resources," or by a distinction between private and public lands. EPA may implement a remedial action, taking whatever action is "necessary," whenever "any hazardous substance is released or there is a substantial threat of such a release into the environment" which is "the navigable waters, the waters of the contiguous zone, and the ocean waters . . . [and] any other surface water, ground water, drinking water supply, land surface or subsurface strata, or ambient air. . . ." See CERCLA sections 104 and 101(8). EPA may order whatever abatement action is deemed "necessary" whenever there is "an imminent and substantial endangerment to the public health or welfare or the environment because of an actual or threatened release of a hazardous substance." See CERCLA section 106. "Remedial actions" are "those actions . . . taken . . . to prevent or minimize the release of hazardous substances . . . so that they do not migrate to cause substantial danger to present or future public health or welfare or the environment." See CERCLA section 101(24). Remedial action also must comply with ARARs, such as revegetation, reclamation, and stream re-configuration requirements. In contrast, NRD actions are triggered by any "injury to, destruction of, or loss of natural resources," which are defined as "land, fish, wildlife, biota, air, water, ground water, drinking water supplies, and other such resources. . .." See CERCLA section 107(f), 43 C.F.R. § 11.14(z). Damages include the costs of "restoration," or whatever actions must be taken to "return an injured resource to its baseline condition . . . when such actions are in addition to response actions completed or anticipated, and when such actions exceed the level of response actions determined appropriate to the site pursuant to the NCP." 43 C.F.R. §11.14(ll). NRD actions are not brought by EPA, but by a federal resource manager, State, or Indian tribe, regarding harm to natural resources owned or controlled by them. Obviously, actions to address "threats" to the "environment" may at times also tend to "restore" "natural resources." This is not at all surprising given that the statutory definitions for "environment" and "natural resources" are similar. Both definitions include surface water, ground water, soil, and air. It should be expected that a remedy to address threats to the environment will also tend to restore natural resources. That may well be the case for the remedial action to be applied to the WMAs as outlined in the ROD. The ROD calls for revegetation and/or engineered covers at the WMAs. See Decision Summary portion of the ROD. EPA's intent is that the revegetation and covers will reduce erosion of surface soils, reduce infiltration of water through the

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[2] Letter from Pamela S. Sbar, Senior Attorney, ARCO, to Andrew J. Lensink, Esq, United States Environmental Protection Agency (U.S. EPA), et. al., of March 18, 1997, at 5.

ARCO's Previously Submitted Comments on the ARWW&S RI/FS	Response
	24b *(Continued from above)* waste to ground water, and interrupt any other pathways for the release of contaminants in the waste at the WMAs. As documented in the FBERA, contaminated soils and ground water could eventually migrate off site if no remedial action is taken. Revegetation and engineered covers will prevent this. Revegetation and covers may well be considered "restoration" of natural resources to some extent, but are perfectly legitimate if they also address "imminent" "threats" to the environment. That the remedy outlined in the ROD will take place partially on private land is no cause for concern. EPA authority to address threats to the environment does not exclude threats on private land. <u>See</u> CERCLA sections 104 and 106. Indeed, the great majority of Superfund sites are located primarily on private land. The FBERA documents that the hazardous substances or contaminants located on ARCO owned land at the WMAs present a risk to the environment, as defined in the NCP, and an "imminent" and "substantial" "endangerment" to the "environment." Therefore, the remedy set forth in the ROD for the WMAs is entirely justified.

TABLES

TABLE 1
ARWW&S OU PUBLIC COMMENTS SUMMARY TABLE

Date	Author	Key Issues	Action/Response	Notes/Comments
Public and Local Government Comments				
10/31/97	Bob Johnson 4511 Hwy 48 Anaconda, MT 59711	• Opportunity Ponds slum dust storms/dust suppression • Warm Springs Creek channel pollution/Old Works Golf Course • Time span for implementation of remedy	Section 2.1 Responses 2, 3, 21	letter includes attachments regarding legal issues concerning Sadie Johnson property; also, pertinent notes by J. DalSoglio (EPA)
12/12/97	Barbara Andreozzi Deer Lodge County Ext. Office 800 S. Main Anaconda, MT 59711-2999	• "Hot spots" on East Park and their effect on downtown tree planting for Anaconda beautification project	Section 2.1 Response 22	letter includes attachment of ARCO soil sampling results conducted 5/16/97 in front of Thrifty Drug and Park Street Antiques
12/23/97	Carl Stetzner* and William Hickey ADLC/Arrowhead Foundation 800 S. Main Anaconda, MT 59711	• Preclusion of future community land use planning • Proposed plan did not address community concerns • Ground water TI • Financial strain on county government: costs of implementing ICs/ground water use controls and maintaining the DPS/Comprehensive Land Use Plan; multi-layer trust fund scenario • Need for infrastructure in West Valley • Consolidation of wastes left in place/remediation to pre-smelting conditions • Control of wind erosion • Involvement in concurrence and design phase	Section 2.1 Responses 1, 2, 4, 5, 7, 8, 22	*attached letter dated 1/14/98 states the withdrawal of Stetzner as a signatory on this letter
½/98	D. DiFrancesco RDM Multi-Enterprises, Inc. P.O. Box 179 Anaconda, MT 59711	• Continued marketing of the Anaconda Washoe Slag Pile by RDM Multi-Enterprises via a long term contract with ARCO	Section 2.1 Response 16	Statement that slag has caused no concern not true based on other comments and community interviews
1/13/98	Melvin Stokke 1803 Tammany Anaconda, MT 59711	• Use of slag in making Portland Cement at the Trident cement plant	Section 2.1 Response 17	letter includes attachments regarding slag analyses and the purchase of slag for industrial uses
1/13/98	Sandra Stash ARCO 307 East Park, Suite 400 Anaconda, MT 59711	• Revision of restrictive covenants on ARCO land to enable development of a regional prison	Section 2.1 Response 19	

TABLE 1
ARWW&S OU PUBLIC COMMENTS SUMMARY TABLE

Date	Author	Key Issues	Action/Response	Notes/Comments
1/15/98	Terry Wilkinson ADLC 800 South Main Anaconda, MT 59711	• Commends EPA for number of public meetings and "good deal" of info to public through the mail • Use B Cell as a waste disposal area • Dust suppression in remaining waste areas • Ground water TI not acceptable • Lack of specificity in the establishment of a trust fund • Future development/land use limited in East Valley • Time span for implementation of remedy has to be funded • Specified level of community involvement needed in design and implementation • Negative image of long term Superfund site • Need revised (quicker) implementation timeline	Section 2.1 Responses 1, 2, 3, 4, 8, 11	
1/15/98	Gene Vuckovich 1205 West Third Street Anaconda, MT 59711	• Concurrence with the statement made by Terry Wilkinson (see above); Proposed Plan needs to be beneficial to citizens, be cost effective, and comply with EPA regulations and law	Section 2.1 Response 1, 2, 3, 4, 6, 8, 11, 15	
1/15/98	*Transcript of the Proceedings* Nordhagen Court Reporting 1734 Harrison Avenue Butte, MT 59701	Transcript of the Formal Public Hearing held 1/15/98 at Anaconda Senior High School, Anaconda, MT. See list of presenters included in transcript.	Section 2.1 Responses 1, 3, 5, 6, 12, 13, 14, 15, 16, 17, 18, 20, 31	attendance list for Formal Public Hearing included
1/21/98	Herbert Lutey 4616 Hwy 48 Anaconda, MT 59711	• Blowing dust off Opportunity Ponds • Clean water • Proposed actions are insufficient	Section 2.1 Responses 2, 12	Montana Bureau of Mines and Geology water quality analysis is attached
received by EPA 1/21/98	Senator Bea McCarthy 1906 Ogden Anaconda, MT 59711	• Continued ground water monitoring/revegetation • Success of crop production/return of birds and wildlife to the Ponds and Hill areas • Continued high level of cleanup desired	Section 2.1 Responses 3	
1/27/98	Dan Hamilton WH Ranch 700 Willow Glenn Lane Anaconda, MT 59711	• Remedial plans for Hamilton property located in VA13A, in Section 20, T4N, R10W, containing all 5 COCs, including elevated arsenic levels (1,800 ppm)	Section 2.1 Responses 22	
1/28/97	Henry Broers Montanans for Property Rights P.O. Box 130399 Coram, MT 59913-0399	• ARCO's property rights may be jeopardized in the Superfund process (confiscation without compensation)	Section 2.1 Response 14	

TABLE 1
ARWW&S OU PUBLIC COMMENTS SUMMARY TABLE

Date	Author	Key Issues	Action/Response	Notes/Comments
received by EPA 1/29/98	Natalie Fitzpatrick	• School-supported tree-planting projects as a means of revegetation without tremendous cost • Support for soil amendments/revegetation rather than relocation of wastes; deep plowing supported • Support for finding alternate water supplies rather than trying to treat ground water in the TI zone • Needs of community balanced with environmental decisions • Do not try to return area to pristine state	Section 2.1 Response 12, 13, 15, 23	
1/29/98	Jim Davison ALDC P.O. Box 842 Anaconda, MT 59711	• Local government and community groups involvement in remedial design process	Section 2.1 Response 1	
1/29/98	William Hickey Arrowhead Foundation P.O. Box 842 Anaconda, MT 59711	• Local government and community groups, TAG (Arrowhead) specifically, involvement in remedial design process • Group would work with EPA to define public's role in design	Section 2.1 Response 1	
1/29/98	Paul Capps 416 East 7th Street Anaconda, MT 59711	• Lack of specifics in Proposed Plan • TI for Ground water ARARs/conflict with NCP criteria • Use of ICs and future O&M responsibility not wise for an underfunded, understaffed county • Economic development ahead of threshold criteria • Need to settle remediation versus restoration issue • Decries lack of trees in currently remediated areas • Expresses cynicism about Responsiveness Summary	Section 2.1 Responses 4, 5, 6, 7, 9, 10	
1/30/98	James Manning ADLC Planning Department 800 South Main Anaconda, MT 59711	• Involvement of elected officials, ALDC, Arrowhead Foundation, and TAG in the remedial design process • Ground water concerns (other than under the Opportunity Ponds); ground water and development (proposed prison) • Need to re-examine remedy proposed for areas where previously development was not expected • Soil contamination between Lost Creek and Warm Springs • Contamination in old irrigation ditches in the area • Dust problem off the Opportunity Ponds • ICs and O&M/funding levels and actual responsibilities, as they relate to the County	Section 2.1 Responses 1, 2, 4, 19, 24, 25-28	

TABLE 1
ARWW&S OU PUBLIC COMMENTS SUMMARY TABLE

Date	Author	Key Issues	Action/Response	Notes/Comments
1/30/98	Dave Elias ADLC County Engineer 800 South Main Anaconda, MT 59711	• North slag pile as a potential contamination source • Investigation of railroad bed contamination in the Georgetown Lake area • Placement of solid waste by ARCO in a Class-II landfill, rather than at the southeast corner of the main granulated slag pile • Need language in ROD for addressing the "unknowns"	Section 2.1 Responses 25-28	
received by EPA 2/2/98	Bill Masella George Grant Trout Unlimited 1900 Tammany Street Anaconda, MT 59711	• Maintenance and preservation of the Mill-Willow bypass in conjunction with remediation of Warm Springs Creek/Warm Springs Ponds • Threats to Mill-Willow Bypass from Opportunity ground water plume • Warm Springs Creek floodplain tailings removal • Opportunity Ponds ground water plume contamination (sampling responsibility/schedules, exceedance parameters, access to data) • Advocates removal of tailings from Warm Springs Creek flood plain	Section 2.1 Response 29	
received by EPA 2/2/98	John Sevores Box 1456 Anaconda, MT 59711	• Land ownership in Anaconda-Deer Lodge County and potential conflict with private landowners	Section 2.1 Response 30	letter includes multiple attachments pertaining to deed transfers in Aspen Hills and Lost Creek areas; property ownership map

State of Montana Agency Comments

1/28/98	C. Richard Clough MDFWP 3201 Spurgin Road Missoula, MT 59804	• Removal of tailings deposits in flood plain of Warm Springs Creek rather than implementing STARS technique	Section 3.0 Response 1	letter includes attachments regarding the termination of a channel restoration project after discovering tailings in the project area
1/28/98	Greg Mullen NRDLP P.O. Box 201425 Helena, MT 59620-1425	• Remediation of Opportunity and Anaconda Ponds via capping or other measure; need to have capillary fringe layer and adequate growth media • Reclamation of upland areas (i.e., Mt. Haggin area) not addressed in the Proposed Plan; extensive tree planting needed (things the Proposed Plan does not address that the State plan does)	Section 3.0 Response 2	

TABLE 1
ARWW&S OU PUBLIC COMMENTS SUMMARY TABLE

Date	Author	Key Issues	Action/Response	Notes/Comments
1/30/98	Matt Marsh MDEQ P.O. Box 200901 Helena, MT 59620-0901	• Soil cover instead of Reclamation Levels I and II for certain areas • Cost calculations/availability of cover soil borrow sources • B2 Cell of Opportunity Ponds as a waste disposal site • Temporary or permanent cover over Main Slag Pile due to airborne contamination • Alternative remedy for South Lime Ditch and Triangle Wastes • Removal of tailings and waste material from Warm Springs Creek, Willow Creek, and Blue Lagoon areas • Proposed Plan listed 8" of cover soil instead of 18" for the East Anaconda Yard; monitoring to determine if 18" is sufficient • Pro-active approach to ground water/surface water cleanup (i.e., ground water interception trenches) • Storm water control (lined detention basins/ditches)/meeting requirements during remedial action rather than at construction completion/storm water monitoring time limitation • Additional methods for use at Opportunity/Anaconda Ponds • Stucky Ridge Pilot Project/development of LRES or similar system • Commercial reuse of slag • Use of the word "reclamation" to describe proposed remedy • Do not allow ARCO to take the lead on remedy character definition	Section 3.0 Response 3	
1/30/98	Mary Capdeville MDEQ P.O. Box 200901 Helena, MT 59620-0901	• Application of State ground water standards beneath Waste Management Areas • Interpretation of the NCP and CERCLA with regard to ARARs/statutory waivers • Feasibility study ARARs (specifically, FS Deliverable No. 5, Appendix B; list of potential ARARs) • "Other Laws" section in ARARs	Section 3.0 Response 4	
1/30/98	Fred Staedler DNRC 1401 27th Avenue Missoula, MT 59804	Cleanup measures limiting revenue generation in these areas: • Potential for residential or commercial development on Stucky Ridge tract • Productive dry land pasture on North Opportunity Subarea tract	Section 3.0 Response 5	

Other Federal Agency Comments

1/29/98	Robert Stewart USDI P.O. Box 25007 (D-108) Denver, CO 80225-0007	• Surface water NFA does not meet threshold criteria • Water quality monitoring program for Cabbage Gulch and Yellow Ditch; include schedule for meeting water quality criteria (five year time period is appropriate)	Section 3.0 Response 6	letter includes attachment: Summary of Four-Step Process for Addressing Wetland Issues in Upper Clark Fork River Superfund Sites

TABLE 1
ARWW&S OU PUBLIC COMMENTS SUMMARY TABLE

Date	Author	Key Issues	Action/Response	Notes/Comments

ARCO Comments

1/30/98	ARCO 307 East Park, Suite 400 Anaconda, MT 59711	Includes the following attachments: • Reclamation Plan • An Approach for Establishing Reclamation Performance Standards for the ARWW&S OU • Conceptual Stormwater Runoff Control Plan for the ARWW&S OU • Institutional Controls Management Plan for the ARWW&S OU • ARWW&S OU Anaconda Smelter Superfund Site - Performance Standards • ARWW&S OU Conceptual Remedial Design/Remedial Action Site Management Plan • Comments on EPA Final Baseline Ecological Risk Assessment • Review of the Final Baseline Ecological Risk Assessment, ARWW&S OU • Risk-Based Calculations for Soil Arsenic, ARWW&S OU • Feasibility Study Comments on EPA's Proposed Plan • Conceptual Operations and Maintenance Plan Framework • ARCO Comments Provided to the EPA for ARWW&S OU	Section 4.0	

APPENDIX A

Transcript of the Proceedings
Heard at Anaconda Senior High School
January 15, 1998

ANACONDA SMELTER SUPERFUND SITE

ANACONDA REGIONAL WATER, WASTE AND SOILS OPERABLE UNIT
ANACONDA-DEER LODGE COUNTY, MONTANA
PROPOSED PLAN

TRANSCRIPT OF THE PROCEEDINGS

Heard at Anaconda Senior High School
Anaconda, Montana

January 15, 1998
7:05 p.m.

Reported by: CHERYL ROMSA

NORDHAGEN COURT REPORTING
CANDI NORDHAGEN
1734 Harrison Avenue
Butte, Montana 59701
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Registered Professional Reporter
Conference Room
1734 Harrison Avenue

ANACONDA SMELTER SUPERFUND SITE

ANACONDA REGIONAL WATER, WASTE AND SOILS OPERABLE UNIT
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WHEREUPON, the proceedings were had as follows:

MS. DalSOGLIO: My name is Julie DalSoglio. I am the Remedial Project Manager for the Environmental Protection Agency working on this site. First of all, I want to thank all of you for coming. It's just wonderful to see this kind of a turnout.

We've been here basically since the end of October conducting a number of meetings, trying to get the information out about what EPA is proposing as the final cleanup plan for across the site. So I'm really pleased to see this kind of turnout tonight for our last public hearing.

I'm going to talk a little bit about the logistics about what we're going to do this evening, and then I'll turn it over to the individuals who have signed up to provide written -- or excuse me, verbal comment. We have a court reporter here to take your comments, and EPA will be responding directly to all comment received tonight in writing as part of our final Record of Decision on the site.

Again, just briefly, we have been, as most of you know, working on this site now for approximately 15 years. The Agency has put out four previous Records of Decisions which have documented the types of cleanup actions for different areas on the site. We've had a number of removal activities that have gone on. And the attempt here with this final site-wide Record of Decision is basically to wrap up into one

complete package the final sets of decision about how to handle all of the rest of the site, including groundwater, surface water, all of the remaining tailings ponds, and all of the remaining arsenic contaminated soils.

We released the Proposed Plan on October 22nd. We originally had a public comment period that was going to end on December 20th. At the request of several members of this community, we extended the public comment period to January 30th. I want to underscore that if you are not comfortable in providing comment or testimony tonight on the Proposed Plan, we are still accepting written comment through the 30th of January. So those of you who either don't feel comfortable or would like to submit comment in that format, please do.

We held an initial public information meeting, I don't remember the dates now, but the week after the 22nd of October. We had a three-day open house/public information activity going on at the Community Services Center in mid-November and a second open meeting, public information meeting in Opportunity on the 20th of November; and basically have been trying to get the information out about what we would like to do on this site.

Beyond this introduction that I am providing this evening, EPA will sit down and open it up to this public comment process. It will not be a situation where will you have an opportunity to question us and us respond to your question during this formal period. But I do want to emphasize, there's a number of individuals from EPA besides myself that are here that would be available after the meeting tonight to try to clarify or address any other issues about the Proposed Plan.

Let me introduce very quickly Bob Fox, who is the Superfund Branch Chief; Charlie Coleman -- oh, he's still outside. Charlie is manning the desk, and he's the other Remedial Project Manager from EPA who has been working on this site for almost ten years. I'd like to also introduce Matt Marsh, who is the State Project Officer on the site, and he's also available to try to take some questions and provide answers on things.

We have about 20 people or individuals who signed up to provide comment. I guess just very quickly, is there anybody else that did not get on the signup sheet that would like to provide verbal comment at this point?

UNIDENTIFIED SPEAKER: You indicated initially that that was for written comment?

MS. DALSOGLIO: Yes. And again, another point of clarification, we're still accepting written comment, so you don't have to sign up tonight. I just want to make sure that anybody who wanted to provide verbal comment or testimony, I have them on the list.

UNIDENTIFIED SPEAKER: I'd like to provide verbal

comment.

UNIDENTIFIED SPEAKER: There's another list out there. Is that the same thing?

MS. DALSOGLIO: No, that's just generally for sign-in here.

Also, I'll check again at the end of the meeting in case somebody said something that prompted you to want to get up and say something to the community at large.

UNIDENTIFIED SPEAKER: Will there be comment made on these written comments--

MS. DALSOGLIO: Yes. Thank you for that point of clarification.

All comments received during this public comment period, both written and the verbal comment received tonight, will be responded to in writing by EPA in the Record of Decision.

Any other points of clarification about logistics that I can make for folks?

Okay. The other thing, I'll just go down the list. As I said, we have 20 people here. If you could come up to the podium, we have the court reporter, Cheryl, sitting here. If you could state your name and spell your last name for her so that she knows who is providing comment, that would be helpful.

Anything else on logistics?

I'll play facilitator here, and I'll just kind of go down the list. Gene Vuckovich was the first person.

MR. VUCKOVICH: Julie, I'd like to yield my place, at the present time, just temporarily, to Commission Chairman Wilkinson.

MS. DALSOGLIO: That's fine.

MR. WILKINSON: I'm Terry Wilkinson, and I'm the Chairman of the Anaconda-Deer Lodge County Commission. And we have a report here that we're going to direct towards Julie. Her being the Project Manager, it will be addressed to her.

Can everybody hear me all right?

AUDIENCE: No.

MR. WILKINSON: First of all, there's 50 copies of the letter that we're going to send to the EPA sitting out on the desk so you can follow along. If you don't have one, there should be some still out there. So this letter, the cover letter will read as follows.

It says: The Anaconda-Deer Lodge County Commissioners recognize and appreciate the diligent efforts of EPA and ARCO over the past 15 years in addressing the Anaconda Smelter NPL Superfund Site. Past successes have occurred because EPA, ARCO, and Anaconda-Deer Lodge County worked together to address and alleviate the Superfund concerns of Anaconda-Deer Lodge County.

Anaconda-Deer Lodge County would like to register the attached concerns so that final decisions can be made regarding the Anaconda site. The following concerns are based on the

input of a broad representation of many community-based groups who have been studying the Anaconda Smelter NPL Site over the past several years. It is our intention that the government of Anaconda and its citizenry, the PRP, and the EPA will work together to achieve cost-effective solutions that fulfill the requirements of the CERCLA and ensure, when all Superfund work is completed in Anaconda-Deer Lodge County, we will be a viable community.

The next things I'm going to cover are the concerns that we're registering with the EPA.

It says: The Anaconda-Deer Lodge County Commissioners appreciate this opportunity to comment on the Proposed Plan for the Anaconda Regional Water, Waste and Soils Operable Unit. At the onset, we would like to commend EPA for conducting a number of public hearings in this area and disseminating a good deal of information to the public through the mail. In addition, we appreciate the time extension you granted for further review and discussion of the plan. All of this activity over the past few months has brought us to the point where Anaconda-Deer Lodge County Commission would like to address the plan for the record.

As community acceptance is one of the nine National Contingency Plan evaluation criteria, we register the following issues be addressed in the Record of Decision for this Operable Unit. We find the plan to be lacking in many respects, some to an alarming degree and others to a lesser degree, but still of concern. We offer our comments on those concerns we have and look forward to working with you and the PRP to assure that when this project is complete, Anaconda-Deer Lodge County can be assured of the best possible future given the circumstances.

The first concern, No. 1, will be Waste Disposal Area. Anaconda-Deer Lodge County has indicated in various settings that the Cell B may be a better site for a waste disposal area due to its accessibility. This seems to have been forgotten in the process and needs to be addressed. Cell A should be remediated to the extent necessary and Cell B should be recognized as Anaconda-Deer Lodge County's waste disposal area.

No. 2, Dust Suppression, Waste Areas. The plan does not address blowing dust from remaining waste areas. This has been a concern of the community for many years. The Record of Decision must have a concise plan to address this problem if waste areas are not removed.

Groundwater, No Further Action. It is not possible for us to accept the premise that one of the most serious, precious commodities that exists, water, is being treated in an unacceptable manner by this Proposed Plan. There are few assets more important to the lifeblood of people and their community than water. It is a vital part of the present and necessary for a viable future. We seriously question the attitude which seems to portray water contamination as

acceptable if it does not meet some undefined cost effectiveness standard. It must be kept in mind that this plan identifies substantial water contamination and then proposes that this community live with that contamination forever.

We cannot accept this approach and insist that the subject of groundwater be treated in the plan in a manner which acknowledges its importance as a resource for today and tomorrow, not only for this community, but for those downstream.

No. 3, Funding Issues, Institutional Controls and Land Use Planning. The Proposed Plan relies on institutional controls to support engineered remedies. In particular, the plan sites the utilization of the Anaconda-Deer Lodge County Development Permit System to track the implementation of the final remedy. Although the plan states that the County's DPS will be funded adequately through the establishment of a trust fund, the plan lacks specificity with respect to this issue. The cooperation of the County is imperative to ensuring that this plan remains protective of our human health and our environment.

Land Use. The County has expressed to the Agency the community's lack of developable land for industrial, residential, and commercial purposes. The use classification, ownership, Superfund designation and condition of properties in the East Valley further precludes future development and limits the community's options for development. The current and

anticipated condition and use of these lands also limits the tax base of our community. The Proposed Plan does not address these concerns.

Short- and Long-Term Effectiveness. The Proposed Plan states that it may take up to 30 years to implement the proposed remedy. Of the three entities involved, EPA, the PRP, and the A-DLC, the only entity with certainty that it will be in operations in the future is Anaconda-Deer Lodge County. Therefore, it is critical that the resources to implement the plan be securely in place with that entity as soon as possible. Furthermore, our community has been taking great strides over the past 18 years to mitigate the negative connotations that are associated with being one of the nation's largest Superfund sites. A remedy that takes 30 years to implement does not mitigate this image, nor does it seem protective from a human health/environmental perspective. The implementation time line should be revised.

Community Involvement. The Record of Decision should specify a meaningful level of involvement the County and community will have in the design and implementation of the remedy.

This final set of Superfund decisions will affect our community for generations to come. This -- Thus, it is important that all issues are addressed in this final record. The concerns outlined above must be addressed for the community

of Anaconda to accept the final Record of Decision for the Anaconda Smelter NPL Site. We are committed and will continue, as we have over the past 15 years, to work with the Agency and the PRP to resolve these issues with the implementation of ethical decision making to see workable solutions to difficult problems. We anticipate and look forward to the Agency's response to these issues.

MR. BEATTY: My name is Dave Beatty, Anaconda-Deer Lodge Commission.

All of us, all of us here present, we, the citizens of Anaconda-Deer Lodge County, have a responsibility in the decision making regarding the information about what is happening. We need feedback and ideas, possible alternative solutions to current situations. Effective communication and mutual respect are essential to develop and maintain teamwork. Inevitably, conflicts will arise. And they must surface so that they can be addressed. We have ownership in the decision making process. Keep hope alive in our community. I encourage all of you people to get involved and to provide comments.

Thank you.

MR. VUCKOVICH: For the record, my name is Gene Vuckovich. I am a life-long citizen of Anaconda-Deer Lodge County. And for the past 11 years, I've been intently involved in Superfund issues as they are related to Anaconda-Deer Lodge County and the rest of the Clark Fork Basin. During this time, I have served as a local government official and on various boards, committees, organizations, and foundations involved with Superfund issues.

My concerns have always been for the future of Anaconda-Deer Lodge County and its citizens. Thus, I agree with the statement read by Chairman Wilkinson, namely that the proposed EPA plan for the Anaconda Regional Water, Waste and Soils Operable Unit is lacking in many respects as set forth in Mr. Wilkinson's statement. My concern is not for the principal responsible party, the PRP or ARCO, nor for the Agency, the EPA, but rather, for the citizens of Anaconda-Deer Lodge County, now and in the future.

Both the PRP and the Agency will soon be gone. But Anaconda-Deer Lodge County and its citizens will remain. It is thus imperative that a plan be adopted that will -- that will not only ensure compliance with the EPA regulations and laws, but also be cost effective and, most importantly, be beneficial for the citizens for Anaconda-Deer Lodge County, now and into the future. I urge the Agency to work with the PRP and the government and citizens of Anaconda-Deer Lodge County in preparing a plan that will address those issues and be a win/win situation for all, as has been done in the past.

Thank you.

MS. DalSOGLIO: Next, I have Jim Flynn.

MR. FLYNN: My name is Jim Flynn. For the record, I am a resident of Anaconda. I've had the opportunity to be involved in reviewing the plan presented by EPA, and I've had the opportunity to review the comments presented by Chairman Wilkinson tonight and would like to go on the record as endorsing those comments. I feel that those are the type of items that need to be addressed with the plan that has been presented. And hopefully, the net result will be something that Anaconda can be comfortable with and live with into the future.

MS. DalSOGLIO: Okay, next, we have Sandy Stash.

MS. STASH: For the record, my name is Sandy Stash. I am a Vice President for ARCO. Basically, I'm the senior person here in Montana for the company. And I guess before I get into some more formal thoughts, I guess I couldn't help but thinking back a little bit on at least the almost nine years I've been involved in this process. And I guess I'm real proud to say, when I look back at that nine years, that together, the EPA, the State of Montana, ARCO, and the community of Anaconda-Deer Lodge County collectively have come a very long way.

When I first got here, and I know Charlie Coleman will remember this, I think we had 77 separate operable units and studies that we feared we would have to do. And I think literally, had we followed that model, we probably would be very much still studying this site and not have accomplished nearly what we have. And I think through the leadership, primarily of EPA and this county, we've done some pretty amazing things in this county. Over a period of eight years, ARCO has spent nearly $350 million in the Basin. Nearly half of that has been in Anaconda-Deer Lodge County. And I'm pretty proud, and I think we all should be very proud, of some of those successes.

The one I think that always stands up kind of front and center, because it is now literally of national significance, is the Old Works Golf Course. And I can't tell you how many phone calls and, and inquiries I get from all around the country on how we, as a PRP, this community, and the agencies were able to, to do that remedy. And I think we all should be very proud of that, as well as the other work we've done.

I also think tonight is an important evening. Although I know we'll have many opportunities to work with each other and talk to each other in the future, this is literally the last formal public hearing in Anaconda. And I think to Gene Vuckovich's comments, that's really important, because I think what that symbolizes is sort of the beginning of the end of what I'm sure has been a difficult process for not only the company, but for the community; and that is, with the Superfund status. And I think this really does indicate that we are nearing the end of a process.

ARCO -- In that, ARCO remains very committed to closing the Anaconda site. And I use the word "closure" very broadly, because it is closure not only of the environmental issues, but literally closure of an era wherein ARCO and its predecessor, Anaconda, were very integral and a part of the Anaconda community. And I do agree with the comments that Chairman Wilkinson made, that it's critical that we work very thoughtfully together on how we close that final chapter. In that we are committed to this closure, we will offer some very specific comments to EPA on their plan, up to and including some very detailed thoughts on the proposal and on how it could be most effectively implemented.

There are a couple of issues that I think we do need to deal with. First and foremost, it's important to the company that this closure be complete and that the settlements be global. And this, too, goes to some of the concerns raised by Chairman Wilkinson and others. Clearly, this remedy goes beyond cleanup by definition and very much gets into issues of natural resource damages. There are numerous parties, most importantly including federal and state government trustees, who have asked us in various court actions to basically do some of the very same things that EPA is requiring us to do in this plan. And as we've said before, it's going to be critical to us, before we embark on this cleanup, that we know, having completed this, that we have closed out all of those concerns and liabilities.

Secondly, there are details that need to be worked out. That, again, I think came off some of what others have said before me. From ARCO's perspective, these details have got to make sense. They've got to address real risks. They have to be cost effective and they've got to be implementable. And I think everyone who has looked at this plan realizes that a site of this size poses some, some difficult technical issues.

We will proceed the best we can with this cleanup. We will only object to spending money for the sake of spending money. We want to be sure that whatever we do in closing this final chapter, we are dealing with real risk and effectuating things that actually mean something. So with that, we look forward to working with everyone in the process.

Thank you.

MS. DalSOGLIO: Next on the list is Chuck Haeffner.

MR. HAEFFNER: I'm Chuck Haeffner. I've been a citizen of Anaconda for the last 30 years. I guess that still makes me a boomer.

I have to go along a little bit with Gene on his, some of his ideas. And Gene was the first one that really got instrumental on getting our golf course going for us. And then he was our, kind of our leader that stepped in and said, "Hey, this is a good idea." And he talked to Bill Williams about it, who was a local Anaconda boy and head of the Anaconda cleanup at the time.

You know, and we pushed forward on that. And most of our dealings at the time were with ARCO. And I know the EPA was there, but we dealt very strongly with ARCO and we got this golf course. It started out just to be a golf course. There was -- and every day that we kind of dealt with them, more amenities were stuck in with that golf course. And I think our dealings today still have to be very strong with ARCO, because that's, they control the pocketbook.

I know the EPA says, hey, this is the law and this is what has to be followed. But our direction that we received while we were on that golf course, our strongest dealings were still with ARCO. And that's where our, I think our ideas have to come from or -- You know, we have to push forward to deal more with ARCO, because somehow, we've kind of pushed them back to be kind of an adversarial group, and I don't know why. Because we started out in a meeting about two years ago and ARCO offered some money and people thought that, oh, yeah, they're out there just trying to bribe the whole damn town and they want to leave and just be gone with it.

But I can honestly say, there's more projects around out there, and if we can deal with these people on a good, honest effort and deal with them with an open mind -- I know we have to follow the ground rules the EPA and the State puts forward, but I still think that our major dealings have to be dealt with with ARCO. I know we did most of it with Bill Williams, and Sandy came in and has done a tremendous job in filling his position.

My idea is that we've got to include those people back into our, any of our dealings. You know, we can sit and fight with, you know, push them off to the side and deal with the governmental agencies and thinking we're going to get it done. And we will get it done, but I think we have to be more compassionate and we can get a lot more projects done other than just a little cleanup out here. Because when they go, they're gone.

And I, I don't plan on just bailing out tomorrow. I went through a quadruple bypass, and I hope it gives me a few more years to live. And I want to be around to, you know, to see more of that green grass other than just the golf course.

So thank you. And I'd like to see ARCO in our dealings rather than just the EPA.

MS. DalSOGLIO: Thanks, Chuck.

Bill Hickey.

MR. HICKEY: My name is Bill Hickey. I've been a school administrator here in Anaconda for the last 21 years. And 18 years ago, on September 30th, many of us were with Ted Schwinden, soon to be Governor of Montana. And on September 30th, 1980, we were awaiting perhaps news of building a new smelter when we heard that it was to close. And our lives in Anaconda fell into the ashes.

A very positive thing is that we have seen Anaconda, in the last eight to nine years, rise from the ashes. And it is alive and well, and it is a place where people want to go to. I was so thrilled last summer when people from all over Montana wanted to travel to Anaconda. This was no longer a place that was not fun to be at. It was no longer a place of slag, a place of doom; it was a very positive place.

I support the comments made by Terry, as one of the many citizens who work with Terry and county government in trying to come together in expressing one voice. The most important thing that we have to say is that we want Anaconda to continue to grow, to thrive, to come from the ashes, and to be a very, very viable place. ARCO has helped, over the past eight to nine years, at bringing this new vision and this new life to Anaconda. What we hope in this final Record is that the ARCO, EPA, and the citizens of Anaconda and the government of Anaconda can come as one and do the right thing by the environment and the people in a cost effective, meaningful fashion. And I hope that we can have the spirit that has thrived for real winning by all sides.

Thank you.

MS. DalSOGLIO: The next individual is Mel Stokke.

MR. STOKKE: I'm Mel Stokke, retired manager of the, general manager of the Anaconda smelter here in Anaconda. And I'm going to say this right off the front. I was kind of caught cold, because I didn't know all of you were going to come up with here with written statements and present them and read them to the audience. So I'm going to just speak off the top of my hat.

Now, all of you are saying how good a community Anaconda is and how well it is and so on and so forth. I don't know if any of you can compare with me. I was born in Anaconda and spent my whole life here, except for the time that I went to Montana State University to get an education, and the other time was when I served in the Army in World War II. Outside of that, I've lived in Anaconda all my life. And I've worked on the smelter for 34 years. When I graduated from Montana State College with a degree in civil engineering, I went to work for the Anaconda Company as a junior draftsman. Over the years, I went through progressive jobs, until I ended up in 1974 as general manager of the Anaconda smelter.

Now, I've been through probably a lot more than you people have ever envisioned as far as environmental problems go. Now, starting in the early '70s, I dealt with the state department and the EPA as far as S02 emissions, the opacity of smoke, arsenic problems, and so on and so forth. Now, in the early days, these things weren't thought of. Everything, everything was do the job, produce the copper, and let it go at that. But starting in the early '70s, when the regulations came out and said that we had to start complying with these things, we --

Well, just to give you an example, we went to Durham, North Carolina, to meet with the EPA and discuss the regulations on arsenic. And at that point in time, they established a regulation of ten micrograms per cubic meter. Now, do any of you know what ten micrograms per cubic meter is? If you took a paper clip, cut it into a thousand parts, and put it into a one cubic meter box, that's what ten -- that's what one microgram is. And, of course, we're looking at ten.

We went back there and discussed this with the EPA. They had a, a board or a group of people that were civilians. And at that point in time, we tried to talk them into 50 micrograms per cubic meter. Now, let me give you some examples. In the converter aisle, the monitoring that we did there showed 19 micrograms per cubic meter. In our casting department, it showed 50. We tried to talk them into a 50 micrograms per cubic meter. We weren't able to. These people had made up their mind and they weren't about to change it. And I still don't know, to this day, how they ever arrived at the figure of ten micrograms per cubic meter. But anyway, that's the regulation that we were held to.

Now, we met with the State, and a big problem was S02. And every year, we went over to Helena and we met with the State Board of Health and we discussed these problems. Starting in 1970, the company committed to $7 million to do some changes on the reverberatory furnaces. This was well and good, because it

was something that we needed. The following year, we went into a program of expansion and we spent $33.5 million. And parts of that was productivity, parts of it was production -- or was environment.

In '74 and '75, we spent another 31 million for the electric furnace, the fluosolid, the components that went with that, to cut down the volume of the gas stream, so that we could contain particulates. The particulates that came off the reverb was a large volume of gas, and there was no way we could treat it in the bag house. Because we found out that state of the art in 1918, that the way to treat particulates was through an electrostatic precipitator.

The only thing that wasn't taken into account was that the ores coming out of Butte had a lot of arsenic in it. Now, arsenic does not go from the gaseous state to the solid state until it is cooled to 220 degrees. So all the years that that large volume of gas went out through the flues and up through the stack, the arsenic went with it. Some of it deposited in the flue as it cooled. But some of it went out through the stack, because it was still in the gaseous state.

So we met with the State and we spent this money. We put in acid plants to collect S02. We enlarged the acid plant by spending another $8 million, to help this. And before the State ever required it, we had tailings ponds and we treated it with lime so that the solid materials and metallic materials

would settle out in the bottoms of ponds so we'd get a clear overflow.

So the thing I'd like to tell you is that we're -- we spent a lot of years and a lot of dollars trying to comply with the regulations of the State, and every year, they gave us a variance for another year, basically because we were spending money and we were making improvements.

Now, I didn't know that everybody was going to have a written statement tonight, but I wrote a memo to Julie and I copied Sandy on it. And the slag has been one of my pet projects. And I don't like the connotation that they keep saying it's a waste. Now, in 1977, I went to Japan and I visited seven smelters. There are no slag piles in Japan. All of the slag goes into cement plants. And Japan has put in more concrete than you can believe in their highways and overpasses and their breakwaters and so on and so forth.

Now, the components of slag fit in with the elements that go into cement. The aluminum, the calcium oxide, the iron oxide, all those products are the portions that make up a slag. Now, some people say to me, "Yeah, that's fine, but we're in a place where we can't ship that stuff." I'm not saying that. I'm not saying we have to ship it. Where do we get our cement? Do we get it from Portland? Do we get the sacks of cement to our lumber yards from these different places? Why can't we do it here?

We sent some of this slag over to Trident, and they ran tests on it and found out that it was a successful project. The only reason it didn't come to pass is we had purchasing people in Denver that couldn't come to an agreement with the people in Trident. So consequently, the thing was never consummated.

We also at one time did some experimenting with slag to make patio tiles. And the tiles that were made were about 18 inches square and about two inches thick. And when they were polished, they were beautiful.

Now, the only thing about slag is when you're looking for structural strength, instead of a five or six sack cement to a yard of concrete, you have to have ten, because it just doesn't give you the body for structural strength.

I think the project that ARCO has been doing here, working with us, and we're trying to work with them, that the town is a lot better off than it ever was. Now, like I say, I worked 34 years on the smelter. And when I was on construction, I walked through all of the departments and around the yards and everything, and I guess I'm still alive. I guess I don't have cancer or all these bad things. But the thing about it is, I've often wondered in my mind, and I haven't asked anybody this question, but how did they ever arrive at the number of a thousand parts per million in arsenic? If it was the same way as they did with the micrograms per cubic meter, I think

there's a lot of fallacy.

Thank you.

MS. DalSOGLIO: Thanks, Mel.

The next person is Art McLean.

MR. McLEAN: I'm Art McLean. I guess I'm here tonight to, to support the community in that I've been a native here since 1951. I teach school, have been for the last 24 years. And I have served on the Anaconda-Deer Lodge County Golf Course Authority Board. It seems as though when we have these community meetings and things, I guess we tend to choose sides one way or another, but my testimony tonight is more along the lines of a partnership than anything else, speaking from that of the Golf Course Authority Board and the trials and the tribulations that we have all gone through there. It required a great amount of cooperation and partnership among many arms from the onset of it, from the Arrowhead Foundation, Anaconda-Deer Lodge County Commissioners, the EPA, the State, and of course, ARCO.

It seems as though we can become cynical when we talk about companies or big companies like ARCO, but without them, we would have had a real tough time. It might look like, you know, the golf course is very, very successful. And it is. And we didn't get there without a lot of cooperation from all of the arms, the parties involved. And it wasn't easy going, it was pretty tough sledding; and there's still some tough

sledding ahead. However, it is successful. And I'd just like to shoot down the idea that there has to be cynicism to accomplish something. I think if we can turn that, as a community, into teamwork, then we're going to have successes. Partnerships work. And the positive results speak for themselves.

Thank you.

MS. DalSOGLIO: The next individual, I believe, is Joe Jordan.

MR. JORDAN: My name is Joe Jordan. I'm the owner of Jordan Contracting. I've been doing business in Anaconda for more years than I even want to remember, but we've been in business as Jordan Contracting heading for eight years. And in those eight years, we've been involved in practically, one way or another, in practically all the reclamation projects that are going on. We employ 50 to 60 people throughout the year.

I'm very concerned -- I have two major concerns with this upcoming work. No. 1 is, I would like to see this work stretched out in a longer period of time. If we try to do this work in, say, two years or three years, that's going to bring in a lot of outside contractors, a lot of outside people. And I don't think that's good for our local community. In order to have young people here, besides everybody else, we have to have jobs. And that can go on for quite some time if we monitor that.

And the second concern that I have, and I think it's been mentioned earlier by practically everyone, especially Mr. Hickey, that we have to do this work cost effective. We've been out, we've been involved, we've seen the work that's done. We know from experience that there's a lot of things that are done that people don't realize. They go beyond to accomplish these things. But we can't expect anybody, ARCO or anybody else, to do something that doesn't make good common sense. We have to do it in a cost-effective way. And I think the Agency has got to look real hard at that.

In other words, what I'm concerned about, and I've seen it in the past, I've seen it in Streamside, that if we get to an impasse and the thing ends up in court, that could go on for 10 or 15 years. The only ones working then is a few attorneys. So we have to have that cooperation that the earlier people have mentioned. And I want to echo that. We need that cooperating and keep the harmony going, and there could be a lot of good things down the road. I'm sure it will happen.

MS. DalSOGLIO: Okay, next is Natalie Fitzpatrick.

MS. FITZPATRICK: I'm Natalie Fitzpatrick. And like Mel Stokke, I was born and raised here. In another month, I'll be twice Jack Benny's 39. And I have managed to survive in what other people have felt is a terrible environment to grow up in, and I have survived very well. I think we have to remember that what we have accomplished, we have accomplished

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through a cooperation with ARCO, with EPA, and with the County. And I think that the only way to, for us to proceed in the future is to sit down together and say, what does Anaconda-Deer Lodge County need and how do we best arrive at that decision?

I'm sorry, I seem to get nervous sometimes.

But in any event, I think that we have before us an opportunity to work together, to say, what is it that we really need? Do we need the impossible? Do we have to sterilize ground, or can we let some of this thing take care of itself, as many things do? You know and I know that many of the trees have come back, our wildlife is returning. And I think Anaconda-Deer Lodge will also return if we work together.

Thank you.

MS. DALSOGLIO: Thank you, Natalie.

I'm going to stumble over this next name. Dan, and I didn't, I can't read the last name, I apologize. It looks like it's about a three- or four-letter last name.

Anybody want to claim that one?

Okay. We'll go through the rest of the names. If you were the person that we skipped over, we can come back. Terry Vaughn is next.

Do we have a Terry Vaughn?

UNIDENTIFIED SPEAKER: I don't see him here.

MS. DALSOGLIO: Okay. Tammy Johnson then.

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MS. JOHNSON: For the record, my name is Tammy Johnson. I'm actually here tonight on behalf of two different bodies. I live in Whitehall, so I'm not a member of your community. However, I have been involved with various grassroots organizations throughout this state supporting multiple use concepts, taking a hard look at, at how we're managing our environment, and trying to bring about some reasonable solutions.

I'm Executive Director of a group in Whitehall called CURE, which stands for Citizens United for a Realistic Environment. I'm also currently serving as President of the Montana Resource Providers Coalition, which is a larger umbrella group comprising 20-some organizations from every sector of resource production in the state, from agriculture to farming to timber, mining, private property rights, et cetera.

I come today bringing one statement. Some people were not able to be here and asked if I would carry this for them. This statement is from Montanans for Private Property Rights, an organization here in Montana. And with permission, I'd like to introduce this into the record on their behalf.

The right to own property is fundamental to the structure of a free nation and has always been one of the most important rights guaranteed to the citizens of this state and country. Citizens have always defended this right with vigor, and our courts have upheld, time and time again, the right to own

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property and has prohibited the taking of private property for public use without just compensation. Many in this room must feel strongly about this issue as it relates to their own property holdings.

The right to determine the end land use for land that is privately owned by ARCO contained in the EPA's Proposed Plan for remediation of the Anaconda Smelter Superfund Site must be respected and upheld. We know that it is often easy to fool ourselves into thinking that large corporations, like ARCO, should have to live by a different set of rules. And perhaps some are thinking that private property rights only belong to the small, individual owner. But no matter how easy the argument seems, the reality is that, yes, even ARCO's right to own property and to determine the appropriate use for that property within the confines of laws that govern our society must be respected, upheld, and championed. There are no exceptions to this fundamental right and philosophy, no matter whose name is on the deed.

Montanans for Private Property Rights plans to further examine the documents and submit written comments.

Sincerely, Carolyn Selan (phonetic), for Montanans for Private Property Rights.

I'd like to introduce some comments on my own behalf of our organization, CURE. Our organization also supports these private property rights and feels that they must remain a

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primary focus as a final plan of action is developed. End land use appears to be, to me anyway, one of the issues that is receiving a great deal of attention, both within the press and within this type of meeting and within documentation that's being submitted on this Proposed Plan.

All of our rural communities are struggling, trying to define their future, trying to figure how the various pieces come together to make up the larger puzzle of what their economic future and what their culture and history has, has taught them and where they want to go. And that is very important. And while it's true that the ARCO holdings in the East Valley may preclude general growth development in this area, it's also my understanding that that has been the case since the latter part of the last century. These holdings have been owned by the Anaconda Company and ARCO for a good deal of time. And I think that it's, it's imperative for everybody to recognize that these are private property holdings, and as any other landowner should have the right to determine the use of their property within the confines of the law, so should ARCO. And that's important to our organization.

I've heard many comments encouraging a cooperative relationship between all parties, and I, too, encourage that relationship. Collectively, there have been many good things to come out of that type of relationship, not only for the community of Anaconda, but for the rest of the citizens of this state. My husband and I bring our kids over to Warm Springs Ponds fishing on a regular occasion. We've been fortunate to play golf at the Old Works Course, although I will be most up-front and say that my skill is not up to that level yet, but it is something that I hope to aspire to. And that benefits not only this community, but other neighboring communities and the rest of the residents of this state.

I heard Sandy Stash comment that $350 million have been spent thus far in environmental remediation. I mean, wow, that is a lot of money. And it's amazing to me sometimes how numb we have become to those types of numbers. We start talking about 60 million here and 180 million here, and we're throwing these numbers around like they mean absolutely nothing. And I sit and try to balance my checkbook and figure out, you know, how to come up with the next $200. So it's something that we have to be cognizant of. Maybe we need to kick ourselves a little bit and really realize what kind of dollars we're talking about.

Both human health and environmental health are paramount to everyone in this community, everyone in your surrounding communities, and to the state. And that is essential. We all support those type of goals. However, it's our organization's belief that common sense must prevail. Cleanup activities do have to accomplish protection for you, as citizens of this community. I believe that ARCO and the agencies and, and

everyone in this room are also strongly committed to that. So I don't -- and I think that there are ways that everybody can work together to ensure that that happens. But I also believe that we have to acknowledge that cost-effective remedies must be included in the final plan. It serves no one's interests if they are not.

Economics have got to be considered. Whether we are balancing our own checkbook for our personal home, for our family, whether it's for our business, whether it's for a larger corporation, such as ARCO, it has got to be considered. And when cost-effective remedies are applied, when human health has been protected, when environmental protection has been accomplished, then it becomes a winning situation for everyone involved.

And believe me, the well can run dry. Just as most of us never believed the Anaconda Company would close down, we were in Livingston and my husband was working for Burlington Northern Railroad in the Shops there, we never believed that could happen. We've all been through this. And we've got to be cognizant of the economics involved.

Thank you very much.

MS. DalSOGLIO: We're going to go back to one that missed over, Joe Saba.

MR. SABA: My name is Joe Saba. First of all -- I've got a little bit of a cold. I'm fairly new at this. I've

lived here most of my life. And I've seen Anaconda when this hill was going and when everything was really prosperous, and I've seen it on the down side. And we talk about long-term things. I'll agree with what everybody has said as far as with ARCO and the EPA. So far, I think everybody has worked pretty good together, because from the time I was a kid here and I seen a lot of the destruction of the land and whatnot going on around here, and in the past few years, I've seen a lot of that come back. And I, for one, it makes me very happy.

But one of the other long-term things that I look at as a young member of this community, or a younger member of this community supporting a family and trying to make my living here is that -- Mr. Jordan made a comment on we need to, you know, one of the long-term things that we have to keep in mind isn't just ARCO and it isn't just the EPA and things like that. We want to be able to maintain what these people have done. I want my kids to be able to work and maintain these things. And the only way they can do that is to stay here, to work here, and to look after it like we're all trying to do. And to do this, we've got to have jobs.

Now, for me, you know, I work for a company, RDM Multi-Enterprises. And I would like a little bit of attention brought to them simply for the fact that they're a company, a small company that has came in here. And the concrete thing was brought up, okay. Well, RDM came in here, and they're

taking that slag up there, they're making a blasting abrasive out of it, roofing granules out of it. They're supplying jobs to our community. They've brought money into this community. And, and it's a long-term thing. It's not just something that's here and going to be gone in a short time. I mean, look at that pile up there. You know, we've been looking at it for a lot of years.

And, you know, I would kind of like to, I don't know, maybe hear some input or hear some fairly close to for-sure things on, you know, what we can do to support that. Because without the people being able to be here, to work here, everything that we're doing, in a way, goes for naught. Because this is our home. This is my kids' home. I want them to be able to raise their families here. But if there's nothing here for them, and if we don't support companies like RDM, who have taken big chances, fought tooth and nail with different people to put down a foothold like they have, you know, what are we going to have? I think that's something we need to look at.

You know, a lot of times, I talk to different people around town and they ask me, "Who do you work for?" And I say, "I work for RDM up on the hill." And they don't know who I'm talking about. Well, you know, that bothers me a lot. Because if people would stop and take the time and look to see who we are and what we're doing, you know, I mean, we need that involvement, that participation. It's for everybody. And if we can, if we can keep that kind of growth going, you know, I mean, like I say, we can do all this cleanup and everything like that. And we have to do it. It was let go for too long. But along with that, we have to bring in the new blood and the new industry to support everything that's been done.

Thank you.

MS. DALSOGLIO: Thank you, Joe.

The next individual we have is Duane Logan.

MR. LOGAN: My name is Duane Logan. I'm a life-long resident of Anaconda. I grew up on a ranch down by Warm Springs, which was one of the, part of the initial reclamation jobs done. And as all, it took time to take in. Grass doesn't grow overnight. I worked on the golf course. It takes time, it takes effort, and you've got to work at it to bring it to something. But it's something to be proud of. And as the Governor's project, on our place, you can see today what used to be green is now lush grass that the cows eat.

I worked on the golf course, which took a lot of community effort, a lot of planning, a lot of compromise, and a lot of long hours by a lot of people. And it has become a success project. And it's like the guy from RDM said, we have to look into the future and find alternate sources. Because ARCO is going to be gone someday. And I've been lucky enough to work for a subconsultant to ARCO on most of this construction work. And it's been, it's taught me a lot, and I was lucky enough to

have that experience. So I just hope that we, as a community, try to work with ARCO and continue with the, the process and the success that's been done so far.

MS. DALSOGLIO: Millie Nash is next – Mike.

MR. NASH: Everybody has kind of established their credentials. I come from a six-generation family that's been born and raised and gotten our education and worked within 100 miles of Anaconda for six generations. And we've been involved in extractive industries and all sides of it for all that time. Well, the sixth generation, they're just little, so they...

I know Mr. Stokke says he's been around the world, to Japan. I've never been to Japan. I've been to some foreign lands, though, I've been to San Francisco and Billings. And I like it right here. But in any event, I'm here actually tonight on behalf of a small, nonprofit organization called the Anaconda Environmental Education Institute, which really doesn't take a stand on the, on the issues of ARCO and EPA as to what better plans might be.

This group provides summaries of the technological, the huge technological documents. Meg Hickey does the basic job. These huge technical tomes take up literally shelves of space and provides what we hope are accurate objective summaries for the use of all parties. And as such, we have the opportunity to observe that a lot of community agencies and people and volunteers have been involved in the statement that was

presented by the Commissioners. And that's just a point of fact. While reading the newspaper, I wasn't sure that everybody was aware of that, and I thought it was appropriate that I observe that and that's just a piece of information, I think, that ought to be available.

The second thing I do think that we would like to see is that the Record of Decision would contain a mechanism that would allow new opportunities, such as the prison, or any other kind of opportunity that might come along that would provide a remediation and at the same time other benefits, or new technologies, such as innovative uses of the slag or other kinds of waste that might develop in the future; that the mechanism would allow for incorporation and modification of the plan as those things become available; that the community and EPA and ARCO would be able to take of advantage of those kinds of things that really – and there's no sense being stuck with an old car if you can get a new one. But the, the Institute will continue to provide the service of providing accurate summaries and helping to analyze the technological information within our resources.

Thank you.

MS. DALSOGLIO: Thank you, Millie.

Don Peoples is next, please.

MR. PEOPLES: I'm Don Peoples from Butte, and I'm feeling a little awkward because I'm violating a basic

principle of nature in Southwestern Montana, and that's basically, a guy from Butte should never come down to Anaconda and try and tell people what to do. And I'm not going to do that. Mike lived in Butte for a long time, and when he moved down to Anaconda, they now call him Millie. I hope you don't call me Donna the next time I'm down here.

But I do feel, I guess a little bit relieved from violating a basic law of nature, because our company is involved in a major development with the prison project. And that is indeed a very, very significant project in, in terms of employment opportunities and in terms of expenditures of dollars. We've expended a lot of money to this point in time. As we speak, or as I speak tonight, there are about 14 architects in a Reno office developing plans for that facility.

It would not have been possible without the great cooperation we've had from the Anaconda-Deer Lodge community and from ARCO. I consider that thinking out of the box. We've done something different here. And frankly, we would not be in this position today if it had not been for what we had seen going on in this community with the development of the golf course. The development of the golf course led our company not only to be involved with the prison development, but also was the impetus for getting us involved with the Greenway development. And that Greenway development came out of our company in Butte, along with a lot of other people.

But I'm here tonight to encourage you to continue to think outside the box. You know, that's a trend that is being used in business all the time today, because you just can't think inside the box. And I think there's a lot of regulations, obviously, you have to adhere to, but let's get outside the box and let's continue to think about all the good things that can happen in Southwestern Montana, if we cooperate and if we work together.

We look forward to becoming a major employer in this area. We're working today with ARCO and with a prospective purchaser's agreement and with EPA and with all of the other agencies that are involved in that and cooperating with the local government here in developing a very worthwhile project. I think that we've got a chance of a lifetime in Southwestern Montana, and we'd better not blow it. If we work together and if we work cooperatively and if we look at making this part of Montana the most livable place in the country, I think we can do it. And I certainly would encourage all you great people down here in Anaconda to continue to think outside the box. We're really looking forward to being a part of your economy down here. And we're looking forward to working with ARCO and working with the community and working with EPA. And all of this cooperation that I've heard tonight and this concept of thinking outside the box leaves me with one closing thought: We're talking about closing out the chapter of ARCO's participation here. Let's make it a happy ending.

Thank you.

MS. DALSOGLIO: The last signup I have is Don Kelley.

MR. KELLEY: I listened to everybody tonight, and I'm going to be right up-front with all you people, my purpose for being here is purely self-interest. I want my kids to stay in this community. I want my family to be here for the next 100 years. My family has been in this community since the late 1800s. They worked for the ARCO, the ACM Company, the Daly Company, whatever you wanted to call it back then.

We have to be in tune with the fact that ARCO is closing its chapter on this community. They are no longer going to be involved in this community. In that respect, we need to look out for our own self-interest. I would like to approach ARCO on a non-adversarial basis. I would like us all to approach them on that basis. In the same respect, I think we need to use caution in dealing with anybody that is telling us they are not going to have anything further to do with this community in the long-term future.

As far as the trusteeship that ARCO speaks of with the State, I would rather not approach ARCO or the State or the EPA on a trusteeship basis. I think we need to be aware of our responsibility in the reclamation for this area. Our responsibility is as an oversight. We're members of the community, we're members of the people that are going to be here 100 years from now. We need to be aware of what's going on with this project. And the people that have turned out here tonight is a good indication that people are concerned with what's going to happen through the next 100 years.

I think a lot of what's happened in the past with the adversarial point of view that ARCO and the community have had is a fear of ARCO no longer being here. I think we still have a little bit of that company town attitude, that what happens to us when they're gone? Well, it's a real evident situation that ARCO is gone. And we need to be involved in the process in saying that goodbye, you know, that we need to look out for our own interest in the process. And I'd like to encourage everybody to continue in that process.

One comment I would like to make on private ownership of the property. There were some comments that were made that ARCO is a private entity and that the property is theirs. I also own property in the affected area, and the rights of ownership are not limited to ARCO, they're all of ours. We own this property. We are owners of the future of Anaconda. And we need to take part in that.

Thanks.

MS. DALSOGLIO: Okay, I had three more people come in to sign up. I just thought I'd take a quick reading to make sure there isn't anybody else out there that would like to sign up to give public comment tonight.

Okay, we'll start with Ed McCarthy.

MR. MCCARTHY: My name is Ed McCarthy. I work for Jordan Contracting. I've been with Joe for seven years now. I've worked with ARCO's contractors since 1983, at the start, when we demolitioned the smelter up there. And I've been working on and off ever since then.

I was fortunate to be chosen this last fall as one of ARCO's people to be featured in the paper. And a lot of people think I fish all day, but that's not the case. But anyway, I've really enjoyed doing some of the work on the golf course project and the Warm Springs Ponds. And one of the greatest comments this summer is people coming into town and seeing the progress we're doing down by the Arbiter, and seeing all the grasses growing down through there instead of the old red sands. And it's just a great positive attitude with the local people working together on that. We can continue to work together to do great.

MS. DALSOGLIO: Next, we have Wayne Ternes.

MR. TERNES: After listening to a lot of folks talk tonight here and thinking about what was said, a lot of things have been alluded to as far as the business that's been here, things that have come and gone. But as a child, I grew up -- I never grew up, I still haven't grown up, but I ran that riverbank and those ponds as a young kid. We grew up down there, and I saw the animals come and go. Matt and I, as kids down there, eight and nine years old, ran up and down that river, around the ponds, and around Warm Springs and what's going on. And I'd like to just say thank you to all the folks that have been involved in this cleanup so far.

We have a long ways yet to go. This last one is supposedly the last one. And what I have found, from hearing people around Anaconda commenting on our cleanup, is people only notice what they see. It's the design work and all that stuff that people don't really understand what's going on and what's happening behind the scenes. In the last year is when I'm hearing folks say, just like Ed talked about, the grass growing here, the wheat coming into Anaconda. People are wondering why we're planting wheat out there and if we can harvest it. Actually, we did cut hay in the East Anaconda Yards this year. Who would have ever thought that would happen?

But the animals that have come back to this area, and looking at what's going on with cleanup, effective cleanup done right can make a real difference. And we need to do it. Nobody is here to be a bad person. We need laws to make sure that we protect human health and the environment. Let's make it sensible. And look what's happened already. Those of you that have been around here for a long time, 20 years ago, 30 years ago, if somebody had ran over a deer down by the slag pile, it's because it had to have fallen out of some hunter's truck. And nowadays, they hit them regularly down there.

You know, how many years ago was it when you saw a fox come across the highway down there? I see them regularly on my way to work. And down by Warm Springs and along the river, there's places where it has come across, places where they've done cleanup has made a big difference. Warm Springs Ponds is a great example. I know there's pros and cons, saying, yeah, water levels aren't whatever. But I remember going to that river when it ran orange in the springtime. That's just what it did. The Clark Fork was orange near Warm Springs. You didn't go near it. The only place you fished was Warm Springs Creek, to where it ran into there. Over the years, that's gone. We don't see those big large orange runoffs anymore. Once in a while, there's some problems, but I've seen the fish change. I used to fish down there when there really wasn't any fish to catch, you were just down there running around the river. And now, there's actually fish you can catch. And I just want to say thank you to what's going on and urge everybody to keeping work with us, and we'll get through it.

Thanks.

MS. DalSOGLIO: Next, we have Jim Davison.

MR. DAVISON: This is the last, but certainly not the only site that needed to be cleaned up in our county. Past solutions which have proven to be safe, healthy, clean, provide economic viability, and have been accomplished in an economically reasonable fashion, were a result of EPA, ARCO,

and the community working together to find those solutions. As the Executive Director of Anaconda Local Development Corporation, we will go on record as supporting the comments made by Commissioner Wilkinson. The Anaconda Regional Waste and Water site, ARWW, is huge and diverse. In fact, it's probably really over 30 sites with over 60 problems. The plan presented is not detailed. The real solutions will come and will be answered in the design and in the implementation stage. Community members and the County must have a meaningful role in those design stages if true success is to be made. And I would hope that the ROD would address that and include the community in those planning stages.

MS. DalSOGLIO: Neil Thomas is next.

MR. THOMAS: I'm Neil F. Thomas. Usually, I'm the last speaker, and I hope I am the last one tonight. But I'm the President of the Anaconda Sportsman Club. And we'd like to see something happen year around with this cleanup business, something that we can do year around. And that's recreation. So if we could get some clean water, like Silver Bow Creek and fish in the creek, get some birds down in the Opportunity Ponds, and also have access sites when these projects are completed so we can have access to them. And then I'd also like to mention that we're kind of interested in putting in a shooting range, a modern shooting range. So if that can happen, we'd like to see that happen.

Thanks.

MS. DalSOGLIO: Well, unfortunately, you are the next to the last one. I have one other individual, Bea McCarthy, if you'd like to come up.

And I'll just do another check, anybody else that has changed their mind or wants to be added to the list?

Okay.

MS. McCARTHY: I'm Bea McCarthy, I'm your state senator. I represent you in Helena, try to do what you want and try to give your views when we come. I'm also a member of the Environmental Quality Council of the State of Montana. And in that capacity, I was meeting last week again with groups from all over the state, when we review all of the projects that are in any way affecting both the environment and our lives and our citizenry. We in Anaconda have been held up as an example of what can be done, both with cooperation of the citizenry and with money. And I think that's something I'm emphasizing at this point. This has not been an inexpensive project to do. Yes, we've got a beautiful golf course; yes, we're working on Greenways. But we also have to realize a lot of money has been expended in that and will continue to be expended in that cleanup.

We've also been very fortunate, I think, in finding contractors and subcontractors that have done a good quality job. Some of the other projects that the EQC has had to monitor throughout the state have not been that lucky. We've been back over them and over them again. And Anaconda has been fortunate in that respect. We need to continue with that and we need to watch the people that are doing our jobs in the future. If we have to do what Mr. Jordan suggested and stretch the jobs out a little bit longer to get quality contractors, then let's do it. Let's not rush through a project in order to get it finished and then have to have it redone at somebody's expense a few years later.

I think the people that are here tonight are sincerely concerned about their community, or they wouldn't have taken the time to come out on such an evening as this. They need to be commended for that. All I'm trying to do to is bring your ideas to Helena and to the people that are making the decisions. And in that, I try not to form my own opinions or have them influence what I'm doing. I'm trying more to see if I can get both sides of the balance and do it, and I hope that in representing you, I will always continue to do that.

I guess I'm a bit prejudiced in what we're doing here, because I've seen it do so much good. And I want to thank ARCO for that, because I think they have really tried to do the very best they can. And we need to thank the contractors in the same respect. And I hope that EPA will look at that when they're making the final decision on this plan and realize that we need to go forward.

We need to also think, though, that there are other uses for this land. The prison is an excellent use for this land. The golf course is an excellent use. We've got to use the slag pile for different things as we come up. Let's brainstorm among ourselves. We're the people that live here. What type of industry do we want? What do we want to bring for our future and for our children and our grandchildren? So work with it together, and we'll get there.

Thank you.

MS. DalSOGLIO: Thank you, Bea.

I would like to just say thank you also for all of you coming out tonight. We've heard echoed quite a bit that this is a real important time for this community, and I think your attendance at tonight's meeting has really showed EPA your ongoing interests and concerns. So thank you very much. I look forward to receiving written comment again through January 30th.

(The proceedings were concluded at 8:30 p.m.)

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COURT REPORTER'S CERTIFICATE

STATE OF MONTANA)
ss.
COUNTY OF JEFFERSON)

I, CHERYL ROMSA, Court Reporter, Notary Public in and for the County of Jefferson, State of Montana, do hereby certify:

That the foregoing proceedings were reported by me in shorthand and later transcribed into typewriting; and that the of my ability.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my notarial seal this 26th day of January 1998.

CHERYL ROMSA
Court Reporter - Notary Public
My Commission Expires 8/4/99
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