

APPENDIX A
WORK PLAN FOR ECOLOGICAL RISK ASSESSMENT
AT THE ROSS-ADAMS MINE

Work Plan for Ecological Risk Assessment at the Ross-Adams Mine

Revision 1

Prepared for:

Newmont USA Limited

*6363 S. Fiddler's Green Circle
Greenwood Village, Colorado 80111*

Prepared by:

Tetra Tech

*3801 Automation Way, Suite 100
Fort Collins, Colorado 80525
(970) 223-9600
Fax (970) 223-7171
Tetra Tech Project No. 114-181862*

June 5, 2009

TABLE OF CONTENTS

INTRODUCTION	1
DESCRIPTION OF WORK	1
Phase 1 – Review of PA/SI	1
Soil	2
Surface Water	2
Stream Sediment	2
Marine Sediment	2
Phase 2 – Review of Data after Each Sampling Event in 2009	4
Phase 3 – Preparation of SLERA for EE/CA.....	5
Phase 4 – Additional ERA Work in 2010.....	7
REFERENCES	8

LIST OF TABLES

Table 1. Surface Soil Data for Metals Compared to Ecological Benchmarks
Table 2. Surface Soil Data for Radionuclides Compared to Ecological Benchmarks
Table 3. Surface Water Data for Metals Compared to Ecological Benchmarks
Table 4. Surface Water Data for Radionuclides Compared to Ecological Benchmarks
Table 5. Stream Sediment Data for Metals Compared to Ecological Benchmarks
Table 6. Stream Sediment Data for Radionuclides Compared to Ecological Benchmarks
Table 7. Marine Sediment Data for Metals Compared to Ecological Benchmarks
Table 8. Marine Sediment Data for Radionuclides Compared to Ecological Benchmarks

LIST OF FIGURES

Figure 1. Ross-Adams Mine Preliminary Conceptual Site Model

INTRODUCTION

This Work Plan summarizes the overall strategy and main steps to be followed in conducting the ecological risk assessment (ERA) for the Ross-Adams Mine. The strategy emphasizes a phased approach with refinement of the Conceptual Site Model (CSM) and list of Contaminants of Potential Concern (COPCs) at key stages of the EE/CA project.

DESCRIPTION OF WORK

The ERA will be prepared mirroring the technical intent of the State of Alaska and U.S. EPA guidance for remedial investigation and risk assessment, with emphasis given to Alaska Department of Environmental Conservation (ADEC) guidance. Guidance documents that will be consulted include:

- “Risk Assessment Procedures Manual” (ADEC 2005a);
- “Policy Guidance on Developing Conceptual Site Models” (ADEC 2005b);
- “Ecoscoping Guidance” (ADEC 2008a);
- “Cumulative Risk Guidance” (ADEC 2008c);
- “User’s Guide for Selection and Application of Default Assessment Endpoints and Indicator Species in Alaska Ecoregions” (ADEC 1999);
- “Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Risk Assessment Guidance for Superfund” (EPA 1997a);
- “*Guidelines for Ecological Risk Assessment*” (EPA 1998); and
- “*EPA Region 10 Supplemental Ecological Risk Assessment Guidance of Superfund*” (EPA 1997b).

The phased risk assessment will utilize the preliminary conceptual site model (CSM) from the PA/SI (Kent and Sullivan 2004) as a starting point for identifying potential exposure pathways and the contaminants of potential concern (COPCs). The model will be refined as additional sampling data and site-specific information become available to confirm whether a pathway is complete or incomplete, or whether a COPC can be eliminated from further evaluation. Presumptive remedies will also be evaluated to determine their impact on potential exposure pathways and COPCs. Below is a summary of the key phases of the risk assessment.

Phase 1 – Review of PA/SI

The first phase of the ERA process, which was completed as part of the preparation of this ERA Work Plan and discussed in the following, is to review the COPCs that were identified in the PA/SI, and to the extent possible based on available data, refine the list of COPCs. In addition, the first phase includes review of the CSM and consideration of potential refinements.

The PA/SI identified the following COPCs for ecological receptors:

- Soil – arsenic, lead, uranium, and radionuclides
- Surface Water – lead, uranium, and radionuclides
- Stream Sediment – lead, uranium, and radionuclides
- Marine Sediment – arsenic, lead, uranium, and radionuclides

The COPC selection process in the PA/SI did not use ecological screening values for soil, and none of the media were screened against ecologically-based screening values for radionuclides. Therefore, in Phase 1 we revisited the screening process and added the screening values for soils and radionuclides to determine whether additional analytes should be considered as COPCs. The additional screening was performed using the maximum concentrations detected in each medium.

For the additional screening process we used conservative ecological screening values from the following sources:

Soil

- Metals: Ecological Risk-Based Screening Concentrations (ERBSCs) (ADEC 2008a); EPA Ecological Soil Screening Levels (EcoSSLs) (EPA 2003a,b, 2005a,b, and 2007).
- Radionuclides: Level 1 values from RESRAD-BIOTA (DOE 2006).

Surface Water

- Metals: Ecological Risk-Based Screening Concentrations (ERBSCs) (ADEC 2008a); and Alaska Water Quality Criteria (ADEC 2003, 2008b). Note that the most conservative values were used for metals with hardness-dependent criteria (i.e., assumed hardness of 25 mg/L). Hardness values measured during the PA/SI were all less than 15 mg/L as CaCO₃ (Kent and Sullivan 2004).
- Radionuclides: Level 1 values from RESRAD-BIOTA (DOE 2006).

Stream Sediment

- Metals: Threshold Effects Level (TEL) and Probable Effects Level (PEL) values in NOAA Squirt Tables, as recommended by ADEC Ecoscoping Guidance (ADEC 2008a).
- Radionuclides: Level 1 values from RESRAD-BIOTA (DOE 2006).

Marine Sediment

- Metals: TEL and PEL values in NOAA Squirt Tables, as recommended by ADEC Ecoscoping Guidance (ADEC 2008a).

- Radionuclides: No screening values were identified for radionuclides, so the RESRAD-BIOTA Level 1 values that were used for stream sediments were also used for marine sediments¹.

The ecological screening values for radionuclides were taken from the RESRAD-BIOTA program developed by DOE (DOE 2006). The RESRAD-BIOTA program is based on DOE's Technical Standard "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota" (DOE 2002). The "Graded Approach" Standard uses the dose limits established by the National Council on Radiation Protection and Measurements (NCRP 1991) and the International Atomic Energy Agency (IAEA 992) as values that are protective of aquatic and terrestrial plants and animals. These dose limits are as follows: 10 mGy/d (1 rad/d) for aquatic animals; 10 mGy/d (1 rad/d) for terrestrial plants; and 1 mGy/d (0.1 rad/d) for terrestrial animals (DOE 2002). The RESRAD-BIOTA program uses these dose limits to calculate radionuclide concentrations in soil, surface water, and sediment that will result in exposures that do not exceed the dose limits for aquatic and terrestrial receptors (DOE 2006).

Tables 1 through 8 present the maximum detected concentrations from the PA/SI, the ecological screening values used, and the results of the comparisons. The results of the revised COPC selection process indicated that analytes identified as COPCs in the PA/SI should be retained as COPCs. There is some indication that lead may not be a COPC for surface water because its maximum concentration is below the surface water screening values, however, it was conservatively retained as a COPC, and will be further evaluated using the field data collected in 2009. In addition to the COPCs identified in the PA/SI, the following analytes are considered COPCs at this phase of the ERA process:

- Soil – aluminum, manganese
- Surface Water – aluminum, cadmium
- Stream Sediment – no additional analytes selected
- Marine Sediment – no additional analytes selected

Aluminum was conservatively included for soil because it exceeds ADEC's ERBSC. However, per EPA's EcoSSL for aluminum (EPA 2003a), aluminum's soluble and toxic forms are only available at a soil pH of less than 5.5 (EPA 2003a), thus it is not a concern under most soil conditions. Soil pH data will be collected at the site to determine whether aluminum is a COPC in soil. If soil pH is greater than 5.5 then aluminum will not be considered further as a COPC in soil. Manganese was included for soil because the maximum detected concentration exceeds the ADEC's ERBSC and EPA's EcoSSL values. Aluminum and cadmium were included for surface water because the maximum concentrations exceed ADEC's ERBSC and Alaska's Water Quality Criteria. The surface water samples from the PA/SI were not filtered and thus provide very conservative concentrations of metals. Note that the SAP will collect both filtered and unfiltered surface water samples and the filtered samples will be used for comparison to aquatic life criteria. For stream sediments and marine sediments no additional analytes are included as COPCs at this phase of the ERA process.

¹ The aquatic animal limits cited in the DOE (2002) guidance as well as the RESRAD-BIOTA program are based on freshwater fish and crawfish, not marine organisms. As such, the appropriateness of applying these dose limits to marine organisms will be evaluated and decision regarding their use will be included in the risk assessment.

The other metals evaluated in the PA/SI are not specifically excluded or included as COPCs after Phase 1 of the ERA process. These analytes will be further evaluated as COPCs for each media after additional data are available from the field sampling events that will be conducted in 2009 (as described in Phase 2). A preliminary literature review will be performed to evaluate the potential toxicity of rare earth elements (REEs). Depending on the results of the review, a determination will be made as to whether sampling for REEs is warranted. The COPC identification process will be ongoing through the ERA process to refine the list and include or exclude analytes as deemed warranted from the available data.

After review of the original CSM in the PA/SI Figure 1, no significant revisions were deemed necessary at this time. The only minor revision is the addition of the several metals for additional consideration as COPCs as described above.

Phase 2 – Review of Data after Each Sampling Event in 2009

There are three sampling events scheduled for 2009 which make up the Expanded Site Investigation (ESI) as described in the SAP. It is advantageous to perform some level of data review after each event in order to make decisions about subsequent steps in the risk assessment process. Below is a summary of the data reviews that are planned for each sampling event.

Surface water and soil samples will be collected during the first sampling event of 2009. The results will be reviewed and compared to the ecological screening values used in Phase 1. The outcome of the data review will be used to determine whether adjustments to the analyte list need to be made for the remaining sampling events scheduled for 2009 (i.e., summer and fall).

Stream and marine sediment samples will be collected during the second sampling event in 2009 (i.e., July). The analytical results will be reviewed and compared to sediment screening values. If sediment screening values are exceeded, a determination will be made as to whether sediment toxicity tests should be conducted in the future to further evaluate potential sediment toxicity. If sediment toxicity testing is needed, stream sediments will be evaluated with the amphipod, *Hyalella azteca* in a 10-day acute toxicity test (EPA 2000) and marine sediments will be evaluated with a 10-day acute amphipod mortality test using *Rhepoxynius abronius* or other suitable amphipod species depending on site-specific conditions (EPA 1994). The amphipod tests are considered the most appropriate because of their ecological relevance and their use in deriving sediment quality screening values (e.g., TELs and PELs). It is preferable to include site-specific reference sediments in these tests for comparison to laboratory controls and site samples. If the sediment toxicity tests are needed they will be conducted in 2010 pursuant to review of the 2009 site characterization data and identification of appropriate reference locations. Any sediment toxicity testing that is conducted will include testing of site samples and site-specific reference sediments, as well as laboratory controls. Chemical characterization would be performed concurrently on any sediments that are tested.

This ERA Work Plan will be revised after the results of the third sampling event are available (the third sampling event will include surface water quality samples; see the SAP for details on what sampling and analysis will be conducted and sampling locations). At this point all three rounds of sampling data will be reviewed and compared to ecological screening values. The results of these comparisons will be used to make any refinements to the list of COPCs and the CSM.

The revised ERA Work Plan will also include a summary of the Biota Inventory that will be conducted during the July sampling event. The Biota Inventory will include a qualitative survey of the terrestrial, freshwater aquatic, and marine aquatic species at the site, with an emphasis on those plants and animals that are important components of exposure routes to humans and ecological receptors as per the CSM. A basic habitat map will be prepared to show the main habitat types associated with the site. Point count surveys (Ralph et al. 1993, 1995) will be conducted to identify the common birds and other wildlife species that utilize the main habitats. Benthic invertebrates occurring in the freshwater streams will be identified through visual examination of the substrate. Intertidal marine species will be identified through visual observation of the substrate at low tide. A review of key references, such as the following, will also be conducted to identify those species likely to occur at the site:

- *2004 Preliminary Assessment/Site Inspection Report, Ross Adams Uranium Mine, Prince of Wales Island, Alaska*, Kent & Sullivan 2004;
- *Biological Assessment and Evaluation for Bokan Mountain*, USFS 2008a;
- *Tongass Land and Resource Management Plan Final Environmental Impact Statement*, USFS 2008b;
- *Mammals of Alaska*, Alaska Geographic Society 1996;
- *Guide to the Birds of Alaska*, Armstrong, 2008;
- *Wildlife Notebook Series*, ADF&G 2009;
- *Marine Life of the Pacific Northwest*, Lamb and Hanby 2006;
- *Marine Invertebrates of the Pacific Northwest*, Kozloff 1996;
- *Fresh-water Invertebrates of the United States*, Pennak 1978; and
- *Native Plants of Southeast Alaska*, Hall 1995.

Natural resource agencies will also be consulted for additional information. Incidental wildlife observations from other visits to the site will also be considered for inclusion in the Biota Inventory summary.

Phase 3 – Preparation of SLERA for EE/CA

A screening-level ecological risk assessment (SLERA) will be developed based on the 2009 Biota Inventory and ESI. The SLERA will be prepared using ADEC risk assessment guidance (ADEC 2005a), and will include the following main components, which are further discussed below:

- 1) Data Evaluation
- 2) Problem Formulation
- 3) Analyses of Exposure and Effects
- 4) Risk Characterization
- 5) Uncertainty Evaluation

The SLERA is an intermediate step between the limited screening evaluation and a complete baseline ecological risk assessment (BERA). For the EE/CA, the SLERA is intended to focus on the specific problems of a removal action. If the SLERA indicates substantive risk that cannot be readily addressed by a removal action, it will be expanded to include additional information and elements of a BERA that will be prepared based on subsequent phases and may include additional data collected in 2010 as discussed below.

Data Evaluation. The Data Evaluation will include a summary of the 2009 sampling data that is pertinent to the SLERA. Summary tables will be included for surface water, sediments, and soil. The tables will show summary results for each analyte, including the number of samples collected, the frequency of detection, the range of detection limits for samples that are non-detects, and the range of detected values (minimum and maximum). The summary will also include relevant information on laboratory qualifiers (such as J or estimated values).

Problem Formulation. The Problem Formulation will include a summary of the site history and environmental setting, documentation of site visits, information about what ecological receptors are most likely to occur at the site, a synopsis of contaminant fate and transport and ecotoxicity, and a discussion of potential exposure pathways. Information about the environmental setting and ecological receptors at the site will be based on the Biota Inventory that will be completed under Phase 2. The Problem Formulation will include a revised CSM that incorporates the revisions made from the additional data collection activities. The Problem Formulation will also include selection of "Assessment Endpoints" and the "Measures" that will be used to evaluate potential impacts to the assessment endpoints. ADEC's guidance on assessment endpoints and indicator species (ADEC 1999a, b) will be used during development of the Assessment Endpoints. Results of the Biota Inventory will be used to identify important wildlife foraging guilds at the site, such as "terrestrial avian invertivore" and "aquatic avian invertivore", and representative species for those guilds. Community-based Assessment Endpoints will likely include freshwater benthic invertebrates, marine benthic invertebrates, terrestrial soil invertebrates, and terrestrial plants. Measures will include Measures of Exposure, Measures of Effects, and Measures of Ecosystem and Receptor Characteristics.

Analysis of Exposure and Effects. This component of the SLERA will combine the measures of exposure and effects to estimate potential impacts to ecological receptors. The analysis of exposure will include conservative calculations of potential contaminant exposures to selected indicator species and communities. Measures of Exposure will be based on exposure point concentrations (EPCs) from field samples collected during the 2009 sampling events. As per EPA risk assessment guidance, EPCs will be based to the extent possible on the 95 percent upper confidence limit on the mean (95% UCL) of the samples, or the maximum concentration, whichever is the lower value. EPA's ProUCL program will be used to calculate 95% UCL values. The analysis of effects will include identification of Toxicity Reference Values (TRVs) and risk-based screening values for the COPCs and the indicator species and communities.

Risks for radionuclides will be calculated using DOE's RESRAD-BIOTA program (DOE 2006). RESRAD-BIOTA was developed to implement DOE's graded approach to dose evaluation (DOE 2002) and its development was co-sponsored by EPA and the Nuclear Regulatory Commission. It is capable of calculating absorbed doses and tissue concentrations for a range of radionuclides and receptors.

In addition to comparisons to sediment screening values, potential effects to benthic invertebrates may be assessed using sediment toxicity tests as described under Phase 2. If these tests are conducted the results will be discussed in this section.

Risk Characterization. The Risk Characterization will address whether potential ecological risks are expected at the site based on the result from the Analysis of Exposure and Effects. Hazard Quotients (HQs) will be calculated as the ratio of the estimated exposure to a COPC to the corresponding TRV for that COPC. Cumulative risk will be evaluated consistent with ADEC guidance (ADEC 2005a). Per ADEC, a Hazard Index (HI) is calculated for those COPCs that are considered to have cumulative toxic effects on a given receptor; the HI is calculated as the sum of the HQs for that receptor (ADEC 2005a). This section will include discussions of the potential risks for each Assessment Endpoint based on exposure media, contaminant of potential concern, and area of the site.

Uncertainty Assessment. This component of the SLERA will identify the main sources of uncertainty associated with the risk assessment, such as exposure assumptions, bioaccumulation factors, and toxicity information. Furthermore, it will provide an indication of whether the sources of uncertainty over- or under-estimate risk, and their significance in interpreting the conclusions of the risk assessment. If applicable, it will also discuss what steps could be taken (such as additional data collection) to reduce important sources of uncertainty.

Science/Risk Management Decision Points. This section will include a discussion of what decisions can be made from the results of the SLERA. These include whether sufficient data are available to characterize potential risk, or whether there are important data gaps that indicate additional investigation in 2010 is warranted. The discussion will also include consideration of removal actions planned (presumptive remedies) for the site that could reduce or eliminate exposure pathways to ecological receptors.

Phase 4 – Additional ERA Work in 2010

It may be necessary to perform additional risk assessment activities in 2010 depending on the results of the SLERA. The SLERA will consider the influence of presumptive remedies for mine impacted areas. The need for additional risk assessment will be determined in part by whether the SLERA indicates the potential for risk, the magnitude of the risks, and the uncertainties associated with the risk estimates. If conducted, the additional work in 2010 would focus on collecting additional data to fill gaps and reduce uncertainties in the risk estimates. Filling data gaps may include measuring tissue concentrations in plants and/or animals, field surveys such as of benthic invertebrates, and additional site-specific sediment- or other toxicity tests. As discussed above, the ERA Work Plan will be revised after completion of the 2009 field sampling program and serve as the decision document to determine if additional risk assessment work is required for 2010.

REFERENCES

- Alaska Department of Environmental Conservation (ADEC). 1999a. User's guide for Selection and Application of Default Assessment Endpoints and Indicator Species in Alaska Ecoregions. Ecoregions/Assessment Endpoint Project. June, 1999.
- ADEC. 1999b. Technical Background Document for Selection and Application of Default Assessment Endpoints and Indicator Species in Alaska Ecoregions. Ecoregions/Assessment Endpoint Project. June, 1999.
- ADEC. 2003. Alaska Water Quality Manual for Toxic and Other Deleterious Organic and Inorganic Substances. As amended through May 15, 2003.
- ADEC. 2005a. Risk Assessment Procedures Manual. Division of Spill Prevention and Response, Contaminated Sites Program. Draft, November, 2005.
- ADEC. 2005b. Policy Guidance on Developing Conceptual Site Models. Division of Spill Prevention and Response, Contaminated Sites Program. November 30, 2005.
- ADEC. 2008a. Ecoscoping Guidance. Division of Spill Prevention and Response, Contaminated Sites Program. March 2008.
- ADEC. 2008b. Water Quality Standards. 18 AAC 70. Amended as of July 1, 2008.
- ADEC. 2008c. Cumulative Risk Guidance. Division of Spill Prevention and Response, Contaminated Sites Program. June 9, 2008.
- Alaska Department of Fish and Game (ADF&G). 2009. Wildlife Notebook Series. Available online at <http://www.wildlife.alaska.gov/index.cfm?adfg=aawildlife.main>.
- Alaska Geographic Society. 1996. Mammals of Alaska. Anchorage, AK.
- Armstrong, R.H. 2008. Guide to the Birds of Alaska. Alaska Northwest Books. 5th Edition.
- Department of Energy (DOE). 2002. A graded approach for evaluating radiation doses to aquatic and terrestrial biota. Voluntary Consensus Technical Standard DOE-STD-1153-2002. Washington, D.C.
- DOE. 2006. RESRAD-BIOTA for Windows. Developed at Argonne National Laboratory for the U.S. Department of Energy with support from the U.S. Environmental Protection Agency and the U.S. Nuclear Regulatory Commission. Version 1.21. May 10, 2006.
- Environmental Protection Agency (EPA). 1994. Methods for Assessing the toxicity of sediment-associated contaminants with estuarine and marine amphipods. EPA 600/R-94/025. Washington, D.C.
- EPA. 1997a. Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Risk Assessment Guidance for Superfund. Environmental Response Team. Edison, New Jersey.

- EPA. 1997b. EPA Region 10 Supplemental Ecological Risk Assessment Guidance of Superfund. EPA Region 10, Office of Environmental Assessment, Risk Evaluation Unit. EPA-910-R-97-005.
- EPA. 1998. Guidelines for Ecological Risk Assessment. Risk Assessment Forum. EPA/630/R-95/002F. Washington, D.C.
- EPA. 2000. Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates. EPA 600/R-99/064. 2nd Edition. Washington, D.C.
- EPA. 2003a. Ecological Soil Screening Level for Aluminum. OSWER Directive 9285.7-60. Office of Solid Waste and Emergency Response. Washington, D.C.
- EPA. 2003b. Ecological Soil Screening Level for Iron. OSWER Directive 9285.7-69. Office of Solid Waste and Emergency Response. Washington, D.C.
- EPA. 2005a. Ecological Soil Screening Level for Arsenic. OSWER Directive 9285.7-62. Office of Solid Waste and Emergency Response. Washington, D.C.
- EPA. 2005b. Ecological Soil Screening Level for Lead. OSWER Directive 9285.7-70. Office of Solid Waste and Emergency Response. Washington, D.C.
- EPA. 2007a. Ecological Soil Screening Level for Manganese. OSWER Directive 9285.7-71. Office of Solid Waste and Emergency Response. Washington, D.C.
- EPA. 2007b. ProUCL Version 4.0. Prepared by A. Singh and A.K. Singh for U.S. EPA. Available at <http://www.epa.gov/nerlesd1/tsc/software.htm>.
- Hall, J.K. 1995. Native Plants of Southeast Alaska. Windy Ridge Publishing.
- Kent & Sullivan, Inc. 2004. 2004 Preliminary Assessment/Site Inspection Report, Ross Adams Uranium Mine, Prince of Wales Island, Alaska. Prepared for U.S.D.A. Forest Service, Alaska Region.
- Kozloff, E.N. 1996. Marine Invertebrates of the Pacific Northwest. University of Washington Press.
- Lamb, A. and B. Handby. 2006. Marine Life of the Pacific Northwest: A photographic encyclopedia of Invertebrates, Seaweeds and Selected Fishes. Harbour Publishing.
- National Oceanic and Atmospheric Administration (NOAA). 2008. Screening Quick Reference Tables (SQuiRTS).
- Pennak, R.W. 1978. Fresh-water invertebrates of the United States. 2nd Edition. University of Colorado. Boulder, CO.
- Ralph, C.J., G. R. Geupel, P. Pyle, T.E. Martin, and D.F. DeSante. 1993. Handbook of Field Methods for Monitoring Landbirds. USDA Pacific Southwest Research Station. General Technical Report PSW-GTR-144.

Ralph, C.J., J.R. Sauer, and S. Droege (eds.). 1995. Monitoring Bird Populations by Point Counts. USDA Pacific Southwest Research Station. General Technical Report PSW-GTR-149.

Regional Sediment Evaluation Team (RSET). 2006. Northwest Regional Sediment Evaluation Framework. RSET is co-chaired by EPA Region 10 and U.S. Army Corps of Engineers, Northwest Division. Interim Final. September 30, 2006.

U.S. Forest Service (USFS). 2008a. Biological Assessment and Evaluation for Bokan Mountain. Craig Ranger District, Tongass National Forest. June 2008.

USFS. 2008b. Tongass Land and Resource Management Plan, Final Environmental Impact Statement. Forest Service R10-MB-603c. January 2008.

Table 1. Surface Soil Data for Metals Compared to Ecological Benchmarks

Analyte	Maximum of Site Samples	Background Samples	ERBSC (2)	EPA EcoSSL (3)	Maximum > Background?	Maximum > ERBSC?	Maximum > EcoSSL?
Underlain by Granite							
Aluminum	9700	1200	5	NA (4)	Yes	Yes	No
Arsenic	16	2.8	0.25	18	Yes	Yes	No
Iron	36000	8900	NA	NA	Yes	NA	NA
Lead	290	24	9.36	11	Yes	Yes	Yes
Manganese	580	220	100	220	Yes	Yes	Yes
Uranium	1900	19	5	NA	Yes	Yes	NA
Underlain by Quartz Monzonite							
Aluminum	2000	2900	5	NA (4)	No	Yes	No
Arsenic	2.1	1	U	0.25	Yes	Yes	No
Iron	8500	7800	NA	NA	Yes	NA	NA
Lead	15	1.9	9.36	11	Yes	Yes	Yes
Manganese	200	150	100	220	Yes	Yes	No
Uranium	22	0.6	5	NA	Yes	Yes	NA
Shoreline Area							
Aluminum	28000	14000	5	NA (4)	Yes	Yes	No
Arsenic	3.7	3.1	U	0.25	Yes	Yes	No
Iron	46000	33000	NA	NA	Yes	NA	NA
Lead	87	31	9.36	11	Yes	Yes	Yes
Manganese	3900	310	100	220	Yes	Yes	Yes
Uranium	2600	210	5	NA	Yes	Yes	NA

(1) All concentrations are mg/kg. Site and background samples are from the PA/SI (Kent and Sullivan 2004).

(2) From ADEC Ecoscoping Guidance March 2008. Arsenic value is for As III.

(3) Value is lowest of EcoSSLs for the receptors evaluated.

(4) Soluble and toxic forms are only available at pH < 5.5; typical range in soils is 10,000 to 300,000 mg/kg

NA = No value available

U = Nondetect; the value shown is the detection limit and is used for screening.

Table 2. Surface Soil Data for Radionuclides Compared to Ecological Benchmarks

Analyte	Maximum of Site Samples	Background (4)	ERBSC (2)	RESRAD Animal(3)	RESRAD Plant(3)	Maximum > Background?	Maximum >ERBSC?	Maximum >RESRAD Animal?	Maximum >RESRAD Plant?
Underlain By Granite									
Th-232 Decay Chain									
Th-232	120	7.5	NA	1510	23500	Yes	NA	No	No
Ra-228	122	9	NA	43.9	245	Yes	NA	Yes	No
Th-228	111	8.5	NA	530	6420	Yes	NA	No	No
Pb-212	125	8.4	NA	NA	NA	Yes	NA	NA	NA
Bi-212	127	9	NA	NA	NA	Yes	NA	NA	NA
U-235 Decay Chain									
U-235	19.7	1	NA	2770	27400	Yes	NA	No	No
Th-227	9.2	6.8	NA	NA	NA	Yes	NA	NA	NA
U-238 Decay Chain									
U-238	278	13.6	NA	1580	15700	Yes	NA	No	No
Th-234	309	14.8	NA	2160	21600	Yes	NA	No	No
U-234	295	12.9	NA	5130	51600	Yes	NA	No	No
Th-230	240	13.2	NA	9980	175000	Yes	NA	No	No
Ra-226	221	8.6	NA	50.6	288	Yes	NA	Yes	No
Pb-214	166	12.5	NA	NA	NA	Yes	NA	NA	NA
Bi-214	152	11	NA	NA	NA	Yes	NA	NA	NA
Underlain by Quartz Monzonite									
Th-232 Decay Chain									
Th-232	4.38	1.1	NA	1510	23500	Yes	NA	No	No
Ra-228	6.6	0.7	NA	43.9	245	Yes	NA	No	No
Th-228	4.41	0.9	NA	530	6420	Yes	NA	No	No
Pb-212	6.71	0.7	NA	NA	NA	Yes	NA	NA	NA
Bi-212	5.4	1	NA	NA	NA	Yes	NA	NA	NA
U-235 Decay Chain									
U-235	0.245	0.1	NA	2770	27400	Yes	NA	No	No
Th-227	5	0.4	NA	NA	NA	Yes	NA	NA	NA
U-238 Decay Chain									
U-238	6.4	0.45	NA	1580	15700	Yes	NA	No	No
Th-234	13.6	0.9	NA	2160	21600	Yes	NA	No	No
U-234	6.2	0.5	NA	5130	51600	Yes	NA	No	No
Th-230	9	1	NA	9980	175000	Yes	NA	No	No

Table 2. Surface Soil Data for Radionuclides Compared to Ecological Benchmarks

Analyte	Maximum of Site Samples	Background (4)	ERBSC (2)	RESRAD Animal(3)	RESRAD Plant(3)	Maximum > Background?	Maximum >ERBSC?	Maximum >RESRAD Animal?	Maximum >RESRAD Plant?
Ra-226	5.7	1.4	NA	50.6	288	Yes	NA	No	No
Pb-214	10.5	0.7	NA	NA	NA	Yes	NA	NA	NA
Bi-214	8.7	0.6	NA	NA	NA	Yes	NA	NA	NA
Shoreline Area									
Th-232 Decay Chain									
Th-232	84	24.3	NA	1510	23500	Yes	NA	No	No
Ra-228	82	20.7	NA	43.9	245	Yes	NA	Yes	No
Th-228	100	19.5	NA	530	6420	Yes	NA	No	No
Pb-212	94	18.3	NA	NA	NA	Yes	NA	No	No
Bi-212	82	17.6	NA	NA	NA	Yes	NA	No	No
U-235 Decay Chain									
U-235	41	1.35	NA	2770	27400	Yes	NA	No	No
Th-227	21.2	18.5	NA	NA	NA	Yes	NA	NA	NA
U-238 Decay Chain									
U-238	557	26.6	NA	1580	15700	Yes	NA	No	No
Th-234	527	39.6	NA	2160	21600	Yes	NA	No	No
U-234	562	26	NA	5130	51600	Yes	NA	No	No
Th-230	223	37.2	NA	9980	175000	Yes	NA	No	No
Ra-226	122	13.6	NA	50.6	288	Yes	NA	Yes	No
Pb-214	159	17.5	NA	NA	NA	Yes	NA	NA	NA
Bi-214	138	15.7	NA	NA	NA	Yes	NA	NA	NA

(1) All concentrations are pCi/g. Site and background samples are from the PA/SI (Kent and Sullivan 2004).

(2) Ecological Risk-Based Screening Concentrations from ADEC Ecoscoping Guidance March 2008.

(3) From RESRAD Biota, Level 1 values

(4) Background is based on Soil-01 and Soil-02

NA = No value available

Table 3. Surface Water Data for Metals Compared to Ecological Benchmarks

Analyte	Maximum of Site Samples		Background Samples		ERBSC (2)	AK WQ Criteria (6)		Maximum > Background?	Maximum > ERBSC?	Maximum > AK WQC?
Antimony	0.3	U	---		30	NA		NA	No	NA
Arsenic	10	U	---		55	(3) 150		NA	No	No
Aluminum	290		130		75	87		Yes	Yes	Yes
Barium	100	U	---		3.9	NA		NA	Yes	NA
Beryllium	1	U	---		0.53	NA		NA	Yes	NA
Cadmium	0.31		0.3		0.013	0.1	(7)	Yes	Yes	Yes
Calcium	2400		1000	U	116000	NA		Yes	No	NA
Chromium	10	U	---		0.21	(4) 23	(4,7)	NA	Yes	No
Cobalt	10	U	---		3	NA		NA	Yes	NA
Copper	2	U	---		0.205	2.9	(7)	NA	Yes	No
Iron	630		---		16	1000		NA	Yes	No
Lead	0.5		0.5	U	1	0.54	(7)	Yes	No	No
Manganese	15		---		80	NA		NA	No	NA
Mercury	0.2	U	---		0.0013	(5) 0.77	(8)	NA	Yes	No
Magnesium	1800		1000	U	82000	NA		Yes	No	NA
Nickel	5	U	---		5	16	(7)	NA	No	No
Potassium	1000	U	---		53000	NA		NA	No	NA
Selenium	5	U	---		1	5		NA	Yes	No
Silver	0.1	U	---		0.012	NA		NA	Yes	NA
Sodium	3500		---		680000	NA		Na	No	NA
Thallium	0.2	U	---		0.8	NA		NA	No	NA
Uranium	42		0.11		2.6	NA		Yes	Yes	NA
Vanadium	10	U	---		19	NA		NA	No	NA
Zinc	20	U	---		21	37	(7)	NA	No	No

(1) All concentrations are ug/L. Site and background samples are from the PA/SI (Kent and Sullivan 2004).

(2) Ecological Risk-Based Screening Concentration, from ADEC Ecoscoping Guidance March 2008, for freshwater.

(3) Arsenic III

(4) Chromium III

(5) Total Mercury

(6) Alaska Water Quality Criteria, from ADEC 2003; values are chronic criteria, total recoverable, freshwater

Table 3. Surface Water Data for Metals Compared to Ecological Benchmarks

Analyte	Maximum of Site Samples	Background Samples	ERBSC (2)	AK WQ Criteria (6)	Maximum > Background?	Maximum > ERBSC?	Maximum > AK WQC?
----------------	--	-------------------------------	------------------	-------------------------------	-------------------------------------	--------------------------------	---------------------------------

(7) Hardness dependent, value is for hardness = 25 mg/L; total recoverable.

(8) Dissolved

NA = No value available

U = Nondetect; the value shown is the detection limit and is used for screening.

Table 4. Surface Water Data for Radionuclides Compared to Ecological Benchmarks

Analyte	Maximum of Site Samples	Background	RESRAD Aquatic Animal (2)	RESRAD Riparian Animal (2)	Maximum > Background?	Maximum >RESRAD Aq.Animal?	Maximum > RESRAD Riparian Animal?
Gross Alpha	34.6	1.63	NA	NA	Yes	NA	NA
Gross Beta	19.1	3.01	NA	NA	Yes	NA	NA
Th-232 Decay Chain							
Th-232	0.284	---	304	1680	NA	No	No
Ra-228	2.18	0.53	8.49	3.4	Yes	No	No
Th-228	0.91	---	374	2040	NA	No	No
U-238 Decay Chain							
Th-230	0.91	---	2570	13900	NA	No	No
Ra-226	2.68	0.11	10.2	4.08	Yes	No	No
Pb-210	0.66	---	601	926	NA	No	No

(1) All concentrations are pCi/L. Site and background samples are from the PA/SI (Kent and Sullivan 2004).

(2) From RESRAD Biota

Table 5. Stream Sediment Data for Metals Compared to Ecological Benchmarks

Analyte	Maximum of Site Samples	Background (2)	SQGs- TEL (3)	SQGs -PEL (3)	Maximum > Background?	Maximum > SQG-TEL	Maximum > SQG-PEL
Aluminum	13000	960	NA	NA	Yes	NA	NA
Arsenic	6.3	10	5.9	17	No	Yes	No
Iron	31000	5600	NA	NA	Yes	NA	NA
Lead	48	J	16	35	Yes	Yes	No
Manganese	1500		86	NA	Yes	NA	NA
Uranium	180	J	3	NA	Yes	NA	NA

(1) All concentrations are mg/kg dry weight. Site and background samples are from the PA/SI (Kent and Sullivan 2004).

(2) Based on SSED-01 and SSED-02

(3) SQGs are sediment quality guidelines; TEL = Threshold Effects Levels; PEL = Probable Effects Level; from NOAA Squirt Tables (2008) as recommended by ADEC.

NA = No value available

J = Estimated Concentration

Table 6. Stream Sediment Data for Radionuclides Compared to Ecological Benchmarks

Analyte	Maximum of Site Samples	Background (2)	RESRAD Aquatic Animal (3)	RESRAD Riparian Animal (3)	Maximum > Background?	Maximum > RESRAD Aquatic Animal?	Maximum > RESRAD Riparian Animal?
Th-232 Decay Chain							
Th-232	33.2	2.31	3.29E+06	1300	Yes	No	No
Ra-228	34.1	3.65	2.90E+04	87.8	Yes	No	No
Th-228	26.9	1.61	1.64E+04	805	Yes	No	No
Pb-212	26.8	2.24	NA	NA	Yes	NA	NA
Bi-212	32.7	4.22	NA	NA	Yes	NA	NA
U-235 Decay Chain							
U-235	3.04	0.38	1.05E+05	3730	Yes	No	No
Th-227	19	0.46	NA	NA	Yes	NA	NA
U-238 Decay Chain							
U-238	60.8	1.9	4.28E+04	2490	Yes	No	No
Th-234	59.8	2.66	4.33E+04	4330	Yes	No	No
U-234	56.8	1.59	3.08E+06	5270	Yes	No	No
Th-230	70	2.03	2.74E+06	10400	Yes	No	No
Ra-226	67	3.2	1.45E+04	101	Yes	No	No
Pb-214	43.2	3.4	NA	NA	Yes	NA	NA
Bi-214	39.1	2.55	NA	NA	Yes	NA	NA

(1) All Concentrations are in pCi/g. Site and background samples are from the PA/SI (Kent and Sullivan 2004).

(2) Based on SSED-01 and SSED-02

(3) From RESRAD Biota, Level 1

Table 7. Marine Sediment Data for Metals Compared to Ecological Benchmarks

Analyte	Maximum of Site Samples	Background (2)	SQG-TEL (3)	SQG -PEL (3)	Maximum > Background?	Maximum > SQG-TEL?	Maximum > SQG-PEL?
Aluminum	23000	16000	NA	NA	Yes	NA	NA
Arsenic	49	13	7.24	41.6	Yes	Yes	Yes
Iron	51000	33000	NA	NA	Yes	NA	NA
Lead	43	4.2	30.24	112	Yes	Yes	No
Manganese	860	350	NA	NA	Yes	NA	NA
Uranium	390	5.4	NA	NA	Yes	NA	NA

(1) All concentrations are mg/kg. Site and background samples are from the PA/SI (Kent and Sullivan 2004).

(2) Based on MSED-01, MSED-02, and MSED-03

(3) SQGs are sediment quality guidelines; TEL = Threshold Effects Levels; PEL = Probable Effects Level; from NOAA Squirt Tables (2008) as recommended by ADEC.

NA = No value available

Table 8. Marine Sediment Data for Radionuclides Compared to Ecological Benchmarks

Analyte	Maximum of Site Samples	Background (2)	Screening Value (3)	Maximum > Background?	Maximum > Screening Value?
Th-232 Decay Chain					
Th-232	117	0.2	1300	Yes	No
Ra-228	45.4	0.38	87.8	Yes	No
Th-228	123	0.17	805	Yes	No
Pb-212	48.3	0.26	NA	Yes	NA
Bi-212	46.3	0.54	NA	Yes	NA
U-235 Decay Chain					
U-235	8.7	0.14	3730	Yes	No
Th-227	16	0.92	NA	Yes	NA
U-238 Decay Chain					
U-238	137	1.35	2490	Yes	No
Th-234	121	1.73	4330	Yes	No
U-234	132	1.33	5270	Yes	No
Th-230	222	0.36	10400	Yes	No
Ra-226	64	0.49	101	Yes	No
Pb-214	82	0.43	NA	Yes	NA
Bi-214	75.2	0.36	NA	Yes	NA

(1) All Concentrations are in pCi/g. Site and background samples are from the PA/SI (Kent and Sullivan 2004).

(2) Based on MSED-01, MSED-02, and MSED-03

(3) No radionuclide screening values were identified that are specific to marine sediments. The values used are the lowest of the RESRAD-BIOTA values for freshwater sediments and are based on riparian animals.

NA = No value available

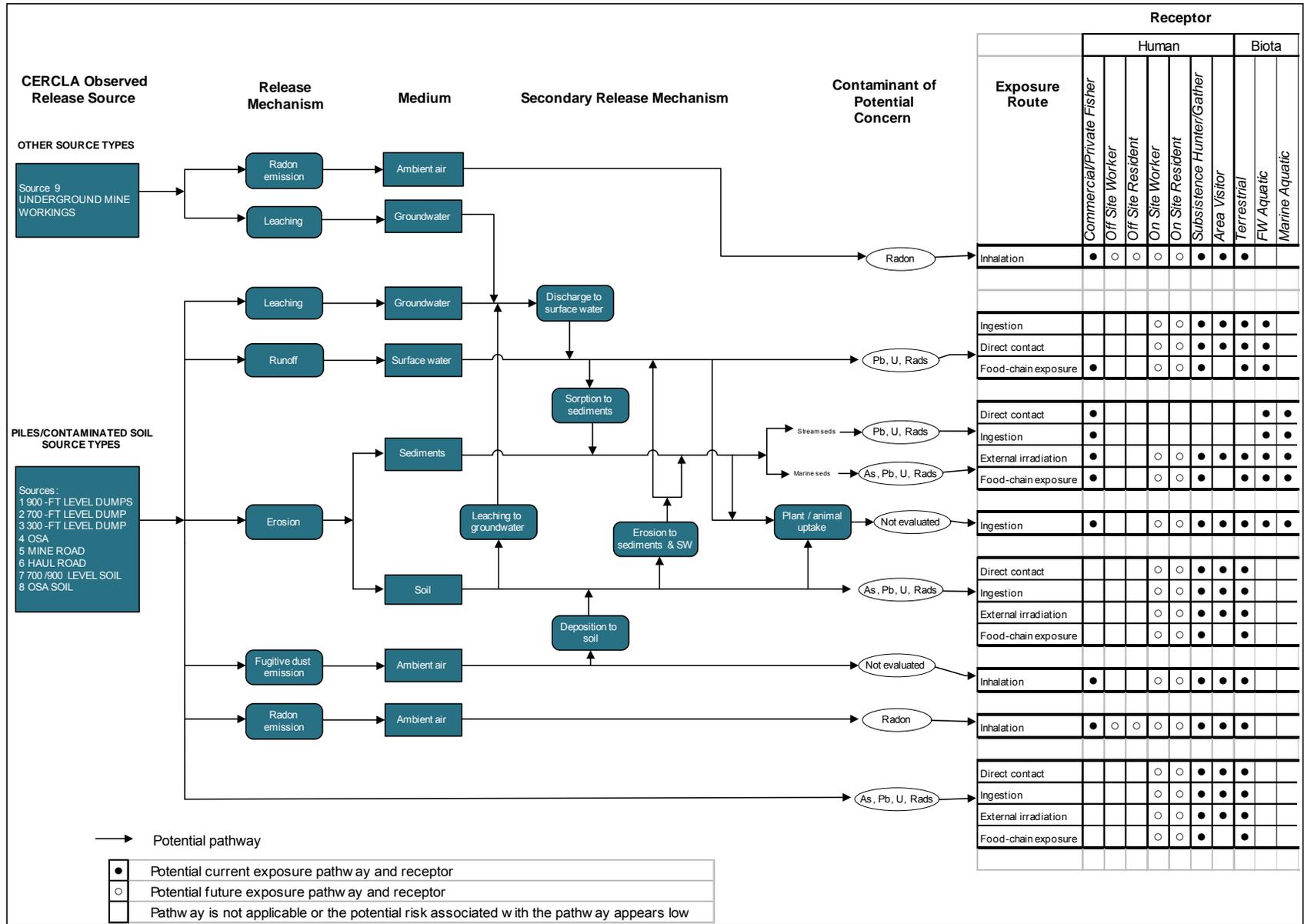


Figure 1
Ross-Adams Mine
Preliminary Conceptual Site Model