Appendix C

Draft Risk Assessment Technical Memorandum
Anaconda Smelter NPL Site 2010 Five-Year Review

U.S. Environmental Protection Agency

Draft Risk Assessment Technical Memorandum

Five-Year Review
Anaconda Smelter NPL Site

Community Soils and Regional Water, Waste, and Soils OUs

September 2010

RESPONSE ACTION CONTRACT
FOR REMEDIAL, ENFORCEMENT OVERSIGHT, AND NON-TIME CRITICAL REMOVAL ACTIVITIES AT SITES OF RELEASE OR THREATENED RELEASE OF HAZARDOUS SUBSTANCES IN EPA REGION VIII

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RISK ASSESSMENT TECHNICAL MEMORANDUM

Anaconda Smelter NPL Site
Anaconda, Montana

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Acronyms

ACM	Anaconda Copper Mining Company
ABS	absorption factor
AF	adherence factor
AOC	administrative order on consent
AWQC	Ambient Water Quality Criteria
ARAR	applicable or relevant and appropriate requirements
ARCO	Atlantic Richfield Company
AT	averaging time
BW	body weight
CD	Consent Decree
CDI	Chronic Daily Intake
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CGWA	controlled groundwater area
COPCs	chemicals of potential concern
CSF	cancer slope factor
CT	central tendency
CWL	critical water level
cy	cubic yard
DEQ	(Montana) Department of Environmental Quality
DNRC	Montana Department of Natural Resources and Conservation
ED	Exposure Duration
EF	Exposure Frequency
ET	Exposure Time
EPA	(U. S.) Environmental Protection Agency
ESD	explanation of significant differences
FWP	(Montana Department of) Fish, Wildlife, and Parks
FS	Feasibility Study
GIS	Geographic Information System
ICs	Institutional Controls
HEAST	Health Effects Assessment Summary Tables
HHRA	Human Health Risk Assessment Summary
HI	Hazard Index
HQ	Hazard Quotient
ICTS	Institutional Controls tracking system
IEUBK	Integrated Exposure Uptake Biokinetic Model
IRIS	Integrated Risk Information System Database
MBMG	Montana Bureau of Mining and Geology
MCL	Maximum Contaminant Level
MPTP	Montana Pole Treating Plant
mg/kg	milligrams per kilogram
NPL	National Priority List (Site)

NRWQC	National Recommended Water Quality Criteria
OU	operable unit
PRP	potentially responsible party
RAOs	Remedial Action Objectives
RCRA	Resource Conservation and Recovery Act
RfC	Reference Concentration
RfD	Reference Dose
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
ROD	record of decision
RPM	(EPA) remedial project manager
SCEM	Site Conceptual Model
SDs	settling defendants
TI	technical impractically (zone)
TRV	toxicity reference value
TRW	technical review work group
UAO	Unilateral Administrative Order
USEPA	U. S. Environmental Protection Agency
WSP	Warm Springs Ponds

Section 1
Introduction

1.1 Overview of Five-Year Risk Assessment Review

The primary purpose of a baseline human health risk assessment is to provide risk managers with an understanding of possible risks to people that live, work, recreate or otherwise visit a site where hazardous materials have been released, and of any important uncertainties associated with the assessment. Similarly, the purpose of a baseline ecological risk assessment is to provide risk managers with an understanding of possible risk to ecological receptors, and of any important uncertainties associated with this risk assessment. As a general policy and in order to operate a unified Superfund program, USEPA may use results of baseline risk assessments to determine whether a release or threatened release poses an unacceptable risk to human health or the environment that warrants remedial action and to determine if a site presents an imminent and substantial endangerment. The National Contingency Plan for Oil and Hazardous Substances (NCP) states that the baseline risk assessment should "characterize current and potential future threats to human health and the environment that may be posed by contaminants migrating to groundwater or surface water, releasing to air, leaching through soil, remaining in the soil, and bioaccumulating in the food chain" (Section 300.430(d)(4)).

The review of risk assessment assumptions and toxicological criteria are required tasks in the five-year review process. This five-year review is a statutory requirement for the Anaconda Smelter NPL Site under the Comprehensive Environmental Response, Compensation Liability Act (CERCLA), 42 U.S.C. 9601 et. seq., and the NCP, 40 U.S.C. Part 300. The purpose of a five-year review is to evaluate the implementation and performance of a remedy in order to determine if the remedy is or will be protective of human health and the environment and to recommend ways to attain or maintain that protection.

In addition, Five-Year Review reports identify issues found, if any, during the review that could suggest that the remedy may not be sufficiently protective and makes recommendations to address such issues. Protectiveness is generally defined in the NCP separately for cancer risk and noncancer hazard quotients (HQ) or hazard indices (HI). Generally, the human health determination is based on whether cancer risk is greater than 10^{-4} and /or HI is greater than 1. Where cancer risks exceed 10^{-4}, clean up goals are often established using a point of departure of 10^{-6}. For ecological receptors, a HQ greater than 1 often represents a threshold of concern.

1.2 Risk Assessment Guidance

The overall approach to human health risk assessments (HHRA) for the Community Soils and Anaconda Regional Water, Waste and Soils OUs under evaluation followed guidance provided in Risk Assessment Guidance for Superfund: Volume I – Human

Health Evaluation Manual (Part A) (USEPA 1989). This document provides guidance on all aspects of HHRA, including evaluating available data and identifying chemicals for quantitative analysis, developing exposure scenarios that depict expected exposure conditions, assessing toxicity of chemicals, combining this information to estimate potential carcinogenic and non-carcinogenic health risks, and addressing uncertainties. This guidance and additional applicable federal, regional and state guidance have been used as deemed appropriate in this review. It should be noted that USEPA released additional HHRA guidance after the ROD issue date for both OUs. Additional HHRA guidance includes, but is not limited to:

- Risk Assessment Guidance for Superfund, Volume I. Human Health Evaluation Manual. (Part F, Supplemental Guidance for Inhalation Risk Assessment). Final. Office of Emergency and Remedial Response. USEPA/540/R/070/002. OSWER 9285.7-82. USEPA. Washington, D.C. January 2009.

- Integrated Exposure Model for Lead in Children (IEUBK) for Windows. IEUBKwin1.1, Build 9. June 2009.

- Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual, (Part E, Supplemental Guidance for Dermal Risk Assessment), Final. OSWER 9285.7-02EP PB99-963312. July 2004.

- Recommendations of the Technical Review Group for Lead for an Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil. January 2003.

- EPA Memorandum, "Human Health Toxicity Values in Superfund Risk Assessments." Michael B. Cook, Director of Superfund Remediation and Technology Innovation, OSWER Directive 9285.7-53. December 5, 2003.

- Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24. 2002.

- Exposure Factors Handbook. Office of Research and Development. National Center for Environmental Assessment. USEPA/600/P-95/002 Fa. August 1997.

Ecological risk assessments (ERAs) are most often conducted using a phased approach that follows EPA guidance *(Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (USEPA 1997)) for conducting ERAs at Superfund sites. This guidance also post-dates the most recent risk assessment efforts for the OUs. USEPA (1997) and others typically recognize that methods for conducting ERAs must be site-specific. USEPA guidance for conducting ERAs at Superfund sites is therefore not a detailed step-by-step "cookbook" but instead provides recommendations on ERA components to be considered and general approaches for performing ERAs.

Currently, the first phase of the ERA is a Screening Level ERA (SLERA). The SLERA is used to determine if further investigation is warranted, that is, if there is a reasonable potential for ecological receptors to suffer adverse effects as a result of exposure to site-related contamination. If the SLERA determines that adverse effects are likely, then the next phase of the ERA process is warranted. This second phase is the baseline ecological risk assessment (BERA). Where indicated by the results of the SLERA, a BERA is performed to better describe ecological risks and to reduce uncertainties associated with conservative risk estimations in the SLERA.

1.3 Objectives and Approach

This analysis is limited to the review of current methods of risk assessment and toxicological data noting any changes from assumptions used in the RODs for the OUs under evaluation. This memorandum provides information to meet the USEPA's Tier 1 data collection effort for risk assessments for the Community Soils and Regional Water, Waste and Soils OUs of the Anaconda Smelter NPL site.

The technical assessment of a remedy examines three basic questions:

- Question A: Is the remedy functioning as intended by the decision documents?
- Question B: Are the exposure assumptions, toxicity data, cleanup levels and remedial action objectives (RAOs) used at the time of the remedy still valid?
- Question C: Has any other information come to light that could call into question the protectiveness of the remedy?

The main focus of this memorandum is to answer the Question B: Are exposure assumptions, toxicity data, cleanup levels and RAOs used at the time of the remedy still valid? Question C is also examined to a limited extent.

To answer Question B, an evaluation was conducted to identify if changes in exposure pathways, changes in land use, new contaminants and/or contaminant sources, remedy byproducts, changes in standards, newly promulgated standards and TBCs (to be considered), and changes in toxicity and other contaminant characteristics (e.g., bioavailability) occurred since the ROD was issued. The validity of original assumptions regarding current and future land/groundwater uses and contaminants of concern, and whether any physical features (or understanding of physical site conditions) have changed (e.g., changes in anticipated direction or rate of groundwater or identification of a new groundwater divide) are evaluated. These changes could include changed or new land uses, including zoning changes, changed or new routes of exposure or receptors, changed physical site conditions that may affect the protectiveness of the remedy, new contaminants, new or updated toxicity criteria for contaminants of potential concern, or a new understanding of geologic conditions.

Cleanup levels at a site may be based on calculated risk for chemicals and/or media where no promulgated standards (e.g., site-specific soil and sediment action levels) exist or where existing standards are not sufficiently protective for site-specific conditions. In addition to toxicity, other contaminant characteristics that determine the nature and extent of contaminant migration and effects on receptors (e.g., sorption, ability to bioaccumulate, bioavailability) are examined. The effects of significant changes in risk assessment parameters used to support the remedy selection, such as reference doses, cancer potency factors, toxicity reference values (TRVs), understanding of other chemical characteristics, and exposure pathways of concern are identified. All of these factors may have a bearing on the validity of the remedial action objectives and may affect the protectiveness of the remedy.

Initial steps in this evaluation include the review of risk assessment reports, RODs, recent updates on current site conditions, and investigation of current and proposed land uses. This information is then assessed considering current risk assessment methods and current toxicological information.

This memorandum will:

- Determine if risk assessment conclusions are still valid and will consider any changes that may affect the validity of cleanup levels.
- Identify if changes in land use or in the anticipated land use within or near the OUs could affect remedy implementation.
- Identify if changes in physical site conditions have occurred at the OUs.
- Determine if new human health or ecological exposure pathways or receptors have been identified.
- Determine if new contaminants or contaminant sources have been identified.
- Determine if any changes in the toxicity values for contaminants of concern might affect risk estimates significantly.
- Identify any other information that could call into question the protectiveness of the remedy.

1.4 Report Organization

This report is composed of four sections listed below. Tables and figures presented at the end of Section.

Section 1 Introduction

Section 2 Site Background

Section 3 Community Soils and Regional Water, Waste and Soils Operable Units

Section 4 References

Section 2

Site Background

Marcus Daly bought a small silver mine called Anaconda near Butte, Montana in 1881. Daly built a smelter at Anaconda in 1882 and connected the smelter to Butte by railroad. The mines at Butte were the primary source of copper ore for smelter operations. Daly continued to buy neighboring mines, and when huge amounts of copper were discovered in the area, his Amalgamated Copper Mining Company, later renamed Anaconda Copper Mining Company, contributed to making Butte "the Richest Hill on Earth". Following the death of Daly and the other Butte "Copper Kings" (William A. Clark and F. Augustus Heinze), the Anaconda Copper Mining Company consolidated their holdings and continued underground copper mining until the early 1950s.

In 1977, ARCO bought the Anaconda Copper Mining Company, but shut down mining at Butte only a few years later because of falling metal prices. In Anaconda, the smelter was demolished after its closure in 1981. The smelter stack, the largest free standing brick chimney in the world, remains in place and is a well-known landmark in western Montana. Heavy metals from historical smelting operations in the area contaminated a large area around the smelter at Anaconda. This contamination resulted in the inclusion of the Anaconda Smelter on the NPL for environmental cleanup in the 1980s.

2.1 Location and Setting

The site is located at the southern end of the Deer Lodge Valley, at and near the location of the former Anaconda Minerals Company (AMC) ore processing facilities. The site covers an area of approximately 300 square miles. It has a temperate climate and includes a variety of terrain - from steep slope uplands to level valley floors. A variety of creeks and drainages are included within the Site. Major mining-related features at the site include two very large tailings ponds (the Anaconda Ponds and the Opportunity Ponds) and the former Anaconda smelter stack. At 585 feet tall, the stack is a local landmark and is the largest freestanding brick chimney in the world. Two communities (Anaconda and Opportunity) are located within the site footprint. US Interstate 90 and the Clark Fork River border the site. The site is divided into a number of OUs, including Mill Creek, Old Works/East Anaconda Development Area, Flue Dust, Community Soils and Anaconda Regional Waste Water & Soil (ARWW&S). Two of the OUs, ARWW&S and the Old Works/East Anaconda Development Area, are further divided into smaller units.

2.2 Regulatory History Summary

Remedial actions have been taken in five OUs within 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. This area, located adjacent to the community of Anaconda, contains areas of future development. 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, addresses all remaining residential and commercial/industrial soils within the Anaconda Smelter NPL Site. The principal contaminant of concern (COC) identified in the Community Soils OU ROD is arsenic in surficial soils from past aerial emissions and railroad beds constructed of waste material. The ARWW&S OU is the fifth OU to receive remedial action at the Anaconda Smelter NPL Site. These actions 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 those under the OW/EADA.

2.3 Summary of Remedy

Remedies for the Community Soils and ARWW&S OUs are similar. A brief summary is provided below to provide context for considering protectiveness.

2.3.1 Soils and Waste Material

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

1. Reduction of surficial arsenic concentrations to below the designated action levels of 250 ppm, 500 ppm, and 1,000 ppm through removal and replacement with clean soil; placement of a vegetative or other protective barrier (e.g. engineered barrier); or a combination of soil cover or in situ treatment, depending on location and land use.
2. Clean up all future residential soils at the time of development that exceed the residential action level of 250 ppm soil arsenic concentration, through the Anaconda-Deer Lodge County (ADLC) Development Permit System (DPS);
3. Clean up all future commercial or industrial areas at the time of development that exceed the commercial/industrial action level of 500 ppm soil arsenic concentration through the ADLC-DPS.
4. Implement ICs to control land uses, provide educational information to all residents describing potential risks and recommendations to reduce exposure to residual contaminants in soils, and to ensure the long-term viability of the remedy.

5. 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.
6. Partial removal of waste materials followed by soil cover and re-vegetation for areas adjacent to streams. Removed material will be placed within designated Waste Management Areas (WMAs).
7. Construct an engineered cover over all contaminated railroad bed material within the community of Anaconda to prevent direct contact with, and reduce potential for erosion and transport of, contaminated materials to residential and commercial/industrial areas;
8. Separate the rail bed from residential and commercial/industrial areas with a barrier to restrict access to the rail bed and to control surface runoff from the rail bed through the use of retaining walls and/or curbing; and,
9. Maintain existing ICs to restrict access.

2.3.2 Groundwater

Major components of the remedy for ground water include:

1. 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.
2. 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.
3. 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.

2.3.3 Surface Water

Major components of the remedy for surface water include:

1. Reclamation of contaminated soils and engineered storm water management options to control overland runoff into surface waters.
2. Selective source removal and stream bank stabilization to minimize transport of COCs from fluvially deposited tailings into surface waters. Removed material will be placed within a designated WMA.
3. 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.
4. 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.
5. 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.

Section 3
Risk Evaluation

The primary document on which this review is based is *Final Baseline Risk Assessment, Anaconda Smelter NPL Site, Anaconda, MT, January 24, 1996* prepared by CDM Federal Programs Corporation. In addition, two previous risk assessments were reviewed, primarily to evaluate the assumption in the above assessment that arsenic, cadmium, copper, lead and zinc are primary COPCs for the site (*Baseline Risk Assessment for the Old Works/East Anaconda Development Area, August 19, 1993* prepared by Life Systems, Inc. and *Final Draft Baseline Risk Assessment for the Flue Dust Operable Unit, November 15, 1990* also prepared by Life Systems, Inc.).

3.1 Summary of the Human Health Baseline Risk Assessment

The final Baseline Human Health Risk Assessment for the site addressed operable units at the site that had not been previously addressed, including community soils in Anaconda and a large surrounding area. This assessment is the last comprehensive risk assessment developed for the site, and forms the basis for current target clean-up levels being used to guide continuing site remediation.

The risk assessment evaluated a variety of possible exposure scenarios, and developed risk-based screening levels for arsenic for residential, agricultural, commercial, and recreational (dirt bike riders and swimmers). No quantitative clean-up targets were established in records of decision for the site for surface water. All quantitative clean-up targets are thus for soils in and around Anaconda.

To evaluate residential soils pathway, the risk assessment used data on surface soils and dust collected by Bornschein in 1992 and 1994. These data were focused on arsenic, but substantial data for cadmium, copper, lead and zinc in soil were also collected. Arsenic and lead were selected as COPCs and were evaluated quantitatively in the risk assessment. Risks from lead were determined to be within EPA's acceptable range even for young children in residential situations. Risks due to arsenic in soils and indoor dust were deemed unacceptable, and therefore arsenic was identified as the sole chemical of concern (COC).

Based on this risk assessment, and consistent with other assessments developed previously for other operable units, clean-up targets for arsenic in soils were identified as 250 mg/kg for residential land use, 500 mg/kg for commercial/industrial land use and 1,000 mg/kg for all other land uses (agricultural, recreational).

3.2 Technical Review of Human Health Risk Assessment

Review of the 1996 EPA risk assessment involved evaluation of chemicals of potential concern, identification of changes in land use, re-assessment of exposure scenarios and exposure parameters, review of exposure point concentrations and the data supporting those concentrations, evaluation of changes in toxicity criteria, and discussion of other information pertinent to the 5-yr review. The review did not include checking calculations performed in the risk assessment; however, calculation of screening levels were re-assessed.

3.2.1 Review of Chemicals of Concern

The risk assessment in 1996 assumed, based on previous risk assessments for the Site, and on experience at other mining sites, that arsenic, cadmium, copper, lead and zinc were the only soil constituents that needed to be considered as chemicals of potential concern (COPCs). A similar assumption was made in the 1993 risk assessment for the Old Works/East Anaconda OU. However, a more complete selection of COPCs was performed for the risk assessment for the Flue Dust OU in 1990. No information was found that suggests that this focus on naturally occurring inorganic constituents was inappropriate.

3.2.2 Review of Land Use

Land uses evaluated in the 1996 risk assessment were evaluated in generic fashion, and these same land uses are likely for parts of the Site for the foreseeable future. In this sense, land uses have not changed. Remedies for the site involve the use of ICs to prevent land uses incompatible with residual contamination (see Section 11 of the Five-Year Review Report). For example, ICs are in place to prohibit residential development in areas cleaned-up to the commercial target of 500 mg/kg arsenic in soil, unless a cleanup to the residential action level occurred. In this sense, changes in current land use in focused areas of the Site are adequately addressed by current remedies. For example, clean up to 250 mg/kg is required for future residential areas at the time of development. Thus, changes in land use within the site should have no impact on protectiveness of remedies.

3.2.3 Review of Human Receptors of Concern

As is the case for land uses, human receptors were evaluated generically and included residents, workers (including those associated with agriculture), and recreation. These general receptor groups appear to cover the range of receptors that might be found within the site.

For some receptor groups, subgroups of receptors could have been identified and evaluated. For example, workers could have included indoor office workers, workers involved in outdoor jobs such as landscaping and maintenance, excavation and construction, etc. No information from the site or in recent guidance suggests that nuances for commercial workers are likely to change the basic conclusions of the risk assessment. Likewise, nuances of exposure for other recreational subgroups (hikers, hunters) are not likely to change conclusions of the risk assessment. The scenarios that were addressed are likely to be protective; evaluation of other scenarios would not result in lower estimates of risk-based screening levels. Thus, no additional information was uncovered that would question original selection of exposure scenarios.

3.2.4 Review of Exposure Parameters

Residents

As part of the five-year review process, exposure parameter values were examined for any changes that may affect protectiveness for residential land use. No changes between parameters used for soil and dust ingestion for residents in 1996 and current recommendations were noted.

GI absorption of arsenic was based on bioavailability data from a study using Cynomolgus monkeys (Freeman et al 1995). This study used soil and dust collected within the Community Soils OU. No additional data on bioavailability for Anaconda soils was located, and this study is still provides the best information available.

For all receptors exposed to soil, dermal exposure to arsenic was not considered. EPA has recently published additional guidance for assessment of dermal exposure (2004). This guidance recommends an absorption fraction of arsenic from soil of 0.03 (3 percent). This absorption fraction is sufficiently high to affect risk calculations and clean-up targets to some extent. However, more recent studies published since EPA guidance was developed that this value is more appropriate for arsenic in solution, and absorption of arsenic from soil may be negligible (Lowney et al. 2007). Thus, the decision not to include dermal exposure is still defensible.

Commercial Workers

No differences between exposure parameters used in the 1996 assessment and those currently recommended by USEPA were noted for commercial workers. No changes to risk or screening levels would be suggested for these workers.

Agricultural Workers

Some key exposure parameters for these workers were based on either site-specific information or on professional judgment. Exposure frequency was based on typical growing seasons in the area, and dust loading during field preparation and harvest was based on professional judgment. These factors still seem appropriate. Soil ingestion rates chosen for this scenario also remain valid. No studies on agricultural workers are available and the ingestion rates chosen cannot be second guessed using more recent information.

The inhalation rate used for workers is appropriate for short-term, heavy activities and could overestimate likely exposure. Workers are unlikely to sustain heavy activity over an 8 hour period for many days. An inhalation rate of 1.5 for moderate activity could be more appropriate for long-term exposure. Reducing the inhalation rate would decrease risks and increase screening levels. Thus, such a change would not compromise the protectiveness of the remedy.

Dirt Bikers

Key assumptions for dirt bikers (representative recreational users for exposure to arsenic in soil/waste) are either site-specific or based on professional judgment. Exposure frequency, exposure time, soil ingestion rate and dust loading are all based on judgments made in the 1996 assessment or in the previous risk assessment in 1993. No new data exist on which to question these judgments was uncovered. The inhalation rate used for dirt bikers was 2.5 m^3/hr, which is an appropriate rate for heavy activities over the short term. This inhalation rate still remains reasonable for occasional strenuous activity.

Lead

Risks due to exposure to lead were calculated using the IEUBK model (USEPA 1994) and model defaults recommended in 1996. Several inputs to the model would be updated if the lead risk assessment for young children were re-run using current methods. Some default parameters in the model have changed in recent updates. Dietary lead intake has been reduced for each year from age 0 to 7 based on new NHANES (National Health and Nutrition Examination Survey) data and maternal blood lead concentration at birth has been reduced. Both of these changes would reduce lead exposure and risk. Additional discussion of lead in site soils is provided in Section 3.2.5 below.

3.2.5 Review of Exposure Point Concentrations

Current methods for evaluating lead risks to young children do not involve calculation of EPCs for large site areas. Instead, the recommended approach examines lead risks on a yard-by-yard basis. Summary data for lead in soil suggest a wide range of lead concentrations in 302 yards in the data set used in the 1996 assessment. Lead concentrations varied from 75 +/- 13 to 582 +/- 282 mg/kg among 10 areas of the Community Soils OU, and individual data points varied from 14 to 2,152 mg/kg. A screening level for lead in soil for residential conditions is 400 mg/kg. Some of these data points exceed the screening level and may merit further investigation. If arsenic and lead concentrations are highly correlated, current clean-up targets for arsenic may be protective for lead risks also. Currently, USEPA is in the process of re-evaluating lead risks and the need to include clean-up targets for lead in remedies for the Site.

3.2.6 Review of Toxicity Values

Oral toxicity values (references doses) and cancer slope factors (SFs) for arsenic were examined for any changes that may affect protectiveness. No changes to these toxicity criteria for arsenic have occurred since the 1996 risk assessment.

A calculation for the dirt biker scenario in the 1996 risk assessment using the current unit risk factor for arsenic (USEPA 2010) substantiates the protectiveness of current remediation goals. Inhalation exposure makes a much lesser contribution to cancer risks for other exposure scenarios, and risks associated with specific targets would remain essentially unchanged if based on new inhalation toxicity criteria and associated exposure and risk calculations.

USEPA did not recommend typical toxicity criteria for lead in 1996 and still has not provided such criteria. Thus, the approach used in the 1996 risk assessment that utilized the IEUBK lead model is still appropriate. The target blood lead criterion for evaluation of lead exposure for young children, a probability of less than 5 percent of blood lead exceeding 10 ug/dL, has not changed since 1996.

3.3 Summary of Baseline Ecological Risk Assessment

The ecological risk assessment for the Site (Final Baseline Ecological Risk Assessment, Anaconda Regional Water, Waste, and Soils OU, Anaconda Smelter NPL Site, Anaconda, Montana, October 1997 prepared by CDM Federal Programs Corporation) focused on identification of areas of potential phytotoxicity. This focus was intended to allow for identification of areas within the Site that might require restoration/re-vegetation. The assessment utilized a plant stress analysis method based on the primary plant growth characteristics of the soil system. Threats to wildlife from COPC in soil, drinking water and forage were also evaluated, along with threats to aquatic fauna in surface water at the Site. The 2002 biomonitoring study (IEHH/TTU 2002) quantified COC (As, Cd, Cu, Pb and Zn) exposure and effects in wildlife inhabiting non-remediated and remediated areas on the Anaconda Smelter NPL Site. That study quantified the level of exposure and effects, and resultant risk, to wildlife inhabiting the site and evaluated the nature of changes in metal and arsenic disposition, and the resulting effects, that occur in wildlife following the implementation of remedial options on the site.

The risk assessment did not focus on quantitative expressions of ecological risk, although some information equivalent to hazard quotients often reported in current ecological risk assessments was included. No screening levels for protection of ecological receptors were developed. Thus, the assessment identified important ecological risks, but did not provide quantitative clean-up targets for the feasibility study.

As indicated in Section 2.3, remedies for protection of ecological receptors do not specify specific clean-up targets. For example, the remedy for the ARWW&S OU calls for selective sediment removal, bank stabilization and stormwater controls, but does not call for achieving specific surface water or sediment concentrations of COCs.

Thus, the question to be answered in review of the ecological risk assessment is "were any exposure pathways or receptors missed that might identify risks not addressed in the remedy".

3.4 Technical Review of Ecological Risk Assessment

The following sections discuss important aspect of the Ecological Risk Assessment for the ARWW&S OU.

3.4.1 Review of Chemicals of Potential Concern

COPCs considered in the evaluation of ecological risks were arsenic, cadmium, copper, lead, and zinc. These constituents were the same as those identified for human health risk assessments for the Site. All are often found to be of concern for ecological receptors at mining sites in the western US. The list of COPCs identified in the ERA appears to be appropriate and complete, and no additional COPCs are likely to contribute substantially to ecological risks.

3.4.2 Review of Receptors of Concern

Ecological receptors identified in the ERA include qualitative general descriptions of likely receptors, such as "plants, grazing herbivores, and other wildlife". Potential receptors are also listed to include macroinvertebrates, fish, amphibians, reptiles, birds, and mammals. Specific wildlife receptors selected for quantitative risk estimations include terrestrial plants, white-tailed deer, deer mouse, red fox, American robin, and kestrel. Protection of these receptors should provide adequate protection of all other taxa not specifically identified, based on adequate consideration of most major trophic levels (e.g., primary producers, herbivores, omnivores, carnivores). The only major category of potentially important ecological receptors not specifically identified in the ERA is piscivorous wildlife. Birds and mammals that consume fish could be at risk if fish have accumulated contaminants from water, sediment, or prey. This pathway is of most concern for chemicals with greater bioaccumulation potential (e.g., cadmium).

3.4.3 Review of Exposure Pathways

The ERA identifies the following exposure pathways as those of concern:

- Terrestrial plants exposed to soil (uptake)
- Aquatic plants exposed to sediments (uptake)
- Aquatic organisms exposed to contaminants in surface water and sediments (uptake and direct contact)
- Herbivores exposed to contaminated plants via ingestion and incidentally exposed to soil via ingestion
- Wildlife exposed to contaminants in surface water via drinking

- Insects exposed to plants via ingestion
- Top predators exposed to contaminants in avian and mammalian prey via ingestion

As stated previously, the most important exposure pathway not considered in the ERA is the ingestion of fish by piscivorous predators, which is linked to bioaccumulative contaminants in sediments and surface water. This pathway may not be critical if it can be demonstrated that aquatic invertebrates and fish have not accumulated site-related contaminants to any significant degree.

3.4.4 Review of Effects Assessment

Surface Water Effects Values

Toxicity of selected metals to aquatic organisms was evaluated and used to estimate risks based upon no-observable-affects-level (NOAELS), lowest-observable-affects-level (LOAELS), and USEPA Ambient Water Quality Criteria (AWQC) (EPA 1992). AWQC for some metals (aluminum, cadmium, copper, iron and zinc) were adjusted based on hardness.

The State has designated uses for Silver Bow Creek (SBC), which flows adjacent to the Anaconda Smelter Site, and has promulgated specific standards accordingly. These standards are as stringent as, or more stringent than, federal water quality criteria. The most stringent human health or aquatic water quality criterion is applied. Silver Bow Creek must meet human health standards and not allow zones of acute aquatic life toxicity (i.e., mixing zones) or allow aquatic life chronic 4-day average and acute 1-hour (instantaneous) concentrations to exceed DEQ-7 aquatic life criteria.

As shown in Table 3-1 AWQC for arsenic, cadmium, copper are lower than values used in the BERA. However, changes in these criteria would not affect the remedy selected to protect aquatic life which was to prevent Berkeley Pit water from entering SBC.

Table 3-1
Ecological Criteria for Contaminants of Concern

COC	AWQC Criterion Acute Concentration (ug/L) [a]	AWQC Criterion Chronic Concentration (ug/L)[a]	AWQC Criterion Acute Concentration (ug/L) [b]	AWQC Criterion Chronic Concentration (ug/L)[b]
Aluminum	750	87	750	87
Arsenic	360	190	340	150

Cadmium	3.9 (19.0)	1.1 (3.4)	0.52* (2.1)	0.097* (0.27)
Copper	18 (65)	12 (39)	3.79* (14)	2.85* (9)
Iron	1000	1000	N/A	1000
Lead	82 (477)	3.2 (18.6)	13.98*	0.545*
Sulfate	No value	No value	No value	No value
Zinc	120 (380)	110 (340)	37* (120)	37* (12)
AWQC ambient water quality criteria AWQC value (value adjusted for site-specific hardness)				
[a] AWQC Federal Register. 57 FR 246.60911-60923. December 22, 1992.				
[b] Montana Numeric Water Quality Standards – Circular DEQ-7. February 2008. Values were adjusted to 25 mg/L as $CaCO_3$, Value in parenthesis is adjusted for a hardness of 100 mg/L $CaCo_3$ for comparison				

EPA has updated surface water quality criteria since the ERA was completed. The most recent update is provided in National Recommended Water Quality Criteria (EPA 2009). For comparison purposes, the table below presents the chronic EPA water quality criteria from 1992 (as described above) and the chronic criteria from the 2009 update, based on hardness of 100 mg/L $CaCO_3$. These updates are most important for cadmium, copper, lead, and zinc, as the chronic National Recommended Water Quality Criteria (NRWQC), adjusted to hardness of 100 mg/L, are substantially lower than the chronic AWQC as presented in the 1992 Federal Register (Table 3-2).

Table 3-2
Comparison of AWQC from 1992 and 2009 for Selected Inorganic Constituents

Surface Water COPC (hardness = 100 mg/L)	1992 Chronic AWQC, ug/L (EPA)	2009 Chronic NRWQC, ug/L (EPA
Arsenic	190	150
Cadmium	3.4	0.25
Copper	39	9.0

Lead	18.6	2.5
Zinc	340	120

Sediment Effects Values

The ERA considered a variety of effects values for sediment. These include values from NOAA, Ontario, Ingersoll, and several regional values from Milltown Reservoir and the Clark Fork River. The NOAA screening levels are based primarily on marine sediments, and therefore may not be fully applicable to this site. The Ontario Low Effect Level (LEL) and the Ingersoll et al. (1996) Effect Range-Low (ERL) and threshold effect level (TEL) values are relatively similar and are generally considered useful for screening sediments. The regional values are in general substantially higher (less conservative) than those of Ontario or Ingersoll et al. (1996). Since completion of the ERA, the most well-accepted sediment screening levels are the consensus-based threshold effect concentrations (TECs; and probable effect concentrations (PECs)) derived by MacDonald et al. (2000). The table below presents the MacDonald TECs as well as the final sediment effects values used in the ERA. These are the ERM (selected as the NOAEL) and NEC (selected as the LOAEL) derived by Ingersoll et al. (1996). As shown below, incorporation of the more current TEC values into the ERA evaluation would likely alter the results of the ERA for screening sediments, and provide a useful comparison to help evaluate 'clean' vs. contaminated sediments (Table 3-3).

Table 3-3
Comparison of Sediment Screening Levels from 1992 to 2009 for Selected Inorganic Constituents

COPC	MacDonald consensus based TEC	Ingersoll ERM	Ingersoll NEC
Arsenic	9.79	50	100
Cadmium	0.99	3.9	8
Copper	31.6	190	580
Lead	35.8	99	130
Zinc	121	550	1300

Surface Soil Effects Values

Surface soil effects values used in the ERA include Soil Effects Concentrations taken from the terrestrial Montana Natural Resource Damage Program (NRDP) report (RCG/Hagler, Bailly 1995). These values were derived from site-specific phytotoxicity tests, and are considered relevant and useful for assessing risks to terrestrial plants onsite.

No surface soil effects values or screening levels are included in the ERA that can be used to estimate risks to other ecological receptor categories. Since the ERA has been completed, EPA has developed Eco-SSLs (ecological soil screening levels) for a variety of metals and for a few organic chemicals. Each chemical specific Eco-SSL includes up to four values, depending on data availability. These are screening levels for (1) terrestrial plants, (2) soil invertebrates, (3) birds, and (4) mammals. Site specific phytotoxicity values should take precedence over the phytotoxicity Eco-SSLs for screening purposes. However, Eco-SSLs for the other three receptor categories can be used to screen contaminants in surface soil specifically to consider these receptors. Eco-SSLs for birds and mammals are generally quite low because they consider bioaccumulation and food web effects. In summary, Eco-SSLs are currently viewed as relevant and useful soil screening levels for selecting COPCs in surface soil. It is recommended that Eco-SSLs be used as conservative screening values for comparison to metals concentrations in surface soil.

Section 3.5 Summary of Risk Assessment Evaluation and Protectiveness Statement

Risk-based target clean-up goals were set for the Anaconda Smelter NPL Site in a series of risk assessments that culminated in a comprehensive assessment in 1996 that addressed all areas surrounding primary sources areas (Smelter Hill, Opportunity Ponds, Old Works area, etc.). Clean-up targets for arsenic in soil of 250 mg/kg, 500 mg/kg and 1,000 mg/kg were established for residential, commercial and agricultural/recreational land uses. These targets were used in the ROD to define, in part, the remedy for non-source areas. No other quantitative clean-up targets (e.g. for protection of ecological receptors) were defined in remedies for Community Soils and RWW&S OUs.

Review of risk assessments focused on several issues, as discussed in Section 1. Each of these issues and results of the analyses are summarized below.

- Identify if changes in land use or in the anticipated land use on or near the OU could affect remedy implementation.

Remedies for the Site include ICs to prevent, for example, residential development in areas that have been remediated to the commercial target for arsenic. Thus, land use could change, but as long as ICs are in place and enforced to ensure these areas are cleaned up to the residential standard, the remedy will remain protective.

Risk assessment efforts examined communities and other areas within the Site in generic fashion. That is, they looked at whole communities and/or large areas of communities or other site area. The results of the risk assessment, therefore, do not apply to specific small areas. Thus, if land use within larger areas, which were addressed generically, changed, the results of the risk assessment would not change.

Risks to soil-associated ecological receptors (e.g., terrestrial plants, soil invertebrates, small burrowing mammals) are evaluated based on land uses and areas that, for the most part, appear to be currently relevant. It is important to recognize that risks to ecological receptors (in this case, soil-associated organisms) consider population- and community-level impacts, and adverse effects to individual organisms are not considered critical unless the organism in question is a species with special status (e.g., threatened or endangered). Therefore, some loss of individual organisms can generally be tolerated as long as populations and communities are protected from adverse effects.

- Identify if changes in physical site conditions have occurred at the Site that could affect risk.

Many changes in physical site conditions have occurred within the Site, much as part of remediation activities. For example, a large part of the Old Works/East Anaconda OU has been remediated and re-developed as a golf course. Since the major changes to the Site are a result of remediation, these changes should not compromise the protectiveness of the remedies.

With regard to ecological risks, changes in physical condition has in some cases reduced risks because suitable habitat has been reduced or eliminated, thereby reducing exposure potential. For example, a golf course can be deemed suitable foraging area for some species such as American robin, but most other ecological receptors will avoid the developed golf course area because cover and foraging areas are limited. Conversely, many acres have been reclaimed at the Site and this has improved wildlife habitat, potentially exposing wildlife to residual COCs (e.g., borrowing animals). Based on the site-specific wildlife study conducted after the ERA, an increase in risk to wildlife is not anticipated based on changes in the physical conditions at the Site due to implementation of the Selected Remedy.

- Determine if new human health or ecological exposure pathways or receptors have been identified.

The human health risk assessment examined a range of exposure scenarios (residential, commercial, agricultural, dirt biker (recreational) and wader/swimmer(recreational)). Such designations could be further divided to provide activity-specific risks. For instance, hikers and hunters could be addressed as recreational exposure scenarios. Such parsing of scenarios is, however, unlikely to yield significantly higher risks. For recreational exposures, the dirt biker scenario includes rather intense exposure via ingestion and inhalation. Reasonable exposure assumptions for other recreational scenarios would likely result in lower levels of exposure. Thus the range of exposure scenarios addressed remains reasonable and protective.

The ecological risk assessment also addressed a range of receptors including plants and terrestrial and aquatic biota. Exposure pathways evaluated in the ERA included direct contact with contaminated media and indirect exposure via ingestion of contaminated prey (i.e., food web effects). The one pathway not quantitatively evaluated in the ERA was that of ingestion of contaminated prey for piscivorous predators. This may not be an important omission if it can be demonstrated that fish have not accumulated site-related contaminants to any significant degree. If fish tissues are suspected of containing elevated concentrations of bioaccumulative contaminants (e.g., cadmium), then this pathway may warrant further investigation.

- Determine if new contaminants or contaminant sources have been identified.

Risk assessment efforts for the Site have been focused, since the early 1990's, on arsenic, cadmium, copper, lead and zinc. No data were uncovered that suggest that this focus is inappropriate.

Ecological risks associated with primary COPCs identified for this site (As, Cd, Cu, Pb, and Zn) are likely to be the major contributors to ecological risk. Any incremental risks contributed by other less well identified contaminants (e.g., other inorganic chemicals such as barium, manganese, thallium, or vanadium) are likely to be low and relatively unimportant. Addressing risks from the major COPCs identified will likely address any risks associated with other contaminants not fully described or identified.

- Determine if any changes in the toxicity values for contaminants of concern might affect risk estimates significantly.

No changes in oral or inhalation toxicity criteria for arsenic have occurred since the 1996 risk assessment was developed. Similarly, targets for blood lead levels for assessing lead risks for young children have not changed since 1996.

Several changes have occurred in the derivation and use of media- and chemical-specific ecological screening levels (ESLs) since the ERA was completed. As described previously, EPA has modified and in general lowered the chronic water quality criteria for several inorganic chemicals. Of major concern is the substantial reduction in the criterion continuous concentration (CCC) for cadmium in surface water. Sediment ESLs are now available to allow for a more certain assessment of risks for sediment-associated biota. Specifically, the consensus-based TECs of MacDonald et al. (2000) can be used to verify the results of the screening and preliminary risk estimation as presented in the ERA. Finally, the regional phytotoxicity values used in the ERA for screening surface soil contaminant concentrations are valid and relevant. The Eco-SSLs derived by EPA since the ERA was completed would, however, provide another source of soil screening values to ensure that risks to other soil associated organisms (i.e., other than terrestrial plants) are adequately evaluated.

- Determine if exposure parameters used in the risk assessment remain valid.

Review of default and site-specific exposure parameters used in calculation of human health risks did not reveal any instances where such parameters did not appear valid. In particular, no information was uncovered to suggest that exposure parameters based on site-specific information and/or professional judgment should be reconsidered.

- Identify any other information that could call into question the protectiveness of the remedy.

No other such information has been identified.

Section 4
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