APPENDIX B
WORK PLAN FOR HUMAN HEALTH RISK ASSESSMENT AT THE ROSS-ADAMS SITE

Work Plan for Human Health Risk Assessment at the Ross-Adams Site

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

LIST OF FIGURES

INTRODUCTION

This Human Health Risk Assessment work plan (the Work Plan) describes the site-specific approach for performing the human health risk assessment at the Ross-Adams site (Site). The strategy emphasizes a phased approach, with refinement of the Conceptual Site Model (CSM) and the list of Contaminants of Potential Concern (COPCs) at key stages of the project. Conditions in the site area have resulted in concentrations of radionuclides and metals in media that may pose an unacceptable risk to human health.

The overall goal with respect to the study at this site is to investigate conditions and evaluate actions needed to protect human health and the environment. The approach for conducting the risk assessment will follow established risk assessment procedures and guidance.

DESCRIPTION OF WORK

The HHRA will be prepared using State of Alaska, U.S. Environmental Protection Agency (EPA), and U.S. Department of Energy (USDOE) guidance, with emphasis given to the Alaska Department of Environmental Conservation (ADEC). Guidance documents and information sources that will be consulted include: “Risk Assessment Procedures Manual” (ADEC 2009), “Policy Guidance on Developing Conceptual Site Models” (ADEC 2005); “Cumulative Risk Guidance” (ADEC 2008a); “Risk Assessment Guidance for Superfund” Volumes 1 through 4 (EPA 1989), the National Academy of Sciences (NAS), the International Commission on Radiological Protection (ICRP), and other recognized risk and dose assessment expert sources.

The phased risk assessment will utilize the preliminary conceptual site model (CSM) from the Kent and Sullivan (2004) PA/SI (Figure 1) 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. A screening-level human health risk assessment (SLHHRA) will be developed based on the 2009 inventory and expanded site investigation (ESI), and expanded if necessary to include exposures through the food chain. A summary of the key phases of the SLHHRA is presented below.

Phase 1 - Review of the PA/SI

The first phase of the process is to review, validate and screen the COPCs that were identified in the PA/SI, and to the extent possible based on available data, to refine the list based on correlations between contaminants. In addition, the first phase includes review of the CSM and consideration of potential refinements. It may be possible to limit the COPCs to one or two key, representative radionuclides after the initial correlations are complete.

The PA/SI identified the following COPCs:

- Soil – Arsenic, lead and naturally occurring radionuclides
- Surface Water – Lead and naturally occurring radionuclides
- Stream Sediment – Lead and naturally occurring radionuclides
- Marine Sediment – Arsenic, lead and naturally occurring radionuclides
- Air – Radon and airborne particulate materials

The 2009 site visits and data collection methodology will focus on the COPCs identified in the PA/SI. Evaluations of the site during 2009 may demonstrate the need to consider additional non-radioactive COPCs, including polychlorinated biphenyls (PCBs). Given the history of the site, no additional radioactive COPCs are anticipated to be identified, although laboratory gamma-energy screening of a limited subset of soil samples may be performed to validate this conclusion. All detected chemicals will be screened using local background, ADEC risk-based values (ADEC 2008) and EPA Regional PRGs (EPA 2009).

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

There are three sampling and gamma-radiation-scanning events scheduled for 2009. The data will be reviewed after each event in order to make decisions about subsequent steps in the risk assessment process. The data review process planned for the sampling events is summarized below.

Limited gamma radiation scanning data, and surface water and soil samples, will be collected during the first sampling event, tentatively scheduled for June 2009. The results of the data review will be used to determine whether adjustments need to be made to the analyte list, or to the gamma scanning or radon evaluation processes, for the remaining 2009 sampling events (summer and fall). Ambient radon data collection devices (radon decay product track etch detector systems) will be deployed in key locations around the site, including the mine portals.

A comprehensive set of gamma radiation scanning data, soil samples, and stream and marine sediment samples will be collected during the second (mid-summer) 2009 sampling event. Analytical results will be reviewed and evaluated. Radionuclide and other COPC concentrations exceeding local background concentration ranges and exceeding health based screening levels may indicate the need for inclusion in the HHRA. Specific correlations between contaminants may allow a focus on a few key COPCs.

Additional ambient radon data collection devices (alpha track detectors) will be deployed during the second (mid-summer) sampling event. Radon concentration data will be evaluated after all alpha track detectors have been collected and analyzed by the vendor (Landauer, Inc.) to develop an ambient radon concentration data set.

Phase 3 - Preparation of SLHHRA for EE/CA

A SLHHRA will be developed based on the 2009 inventory and ESI. The assessment will be prepared using ADEC and USEPA exposure and risk assessment guidance, the Integrated Risk Information System (IRIS) database, site-specific cultural characteristics provided by the USDA Forest Service (USFS), ICRP recommendations for radionuclides and radiation exposure, and other agencies and recognized sources as appropriate. Given the location and cultural uses of the geographical area, it is possible that the SLHHRA may need to incorporate exposure through locally-significant foods. If so, the additional exposure pathways will be accounted for when assessing total risks.

The data generated by the 2009 site characterization project will be evaluated in accordance with the data quality objectives established in the Quality Assurance Project Plan (QAPP) (Tetra Tech 2009). Data will also be evaluated with regard to laboratory detection limits and site background or reference values to ensure that limits are sufficiently low compared to human-health based standards.

Preparation of an HHRA for the EE/CA will involve data review and further identification of COPCs, refining the CSM and identification of all exposure parameters and complete pathways, toxicity assessment for COPCs, and calculation of radionuclide and non-radionuclide risks using the appropriate modeling for each classification of COPC. Each step is further described below.

Problem Formulation

This section will include a summary of the site history and environmental setting, documentation of site visits, information about site-specific potential human health risks, a synopsis of contaminant fate and transport, and details concerning potential exposure pathways. The statement will include a revised CSM that incorporates modifications based on evaluation of the additional data and site use information collected in 2009, information obtained through community outreach meetings directed by the U.S. Forest Service, and information concerning presumptive site remedies.

Data Review and Selection of COPC

Chemicals and radionuclides of potential concern (COPCs) at the site consist of metals and radionuclides in the uranium-238, uranium-235, and thorium-232 decay series. Based on historic data and the Preliminary Assessment/Site Inspection (PA/SI) (Kent & Sullivan, 2004), COPCs have been tentatively selected for each media at the Site. Rare earth elements (REEs) may also be present at the Site; however, many REEs have been reported to have limited water solubility and low oral bioavailability. Additionally, mining at the Ross-Adams site focused on the relatively high grade uranium resources, however the presence of rare earth element (RRE) prospects has been noted. As described in BOM (1989) and more recently by Ucore (2009), REE mineralization has been characterized to be in an inverse relationship with uranium concentrations, with the best REE values found distal to the high grade uranium ore. Consequently, no characterization of REEs is planned at present. A more formal review of the literature will be conducted to support this decision.

Maximum concentrations of COPCs in air, soils, sediment, surface water, and groundwater will be compared with local background concentrations and health based screening levels to identify the constituents to be carried forward in the risk assessment, and to establish exposure point concentrations (EPCs) for each specific medium in each exposure area. All COPCs elevated above local background and health-based screening levels that are detected in specific media or exposure areas will be considered during the HHRA.

CSM and Exposure Assessment

The exposure assessment involves the methodology to be used to estimate human exposure to the COPCs determined to be present in the environment at concentrations exceeding local background and health based screening levels. Specific considerations include:

- current and future land use
- local background (for example background concentrations at the Ore Stockpile Area are expected to be different than background in the mineralized 900 and 700 foot level areas)
- potential human exposure pathways including scenarios for indigenous groups and their cultural characteristics such as consumption of local flora and fauna
- applicable exposure factors, and

- appropriate intake equations to be used to estimate the intake for each COPC, exposure pathway, and receptor.

After review of the available data as previously described, the CSM and the COPC list will be revised as needed. The current proposed CSM is presented in Figure 1.

As noted in the ERA work plan (Appendix A of the SAP), a biota inventory will be conducted during the July sampling event. The inventory will include a qualitative survey of the terrestrial, freshwater aquatic, and marine aquatic species at the site, including an emphasis on those plants and animals that are important components of exposure pathways for human receptors. Point count surveys will be conducted to identify the common birds and other wildlife species that utilize the main habitats, including those with potential for involvement in the human food chain. Intertidal marine species, including those with the potential for human food chain involvement, will be identified through visual observation of the substrate at low tide. Review of appropriate references will also be conducted to identify those species likely to occur at the site with potential for human food chain involvement. Reference materials will be searched to identify food chain pathway key parameters, including concentration factors, for use in the HHRA process.

Risk Characterization

The risk characterization will combine the measures of exposure, i.e. EPCs and exposure factors, to estimate potential impacts to human receptors.

EPCs will be determined based on the information from the PA/SI (Kent and Sullivan, 2004) and the 2009 characterization data. Where data are sufficient, the upper 95th percent confidence limit of the mean (95UCL) will be calculated using ProUCL software to provide a reasonable maximum EPC. If a 95UCL cannot be calculated, the maximum detected concentration for each chemical in the exposure unit will be used.

Potential exposures associated with the reasonable maximum exposure scenario will be determined using the ADEC Risk Assessment Procedures Manual (ADEC 2009), USEPA Exposure Factors Handbook (EPA 1997), site-specific cultural factors based on local sources of information obtained from USFS Community Outreach Meetings, and information from other agencies as appropriate. Selected parameters will be used in exposure equations as presented in Risk Assessment Guidance for Superfund (EPA 1989, 1991a, 1991b, 2001. 2004) and Risk Assessment Procedures Manual (ADEC 2009).

Concentrations in environmental media will be screened based on Human Health Risk Based Concentrations established by ADEC, Regional Screening Levels available from USEPA (EPA 2009), or equivalent values. The risk-based screening will use concentrations corresponding to a risk of 1E-6 or hazard quotient of 0.1, per ADEC guidance (ADEC 2008, ADEC 2009). COPCs that are shown to be present above the laboratory detection limits and significantly exceeding screening level and local site-specific background concentrations, will be carried through the SLHHRA. Arsenic and uranium risks will be evaluated both as non-carcinogens and as carcinogens. Lead will be evaluated using the USEPA Integrated Exposure Uptake Biokinetic (IEUBK) model and the Adult Lead Model (ALM) as needed, if lead is retained as a COPC in the human health risk assessment. As needed, exposure to COPCs through food sources will also be evaluated.

Potential hazards for non-carcinogens will be determined using reference doses or reference concentrations from the IRIS database or other literature sources and will be expressed as Hazard Quotients (HQs) and Hazard Indices (HIs). The HQ is the ratio of the average daily dose (intake) to the reference dose. The HI is the sum of the HQs. Total HI for each scenario will be determined by summing each chemical-specific HI.

Similarly, for non-radioactive carcinogenic COPCs, risks will be determined using chemical-specific EPCs and cancer slope factors, combined with the exposure equations, to estimate potential risk. The chemical dose is estimated from the EPC and exposure equation, multiplied by the cancer slope factor to estimate an incremental lifetime cancer risk. All chemical-specific risks will be summed to calculate a total risk for each scenario.

Radiation doses attributable to radionuclides in environmental media will be calculated in part using the Department of Energy's RESRAD (RESidual RADioactivity) program (USDOE 2006). RESRAD was developed to implement DOE's approach to dose evaluation and its development was co-sponsored by the USEPA and the U.S. Nuclear Regulatory Commission (USNRC). It allows for the development of a variety of land use and exposure scenarios, and is capable of calculating radiation doses for a broad range of radionuclides including those of interest in this study. The following information concerning the RESRAD codes and approach to dose and risk calculation is summarized from the Argonne National Laboratory RESRAD website (http://web.ead.anl.gov/resrad/):

The RESRAD model and computer code were developed to create a multifunctional tool to assist in developing removal criteria and assessing the dose or risk associated with residual radioactive material. RESRAD may be used to:

- Compute soil guidelines (concentrations that will comply with dose-based cleanup or release requirements set forth in various federal and state regulations),
- Compute potential annual doses to workers or members of the public resulting from exposures to residual radioactive material in soil,
- Compute concentrations of radionuclides in various media (air, surface water, and groundwater) resulting from residual activity in soil, and
- Support an ALARA (as low as reasonably achievable) analysis or a cost/benefit analysis that can help in the cleanup decision-making process.

The current radiation dose and risk standards will be considered during the HHRA development, including 10 CFR 20 standards. As Low As Reasonably Achievable (ALARA) considerations, based on the defined and potential USFS and State of Alaska land uses, will be incorporated into the evaluation.

All significant exposure pathways for each scenario will be considered. These pathways may include the following:

- Direct exposure to external radiation from the mine rock and contaminated soil.
- Internal dose from inhalation of airborne radionuclides including radon progeny; and
- Internal dose from ingestion of contaminated soil, plants, water or animals.

Uncertainty Assessment. This component will identify the main sources of uncertainty associated with the risk assessment, including exposure assumptions, pathway and land use assumptions, bioaccumulation factors, and toxicity information. The current version of the RESRAD code provides uncertainty assessment tools.

Phase 4 - Additional HHRA Work in 2010

It may be necessary to perform additional risk assessment-related activities in 2010, depending on the results of the screening-level 2009 work, to support development of removal action alternatives. The need for additional assessment will be determined in part by whether the initial evaluations indicate significant uncertainty regarding the magnitude of potential for risk, and if the uncertainty about the risk characterization impairs the ability to correctly identify appropriate removal alternatives. If conducted, additional work would focus on collecting data to fill gaps and reduce uncertainties in the risk estimates and the potential effectiveness of removal action alternatives. Filling data gaps may include measuring tissue concentrations in plants or animals potentially involved in the human food chain, additional field surveys, and/or additional site-specific or regional (background) sampling. The HHRA Work Plan will be revised if additional risk assessment work is required in 2010.

REFERENCES

(The following documents have been cited in this Appendix or may be used in the HHRA.)

ADEC. 2005. Policy Guidance on Developing Conceptual Site Models. Division of Spill Prevention and Response, Contaminated Sites Program. November 30, 2005.

ADEC. 2008a. Cumulative Risk Guidance. Division of Spill Prevention and Response, Contaminated Sites Program. June 9, 2008.

ADEC. 2008b. Water Quality Standards. 18 AAC 70. Amended as of July 1, 2008.

ADEC. 2009. Risk Assessment Procedures Manual. Division of Spill Prevention and Response, Contaminated Sites Program. Draft, February 18, 2009.

Chappell, W.R., C.O. Abernathy, C. R. Cothern. Arsenic -- Exposure and Health. Science and Technology Letters. Northwood. 1994.

Doull, John, C. Klaassen, M. Amdur. Casarett and Doull's Toxicology. Macmillan. 1980.

International Commission on Radiological Protection (ICRP), 1994. ICRP Publication 65: Protection Against Radon-222 at Home and at Work. Annals of the ICRP Volume 23/2. Elsevier, New York, NY.

International Commission on Radiological Protection (ICRP). 2001, Database of Dose Coefficients for Workers and Members of the Public.

Kent & Sullivan, Inc. 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.

Lippmann, Morton, Editor. Environmental Toxicants – Human Exposures and Their Health Effects. Wiley-Interscience. 2000.

National Council on Radiation Protection and Measurements (NCRP). 1996. Screening Models for Releases of Radionuclides to Atmosphere, Surface Water and Ground. NCRP Report No. 123I. NCRP. Bethesda. MD.

National Research Council. 1999. Health Effects of Exposure to Radon. BEIR VI. National Academy Press. Washington, DC.

National Research Council (of the National Academies). 2006. Health Risks from Exposure to Low Levels of Ionizing Radiation. BEIR VII Phase 2. The National Academies Press. Washington, DC..

Sittig, Marshall. World-wide Limits for Toxic and Hazardous Chemicals in Air, Water and Soil. Noyes Publications. 1994.

Till, J.E. and H.R. Meyer, Editors. Radiological Assessment, A Textbook on Environmental Dose Analysis. USNRC. 1983.

Till, J.E. and H.A. Grogan, Editors. Radiological Risk Assessment and Environmental Analysis. Oxford University Press. 2008.

Ucore Uranium, Inc, 2009, Bokan Mountain website, http://www.ucoreuranium.com/bokan.asp

U.S. Bureau of Mines (BOM), 1989, *Columbium- and Rare-Earth Element-Bearing Deposits at Bokan Mountain, Southeast Alaska*, OFR 33-89.

USDOE. RESRAD and the RESRAD family of codes. 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. 2001-2007.

U.S. Environmental Protection Agency (EPA). 1989. Risk Assessment Guidance for Superfund (RAGS), Volume I: Human Health Evaluation Manual, Part A. EPA/540/1-89/002. December 1989.

U.S. Environmental Protection Agency (EPA). 1991a. Risk Assessment Guidance for Superfund (RAGS), Volume I: Human Health Evaluation Manual, Part B. EPA/540-R-92/003. December 1991.

U.S. Environmental Protection Agency (EPA). 1991b. Risk Assessment Guidance for Superfund (RAGS), Volume I: Human Health Evaluation Manual, Part C. Publication Number 9285.7-01C. October 1991.

U.S. Environmental Protection Agency (EPA). 2001. Risk Assessment Guidance for Superfund (RAGS), Volume I: Human Health Evaluation Manual, Part D. Publication Number 9285.7-47. December 2001.

U.S. Environmental Protection Agency (EPA). 2004. Risk Assessment Guidance for Superfund (RAGS), Volume I: Human Health Evaluation Manual, Part E. EPA/540/R/99/005. July 2004.

US Environmental Protection Agency (EPA). 1997. Exposure Factors Handbook, Volumes I, II, and III. National Center for Environmental Assessment. Office of Research and Development. August.

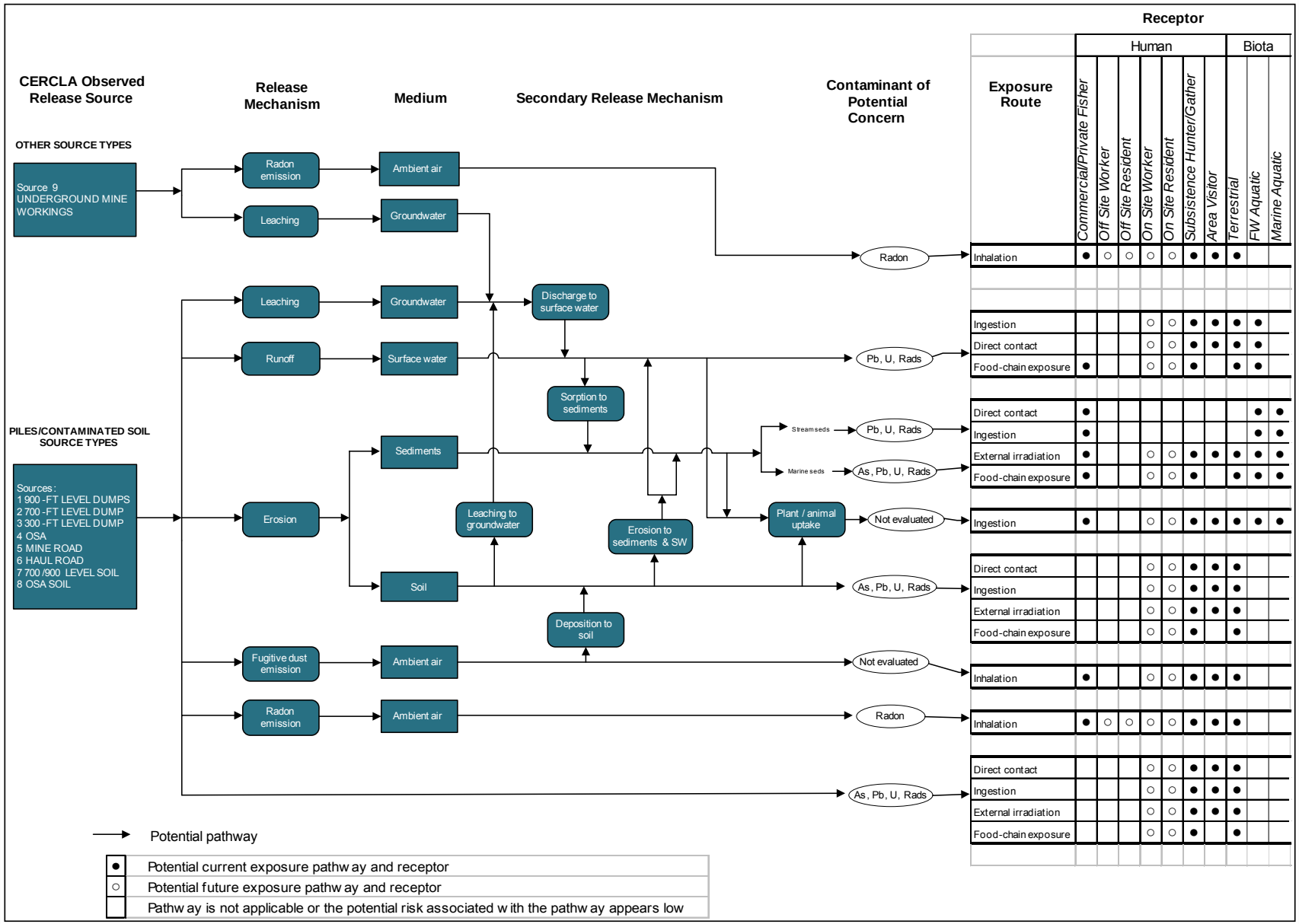
US Environmental Protection Agency (EPA). 1999. Federal Guidance Report No. 13, Cancer Risk Coefficients for Environmental Exposure to Radionuclides. Office of Radiation and Indoor Air. Oak Ridge National Laboratory: Oak ridge, TN. EPA 402-R-99.001.

US Environmental Protection Agency (EPA) Region 9. 2009. Preliminary Remediation Goals/Regional Screening Levels Table. http://www.epa.gov/region09/superfund/prg/index.html.

US Environmental Protection Agency (EPA). Integrated Risk Information System (IRIS) Database. http://www.epa.gov/iris

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

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



Project No. 181862

Reproduced from Kent & Sullivan, 2004

May 2009

Figure 1
Ross-Adams Mine
Preliminary Conceptual Site Model

A human health risk human health riskThe likelihood that a given exposure or series of exposures may have damaged or will damage the health of individuals. assessment is the process to estimate the nature and probability of adverse health effects in humans who may be exposed to chemicals in contaminated environmental media, now or in the future. Human health risk assessment includes 4 basic steps: Planning - Planning and Scoping process EPA begins the process of a human health risk assessment with planning and research.Â To explain this better, a human health risk assessment addresses questions such as: What types of health problems may be caused by environmental stressors such as chemicals and radiation? Hazard Assessment Exposure Assessment Consequence Assessment Risk Estimation - actually looking at outcome. Sensitivity analysis. - requires data on the range and probability function of each exposure factor within the scenario.Â Two levels of risk. De manifestis - so great they must not be allowed to occur De minimis - so insignificant they are not addressed regardless of the insignificance of the cost. Attributes of a risk assessment. Major attributes - Identification and ranking of all existing and anticipated potential hazard Explicit consideration of all current and possible future exposure scenarios Quantification and/or qualification of risk associated with the full range of hazard situations, system responses, and exposure scenarios. Risk assessment in HR. Risks are inevitable and organizations have a moral and legal obligation to attend to the safety and well-being of those they serve, those who work for them and others who come into contact with their operations. This is known as "Duty of Care." Organizations need to look at all the risks throughout their entire operation and incorporate risk management into all planning and decision-making. However, the specific focus of this section is risk management as it applies to HR activities. Applying risk management to HR. The risk management process. Who is involved