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Revised Screening Level Ecological Risk Assessment for the Red Devil Mine Site

EPA Comments on

The Screening Level Ecological Risk Assessment for the Red Devil Mine Site (2-6-12) and

E&E Responses to EPA Comments (March 2012)

Specific Comments:

1. P. 1, 2nd parg. Executive Summary. The text "chemicals were retained for evaluation in the BERA if the screening-level HQ exceeded 1" should be modified to read "if the screening-level HQ was greater than or equal to 1" (i.e. HQ ≥ 1) to be consistent with EPA risk assessment policy. This does not appear to have had any effect on the COPECs identified in the SLERA (for example, cobalt in sediment had a HQ = 1.0, but was correctly identified as a COPEC). Similar language appears several other locations in the SLERA (e.g. Section 4.5.2, page 11), and should be corrected throughout the SLERA.

Response: The text will be revised accordingly.

2. Executive Summary, Table ES-1. While providing a good overall summary of the findings of the SLERA, Table ES-1 could be made much more useful to risk assessors and risk managers reading the document with the following changes. Instead of using an 'X' to identify the chemicals of potential ecological concern (COPEC's) in the SLERA, enter the maximum identified hazard quotient responsible for identifying the chemical as a COPEC in each medium or receptor. Also, where applicable, list the number of samples out of the total number of samples where the hazard quotient was greater than or equal to one. By preparing the summary table in this manner, it informs the reader of both the magnitude of potential risk, as well as giving a sense of the spatial extent of the risk. This information, in addition to the mere listing of COPECs by receptor or medium, will quickly allow the reader to identify the chemicals with both the greatest potential for risk, as well as the chemicals potentially posing risk across the largest proportion of the site, as opposed to chemicals with both a low magnitude and incidence of potential risk. Chemicals without screening level benchmarks that are passed forward into the BERA should continue to be identified as they are in Table ES-1. These comments also apply to Table 4-26, which is identical to Table ES-1.

Response: The tables will be improved as suggested.

3. P. 4, Sect. 2.4. Are wood frogs (*Rana sylvatica*) resident in the vicinity of the site? If they are, this appears to be the only major taxon not evaluated in the SLERA, and should be added as a target ecological receptor if present. If not present, add a sentence confirming the absence of any amphibian and reptile species at the site.

Response: It is unknown if wood frogs are present at the site. Amphibians (aquatic stages) are included in *the Fish and Other Aquatic Biota* assessment endpoint listed in Table 3-1and were evaluated by comparing surface water chemical concentrations to water quality criteria. Table 3-1 will be revised to make clear that amphibians are included under this assessment endpoint. Also, Section 4.4 will be revised to be clear that other aquatic organism besides fish are being evaluated.

4. Table 3-1. Comparison of surface water chemical concentrations with water quality criteria is also an applicable measure and analysis approach for benthic invertebrates, as it is for amphibians (wood frog, assuming they are present in the vicinity of the site), and should be listed as such in Table 3-1.

Response: We agree with the observation that benthic macroinvertebrates and amphibians are exposed to surface water. Both groups of receptors are implicitly included in the *Fish and Other Aquatic Biota* assessment endpoint. Table 3-1 will be revised to make clear that benthic invertebrates and amphibians are included under this assessment endpoint. Also, Section 4.4 also will be revised to be clear that other aquatic organism besides fish are being evaluated.

5. P. 7, Sect. 3.1.6. At a minimum, identify the tables in the cited documents from which the data used in the

SLERA was taken. Better yet, append the data tables themselves to the SLERA, along with maps or figures of where the samples used in the SLERA were collected. Sampling location figures will help identify areas to be evaluated and sampled during development of the problem formulation and analysis plan of the BERA. This will help address a specific Agency concern, the determination of the contribution of contaminants from Red Devil Creek to organisms in the area of the confluence of the creek with the Kuskokwim River.

Response: The revised SLERA will identify the RI report tables that present the data used in the SLERA. We will do the same regarding the BLM data for fish and benthic macroinvertebrates if draft reports are available from BLM at the time the revised SLERA is released.

6. Table 4-1. Two corrections need to be made to this table when identifying the rationale for selecting chemicals as COPECs. For plants, correct the rationale for selecting vanadium as a COPEC from NSL (no screening level available) to >SL (maximum detected concentration exceeds screening level). For soil invertebrates, correct the rationale for selecting mercury as a COPEC from NSL (no screening level available) to >SL (maximum detected concentration exceeds screening level). The text in Sections 4.1 and 4.2 correctly reflect the COPEC calculations and identification, only the rationales in Table 4-1 need correction.

Response: The requested corrections will be made.

7. Tables 4-1, 4-2 and 4-3. All three of these tables would be greatly improved by addition of a column tabulating the number of stations where hazard quotients ≥ 1.0 were found, along the lines of the frequency of detection column already present in these tables.

Response: The tables will be modified as suggested.

8. P. 8, Sect. 4.4. EPA finds it curious that at a former mercury mine location where mercury is considered to be one of the primary site related contaminants (Sections 2.1 and 3.1.2) that mercury is not identified as a COPEC in surface water or to fish. We believe this is due to use of an insufficiently conservative screening level benchmark for mercury in surface water. The screening value used for total mercury, 0.77 µg/L, derives from EPA's criterion continuous concentration (CCC) aquatic life criteria for freshwater. However, EPA's mercury aquatic life criteria, in its *1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water* (EPA-820-B-96-001, September 1996) also states that the mercury CCC might not adequately protect such important fishes as the rainbow trout, Coho salmon and bluegill. The 1995 updates also provide the rationale for this conclusion. Because Coho salmon are known to be present in the Kuskokwim River, and to be adequately protective of Coho and other sensitive species, EPA requires the use of the published EPA 0.012 µg/L mercury criterion as the screening level benchmark value in the Red Devil Mine SLERA. Use of the 0.012 µg/L screening level benchmark results in a maximum surface water HQ = 32, and identifies mercury as a COPEC at the conclusion of the SLERA. Although not screened in the SLERA, measured tissue mercury concentrations in sculpin from the site (SLERA Table 4-6) are well in excess of published ecological risk screening level benchmarks for mercury in fish tissue, which range between 0.06 – 0.20 µg/g whole body, wet weight (Beckvar et al. 2005, Dyer et al. 2000, Shephard 1998). Recent literature reviews of mercury fish tissue residue effects on fish themselves are also available for use in the BERA (e.g. Sandheinrich and Wiener 2011, Dillon et al. 2010). Failure to identify mercury in surface water and fish tissues as a COPEC is the largest single shortcoming in the SLERA, and must be corrected going forward into the BERA. This will require modification to the text in Section 4.4, and to Tables ES-1 and 4-3.

Beckvar, N., T.M. Dillon and L.B. Read. 2005. Approaches for linking whole-body fish tissue residues of mercury or DDT to biological effect thresholds. Environ. Toxicol. Chem. 24:2094-2105.

Dillon, T., N. Beckvar and J. Kern. 2010. Residue-based mercury dose-response in fish: An analysis using lethality-equivalent test endpoints. Environ. Toxicol. Chem. 29:2559-2565.

Dyer, S.D., C.E. White-Hull and B.K. Shephard. 2000. Assessments of chemical mixtures via toxicity reference values over predict hazard to Ohio fish communities. Environ. Sci. Technol. 34:2518-2524.

Sandheinrich, M.B. and J.G. Wiener. 2011. Methylmercury in Freshwater Fish: Recent Advances in Assessing Toxicity of Environmentally Relevant Exposures. pp. 168-190 in Beyer, W.N and J.P. Meador. Environmental Contaminants in Biota. Interpreting Tissue Concentrations, 2nd edition. CRC Press, Boca Raton, FL. 751 pp.

Shephard, B.K. 1998. Quantification of Ecological Risks to Aquatic Biota from Bioaccumulated Chemicals. p. 2-31 to 2-52 in National Sediment Bioaccumulation Conference Proceedings, EPA 823-R-98-002, Office of Water, U.S. Environmental Protection Agency, Washington, D.C.

Response: The 0.012 µg/L criterion will be added to the SLERA as a surface water screening level for mercury. As suggested, a second measure to evaluate potential risks to fish will be included in the SLERA and BERA.

9. Table 4-3. The rationale for excluding methylmercury as a COPEC given in the table should be corrected from NSL (no screening level available) to <SL (maximum detected concentration less than screening level). EPA is not surprised at this result, as a very low proportion of total mercury present in surface water is normally present in the form of methylmercury.

Response: Table 4-3 will be revised accordingly.

10. Table 4-3. Alkalinity should not be identified as a COPC in surface water. The rationale for EPA's alkalinity criterion is that it reflects a minimum level of alkalinity to be present in surface water (unless naturally occurring alkalinity <20 mg/L as $CaCO_3$), not a maximum level. As all detected alkalinity concentrations exceed 20 mg/L as $CaCO_3$, there is no need to carry alkalinity forward into the BERA. Although this explanation of the alkalinity criterion is not discussed in EPA's current compilations of water quality criteria, it is given in older water quality criteria compendia, such as EPA's Red Book and Gold Book.

Response: The oversight will be corrected.

11. P. 9, Sect. 4.5.1.3. The literature models used to estimate chemical concentrations in prey of terrestrial wildlife species feeding on soil invertebrates or mammals are the same models used in the exposure point concentration section of the human health risk assessment for the Red Devil Mine site. Those modeling approaches were reviewed as part of EPA's review of the HHRA, were deemed acceptable for use in the HHRA, and are equally appropriate for use in the SLERA.

Response: Agreed.

12. Table 4-8. Any reason surface water ingestion was not included in the ingested contaminant dose estimates for green-winged teal, whereas it is included in the ingested dose calculations for all other bird and mammal species? Teal also drink water. The inclusion of surface water ingestion as part of the bird and mammal ingested dose calculation should also be identified as a complete exposure pathway in the conceptual site model, Figure 3-1. If surface water ingestion is not a complete exposure pathway, it would not need to be included in the ingested dose calculations. In this regard, the ingested dose calculations and conceptual site model are contradictory with respect to surface water ingestion. The contradiction should be corrected by denoting surface water ingestion as a complete pathway for birds and mammals.

Response: No surface water was present in the settling ponds during sampling activities at the site. Hence, only sediment (dry) and pond vegetation were collected for the teal scenario. To remedy this data gap, E & E will use surface water data from Red Devil Creek as a surrogate for settling pond surface water.

In the ecological conceptual site model figure, the dash (–) symbol means incomplete or insignificant pathway. The latter meaning is applicable to surface water ingestion for wildlife. The wildlife exposure estimates illustrate this point (see SLERA Tables 4-15 to 4-24); example calculations are provided in the table below.

Examples Showing the Relative Importance of Different Exposure Routes to Total Exposure for Wildlife		
Exposure Route	Exposure (mg/kg-day)	Percent of Total Exposure
Robin – Antimony (see Table 4-15)		
EE-water	2.6E-02	0.0005%
EE-soil	5.8E+01	1%
EE-diet	5.6E+03	99%
EE-total	5.7E+03	100%
Spruce Grouse – Mercury (see Table 4-17)		
EE-water	2.8E-05	0.0002%
EE-soil	1.7E+01	96%
EE-diet	6.4E-01	4%
EE-total	1.8E+01	100%
Common Snipe – Arsenic (see Table 4-21)		
EE-water	1.24E-01	0.0067%
EE-sediment	1.79E+03	97%
EE-diet	5.11E+01	3%
EE-total	1.84E+03	100%

Key:

EE-diet = estimated chemical exposure from diet

EE-sediment = estimated exposure from incidental sediment ingestion

EE-soil = estimated chemical exposure from incidental soil ingestion

EE-total = total chemical exposure

EE-water = estimated chemical exposure from surface water consumption

For the examples given above, surface water exposure accounts for much less than 1% of total chemical exposure. The legend in Figure 3-1 will be revised to clarify the meaning of the dash (–) symbol.

13. P. 11, Sect. 4.5.2 and Table 4-25. Is there a reason, other than lack of data, that mink were not screened against polychlorinated biphenyl (PCB) concentrations and/or ingestion? PCB toxicity data with mink is the basis for mammalian toxicity reference values for PCBs in the ecological risk literature, as it is the most sensitive mammal tested to date. If possible, PCB risks should be screened, or if that is not feasible given the available data, carried forward as a COPEC into the BERA.

Response: PCB data were not collected for sediment, surface water, and fish in Red Devil Creek because PCBs are not expected to be present in the creek based on past site uses. For the RI, it was agreed to by all parties that PCBs would be measured in soil from the area were electrical transformers were used and stored. Eighteen soil samples were collected from this area. No PCBs were detected in 17 of the samples. Aroclor 1260 was detected in one sample at 21 parts per trillion (0.021 µg/kg), well below a level of concern for the terrestrial ecological receptors evaluated in the SLERA, including mammalian wildlife (i.e., NOAEL-based HQs for terrestrial mammalian wildlife were several orders of magnitude < 1). The mammalian NOAEL for PCBs used in the SLERA was derived from a study with mink. Given these results and prior agreements between the agencies, we do not see a compelling reason to evaluate PCBs in Red Devil Creek and/or carry PCBs forward into the BERA.

14. P. 12, Sect. 5. Several uncertainties in the SLERA are not discussed, and warrant a brief discussion. These include:

- Area and seasonal use factors (values of 1 used in the SLERA likely overestimate risks)
- Sediment, surface water screening benchmark uncertainties and reliability
- Chemicals without screening level benchmarks (potential underestimation of risks)

Response: These uncertainties will be described in the *Uncertainties* section in the revised SLERA.

15. P. 13, Sect. 6. The EPA 8-step ecological risk assessment process calls for a scientific management decision point (SMDP) at the end of Step 2 (completion of the SLERA). Has there already been a decision made to go forward into a BERA? If so, has the risk manager for the site documented this decision? If the decision has not been made to go forward into a BERA, have the risk assessors made recommendations to the risk managers on how to proceed? Tables ES-1 and 4-26 both document which contaminants and pathways can be eliminated from further assessment. Based on the results of the SLERA, the risk manager and risk assessor will determine whether or not contaminants from the site pose an ecological threat that warrants additional assessment, or whether there is adequate information to conclude that ecological risks are negligible and therefore no need for remediation on the basis of ecological risk. This decision needs to be documented, either in a brief SMDP or risk management section of the BERA, or in a separate document outside of the SLERA.

Response: BLM has directed E & E to prepare a BERA for the site. This decision will be documented in the BERA. Given the results of the SLERA, we assume that EPA agrees that a BERA is warranted.

REVISED
Screening Level Ecological Risk Assessment for the Red Devil Mine Site
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For
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1 Introduction

This report presents a Screening Level Ecological Risk Assessment (SLERA)1 for the Red Devil Mine (RDM) site. The SLERA consists of Steps 1 and 2 of the eight-step ecological risk assessment (ERA) process described in *Ecological Risk Assessment Guidance for Superfund (ERAGS): Process for Designing and Conducting Ecological Risk Assessments* (EPA 1997). The SLERA also is consistent with other notable federal and state ERA guidance documents, including:

- *Guidelines for Ecological Risk Assessment* (EPA 1998)
- *Wildlife Exposure Factors Handbook* (EPA 1993a)
- *Guidance for Developing Ecological Soil Screening Levels* (EPA 2005a)
- *Risk Assessment Procedures Manual* (Alaska DEC 2011)

In addition to the above mentioned state and federal guidance documents, this assessment also utilizes publications from Oak Ridge National Laboratory (ORNL) and recent articles from relevant peer-reviewed literature, as appropriate. The goal of the SLERA is to determine whether risks from site-related chemicals are great enough to warrant further evaluation and, if so, identify chemicals that should be carried forward in the ERA process.

The remainder of this report is organized as follows:

Section 2 describes the site and its ecological resources;

- Section 3 presents a screening-level problem formulation and ecological effects evaluation (ERAGS Step 1).
- Section 4 presents screening-level exposure estimates and risks calculations (ERAGS Step 2).
- Section 5 identifies and discusses sources of uncertainty in the SLERA.
- Section 6 presents a summary.

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1 An acronyms list for this appendix is provided in Section 8.

2 Site Location and Description

2.1 Site Overview

The RDM site is an abandoned mercury mine and ore processing site on the south bank of the Kuskokwim River in a remote area of Alaska, approximately 250 air miles west of Anchorage. The RDM site is located on public land managed by the United States Department of the Interior Bureau of Land Management (BLM) and consists of four main areas: surface mined area, main processing area, Red Devil Creek area, and Kuskokwim River area. A detailed description of the site and its operational history is provided in the RDM Remedial Investigation/Feasibility Study (RI/FS) Work Plan (E & E 2011). This report focuses on the habitats and ecological characteristics of the RDM site. The information provided below is based on earlier site reports (HLA/Wilder 2001) and observations made by E & E and BLM personnel during field activities at the site in 2010 (BLM 2010; E & E 2010).

2.2 Climate

The RDM site is located in the upper Kuskokwim River Basin and lies in a climatic transition between the continental zone of Alaska's interior and the maritime zone of the coastal regions. Average temperatures in this area can vary from −7 to 65 °F (−22 to 18 °C). Annual snowfall averages 56 inches (142 centimeters [cm]), with a total mean annual precipitation of 18.8 inches (48 cm). The Kuskokwim River is ice-free from mid-June through October.

2.3 Vegetation

The vegetation around the RDM site is characterized by spruce-poplar forests and upland spruce-hardwood forests. During the 2010 sampling season, vegetation characteristics were recorded at surface soil sample locations. E & E field personnel documented the following percent cover of vegetation in each of three layers, or strata: (1) trees (woody vegetation with diameter at breast height [DBH] > 3 inches and over 15 feet tall); (2) samplings/shrubs (woody vegetation with DBH < 3 inches); and (3) herbs (non-woody vegetation). Trees observed included Sitka alder (*Alnus sinuata*), black cottonwood (*Populus trichocarpa Torr. & Gray*), quaking aspen (*Populus tremuloides*), and willow (*Salix sp.*). Saplings and shrubs observed included Sitka alder, black cottonwood, and willow. The dominant species in the herb strata included horsetail (*Equisetum sp.*), various grasses (*Poa sp.* and other unidentified species), ferns (*Athyrium sp.*), various weedy plants (e.g., *Epilobium sp.*), and moss.

Vegetative cover in the main processing area was limited, often consisting of only moss and occasional patches of grass. Cover in this area ranged widely, from 0 to 90 %, represented almost entirely by moss. If moss were removed from this category, vegetative cover would likely be less than 10%. These areas offer limited soils and were heavily compacted in locations subjected to vehicular travel; a majority of the surface material consisted of rock. On the perimeter of the disturbed areas, such as around the processing areas, on the sides of the roads, and along the slopes leading to the creek, saplings were more prevalent, making up 15 to 100 % of vegetative cover. Sitka alder and black cottonwood were the prevalent species occurring in these areas. In areas that showed no sign of disturbance in recent years, vegetation cover was dominated by trees (between 10 and 75 %) and saplings (between 20 and 100%).

The area of Red Devil Creek north of the main processing area, between the two roads, and in the vicinity of settling ponds 2 and 3, was dominated by Sitka alder and black cottonwood trees and saplings, with ferns, grasses, and horsetail in the lower strata. Settling pond 1 was dominated by horsetails.

In general, the disturbed surface mined area of the RDM site had a thick growth of saplings and trees with moderate understory coverage. Vegetation in the upper strata consisted largely of Sitka alder saplings and trees, with black cottonwood and occasional quaking aspen trees. The herb layer in this area was dominated by ferns, grasses, and weedy plants. The vegetation in the Dolly Sluice and Rice Sluice areas was similar in nature, and neither appeared to have any stressed vegetation. The vegetation did not consist of any large alder trees in the channel area of either sluice.

2.4 Red Devil Creek and Kuskokwim River Biota

2.4.1 Red Devil Creek

Red Devil Creek runs through the middle of the main processing area and discharges to the Kuskokwim River. A historical bridge, now collapsed, crossed the creek and connected the two sides of the main processing area. In the vicinity of the former bridge location, large piles of tailings and/or waste rock make up the creek banks. The creek contains some metal and other debris, likely from past mining activities. During field work in fall 2010, the creek's discharge was visually estimated to be between 2 and 7 cubic feet per minute upstream from the main processing area. Near its confluence with the Kuskokwim River, the creek's discharge was visually estimated to be 15 to 20 cubic feet per minute. Water depth in the creek varied from 3 to 12 inches at locations where surface water and sediment were sampled in fall 2010. Current velocity appeared to decrease upstream of the main processing area, and pool/riffle structure was more frequently observed in addition to woody material.

In 2010, BLM staff collected fish from Red Devil Creek for contaminant analysis (BLM 2010). Slimy sculpin (*Cottus cognatus*, 6 to 9 cm length); juvenile Dolly Varden (11 to 17 cm length); and juvenile salmon (8 to 11 cm length) were collected for analysis. BLM staff found no large game fish in Red Devil Creek, likely due to the creek's shallow depth and narrow width. Also in 2010, BLM staff collected composite samples of two different mayfly genera—*Baetis* spp. and *Cinygmula* spp.—from the creek. *Baetis* spp. and *Cinygmula* spp. are small mayfly species, requiring the BLM to include several hundred individual organisms in each 1-gram composite sample. In fall 2010, the E & E field team that collected sediment from the creek reported seeing numerous small benthic invertebrates and their casings on the undersides of rocks throughout the creek. The small benthic invertebrates observed by the E & E field team likely were mayfly larvae. The E & E field team also observed other benthic invertebrates, including midge (Family Chironomidae) and cranefly (Family Tipulidae) larvae, during sediment sampling. Lastly, the E & E field team reported that moss and brown algae were present in the creek and generally appeared to trend toward increased coverage as sample locations progressed up the reach, but that moss and algae were not present at all sample locations.

2.4.2 Kuskokwim River

The Kuskokwim River is a major anadromous fish stream (HLA/Wilder 2001). Fish found in the river in the vicinity of RDM site include whitefish (*Coregonus sp.*), Arctic grayling (*Thymallus arcticus*), sheefish (*Stendous leucichthys nelma*), Dolly Varden (*Salvelinus malma*), burbot (*Lota lota*) and northern pike (*Esox lucius*), as well as chinook (*Oncorhynchus tshawytscha*), sockeye (*O. nerka*), coho (*O. kisutch*), and chum salmon (*O. keta*) (HLA/Wilder 2001; BLM 2010).

2.5 Mammals

Moose (*Alces alces*), wolves (*Canis lupis*), black bears (*Ursus americanus*), brown bears (*Ursus arctos*), lynx (*Lynx canadensis*), martens (*Martes spp*.), foxes (*Vulpes vulpes*), beavers (*Castor canadensis*), minks (*Neovision vison*), muskrats (*Ondatra zibenthicus*), otters (*Lutra canadensis*), and various small rodents are known to occur in the area (HSA/Wilder 2001). During field activities in September 2010, three river otters (*Lontra canadensis*) were observed in the Kuskokwim River near the mouth of Red Devil Creek. In addition, moose and bear (*Ursus sp.*) tracks were observed near the upper pond, and bear tracks were also observed near the mouth of Red Devil Creek.

2.6 Birds

The upper Kuskowkim River is a low density waterfowl area (HLA/Wilder 2001). Nonetheless, according to Alaska DEC staff, there have been reports of waterfowl (species not specified) using the settling ponds near the main processing area. Songbird species that migrate through the area include the olive-sided flycatcher (*Contopus cooperi*), gray-cheeked thrush (*Catharus minimus*), Townsend's warbler (*Dendroica townsendi*), blackpoll warbler (*D. striata*), and Hudsonian godwit (*Limosa haemastica*) (HLA/Wilder 2001). A raptor survey conducted on the Kuskokwim River in July 2000 found an active peregrine falcon (*Falco peregrinus*) nest 7 miles downstream from the RDM, on rock cliffs on the north side of the river (BLM 2001). Finally, during field work in September 2010, many spruce grouse (*Dendragapus canadensis*) were observed on and near the RDM site, and an osprey (*Pandion haliaetus*) was observed foraging in the Kuskokwim River near the site.

2.7 Special Concern Species

2.7.1 Federally Listed Species

The United States Fish and Wildlife Service (2011) lists the following four species as being either endangered, threatened, or candidate species for Bethel County, Alaska:

- Short-tailed albatross (*Phoebastria albatrus*), federally listed endangered.
- Spectacled eider (*Somateria fischeri*), federally listed threatened.
- Steller's eider (*Polysticta stelleri*), federally listed threatened.

- Kittlitz's murrelet (*Brachyramphus brevirostris*), federal candidate species.

Given their habitat preferences, none of these species are likely to occur at the RDM site. The short-tailed albatross is a sea bird that is sighted occasionally along the west coast of Alaska. The two eider species breed on wet, low-lying tundra along the north and west coasts of Alaska (Kaufman 1996). In other seasons, the spectacled eider and Steller's eider occur along the coast, where they forage by diving, mostly for mollusks. Kittlitz's murrelet is found along the Alaska coastline, being common mainly from Kodiak Island east to Glacier Bay (Kaufman 1996). It prefers cold sea waters, mostly in calm protected bays and among islands, usually close to shore.

2.7.2 State Listed Species

The Alaska Natural Heritage Program (NHP) was contacted for current information on plant and animal species of concern in the vicinity of the Site. When available, the information provided by the Alaska NHP will be added to the SLERA or incorporated into the baseline ecological risk assessment (BERA) for the site.

3 ERAGS Step 1—Screening Level Problem Formulation and Ecological Effects Evaluation

3.1 Screening-Level Problem Formulation

Problem formulation is the first step in the risk assessment process. It identifies the goals, breadth, and focus of the assessment (EPA 1997, 1998). The problem formulation step identifies site-related contaminants (stressors), potential ecological receptors, and potential exposure pathways. A conceptual site model (CSM) is then developed to summarize the relationship between stressors and receptors. Lastly, assessment endpoints and measures (previously called measurement endpoints) are developed to guide the remaining steps of the risk assessment process. This section presents a preliminary problem formulation and CSM for the Site. The CSM may be refined during subsequent phases of the ERA process.

3.1.1 Contaminant Sources and Migration Pathways

The RDM was Alaska's largest mercury mine, producing 1.2 million kilograms (kg; 2.73 million pounds) of mercury between 1933 and 1971 (Bailey et al. 2002). Cinnabar (HgS) and stibnite (Sb_2S_3) are the principal metallic minerals at the site, with minor amounts of realgar (AsS), orpiment (As_2S_3), and pyrite (FeS_2). High-grade ore from the mine contained as much as 30% mercury by weight, but most ore contained 2 to 5%. Several hundred meters of trenches, where surface mining took place, are present on the site. In addition, tailings and calcine piles are located on the site, several of which lie near Red Devil Creek. During a site investigation by the U. S. Geological Survey (Bailey et al. 2002), abundant cinnabar, lesser amounts of stibnite, and a few beads of liquid mercury were visible in Red Devil Creek. Additional information on the RDM site and previous site investigations is provided in the RI/FS Work Plan (E & E 2011).

Contaminated soil, crushed ore, tailings, and other wastes from the RDM have been exposed at the surface for decades. Mercury and other metals in these wastes were subject to transport by water and wind to Red Devil Creek, the Kuskokwim River, groundwater beneath the site, and surrounding terrestrial areas. In addition, liquid mercury at the site was subject to volatilization to the atmosphere. Approximately 10 years ago, the BLM conducted remedial work to address these problems. However, the success of the remedial work and current site conditions are not fully known.

3.1.2 Principal Site-Related Contaminants

Based on the minerals present at the site (see Section 3.1) and previous site assessment work (Ford 2001), mercury, methylmercury, antimony, and arsenic appear to be the primary Site-related contaminants, with the potential to adversely affect terrestrial and aquatic ecological receptors. In addition, due to accidental releases of fuel oil during past mining operations, diesel range organics (DRO) and perhaps other fuel-related organics (e.g., benzene, toluene, and polycyclic aromatic hydrocarbons [PAHs]) may be present at a level of concern in the historical fuel storage area and/or elsewhere at the site. Finally, lead may be present at elevated levels in soil at the locations of some historical mining structures (HLA/Wilder 2001).

3.1.3 Potential Ecological Receptors

Based on the site ecology, the following ecological receptor groups have the potential to be affected by site-related contaminants at the RDM site:

- Terrestrial plants and invertebrates.
- Mammals and birds that use the mine site, Red Devil Creek, and Kuskokwim River near the site to satisfy their food and habitat needs.
- Aquatic biota (e.g., amphibians, benthos, and fish) in Red Devil Creek and the Kuskokwim River.

3.1.4 Preliminary Conceptual Site Model

Figure 3-1 provides a preliminary ecological CSM for the site featuring the ecological receptor groups identified in the previous section. Terrestrial plants may be exposed to site-related chemicals by direct contact with contaminated soils, tailings, and overburden. Terrestrial invertebrates may be exposed to site-related contaminants through direct contact with contaminated soils, tailings, and overburden; ingestion of contaminated soils, tailings, and overburden; and through the food chain. Birds and mammals may be exposed to site-related chemicals through incidental ingestion of soil/sediment, tailings, and overburden; consumption of contaminated prey; and ingestion of contaminated surface water. It should be noted, however, that consumption of contaminated surface water typically accounts for only a minor fraction of total exposure for wildlife. Dermal exposure of wildlife to site-related chemicals is expected to be negligible compared with other exposure routes due to the protection provided by their external coverings (heavy fur and feathers). Fish and benthic invertebrates in Red Devil Creek and the Kuskokwim River may be exposed to site-related chemicals through direct contact with and ingestion of contaminated sediment and surface water and through the food chain.

3.1.5 Assessment Endpoints and Measures

In an ERA, assessment endpoints are expressions of the ecological resources that are to be protected (EPA 1997). An assessment endpoint consists of an ecological entity and a characteristic of the entity that is important to protect. According to the EPA (1998), assessment endpoints do not represent a desired achievement or goal and should not contain words such as "protect" or "restore" or indicate a direction for change such as loss or increase. Assessment endpoints are distinguished from management goals by their neutrality (EPA 1998).

Measurements used to evaluate risks to the assessment endpoints are termed "measures" and may include measures of effect, measures of exposure, and/or measures of ecosystem and receptor characteristics (EPA 1998). Based on the site ecology, primary site-related chemicals, and preliminary CSM, the ecological resources potentially at risk at the RDM site include terrestrial vegetation and invertebrates, mammals, birds, and aquatic biota (fish, amphibians, benthos, and other aquatic organisms). The assessment endpoints and measures for this screening level assessment are listed in Table 3.1.

3.1.6 Data Sources for the SLERA

The SLERA is based on chemical data for surface soil (0 to 2 feet below ground surface [bgs]), sediment (0 to 4 inches below the sediment surface), surface water, and vegetation samples collected from the RDM site in 2010 and 2011 for the RI/FS (E & E 2010, 2011). The Draft RI report (E & E 2012) presents full results for surface soil (RI Tables 4-17 to 4-23), surface water (RI Table 4-31), sediment (RI Tables 4-32 and 4-33), and vegetation (RI Table 4-34 to 4-37). Additionally, metals data for sculpin and benthic macroinvertebrates from Red Devil Creek collected by the BLM (2010) were used to help evaluate potential risks to aquatic-dependent wildlife. Draft reports are not yet available from the BLM for these data.

A value for total polychlorinated biphenyls (PCBs) in soil was calculated as the sum of Aroclors 1016, 1221, 1232, 1242, 1248, 1254, and 1260. One-half of the method detection limit (MDL) was used for non-detected Aroclors when calculating total PCBs. PAHs in soil and sediment were summed into low- and high molecular weight groups for evaluation. A value for low molecular weight PAHs (LPAHs) was calculated as the sum of acenaphthene, acenaphthylene, anthracene, fluorene, methylnaphthalene, naphthalene, and phenanthrene. A value for high molecular weight PAHs (HPAHs) was calculated as the sum of benz(a)anthracene, total benzofluoranthenes, benzo(a)pyrene, benzo(g,h,i)perylene, chrysene, dibenzo(a,h)anthracene, fluoranthene, indeno(1,2,3,-c,d)pyrene, and pyrene. One-half of the MDL was used for non-detected PAHs when calculating HPAH and LPAH sums.

3.2 Screening Level Ecological Effects Evaluation

Screening levels for soil, sediment, and surface water were identified in the final Risk Assessment Work Plan (RAWP; E & E 2011, Appendix B) and are provided again in the screening tables in Section 4 in this report. For soil, EPA Ecological Soil Screening Level (Eco-SSLs) for effects on plants and soil invertebrates were used preferentially (EPA 2010). Efroyomson et al. (1997a, b) and Alloway (1990) were used as supplemental sources of soil screening levels. For sediment, threshold effect concentrations from MacDonald et al. (2000) were used preferentially. Supplemental sediment screening levels were taken from MacDonald et al. (1999) and Buchman (2008). Surface water screening levels were taken preferentially from EPA (2009) and Alaska DEC (2008, 2009). Supplemental surface water screening levels were taken from Suter and Tsao (1996). Fish tissue screening concentrations were taken from Dyer et al. (2000) and Sandheinrich and Wiener (2011).

Because media screening levels for effects on wildlife are not available for all media and chemicals, screening-level exposure estimates and hazard quotients (HQs) were calculated as per EPA (1997) for the wildlife receptors identified in the final RAWP (E & E 2011). Toxicity reference values (TRVs) used for this effort are provided in Table 3-2.

4 ERAGS Step 2:Screening Level Exposure Estimates and Risk Calculation

Screening-level exposure estimates and risk calculations are presented below for the terrestrial plant community (Section 4.1), soil invertebrate community (Section 4.2), benthic macroinvertebrate community (Section 4.3), fish and other aquatic biota (Section 4.4), and representative terrestrial and aquatic-dependent wildlife receptors (Section 4.5).

4.1 Terrestrial Plant Community Screening Level Exposure Estimate and Risk Calculation

Contaminants of potential concern (COPCs) for the terrestrial-plant community at the RDM site were selected by comparing maximum detected chemical concentrations in soil with soil screening levels for effects on plants. The results of the comparisons are shown in Table 4-1. The maximum concentrations of arsenic, chromium, cobalt, copper, lead, manganese, mercury, nickel, vanadium, and zinc exceeded the available screening levels. The greatest HQs were for arsenic (549) and mercury (5400), and greater than 95% of site samples exceeded the screening levels for these analytes. Soil screening levels for plants are not available for antimony, barium, beryllium, or several semivolatile organic compounds (SVOCs), so these analytes also were retained as COPCs for the terrestrial plant community.

4.2 Soil Invertebrate Community Screening Level Exposure Estimate and Risk Calculation

COPCs for the soil-invertebrate community at the RDM site were selected by comparing maximum detected chemical concentrations in soil with soil screening levels for effects on earthworms and other soil fauna. The results of the comparisons are shown in Table 4-1. The maximum concentrations of antimony, barium, copper, lead, manganese, mercury, and zinc exceeded the available screening levels. The greatest HQs were for antimony (299) and mercury (16200), and a high percentage of site samples exceeded the screening levels for these analytes. Soil screening levels for effects in soil invertebrates are not available for arsenic, chromium, cobalt, silver, thallium, vanadium, or several SVOCs, so these analytes also were retained as

COPCs for the soil invertebrate community.

4.3 Benthic Macroinvertebrate Community Exposure Estimate and Risk Calculation

COPCs for the benthic macroinvertebrate community in Red Devil Creek and Kuskokwim River near the RDM site were selected in two ways: (1) by comparing maximum detected chemical concentrations in sediment with sediment screening levels for effects on benthic macroinvertebrates and (2) by comparing maximum detected chemical concentrations in unfiltered surface water with chronic water criteria for protection of freshwater aquatic life. The results of the comparisons are shown in Tables 4-2 and 4-3.

The maximum sediment concentrations of antimony, arsenic, chromium, cobalt, copper, iron, manganese, mercury, nickel, and zinc exceeded the available screening levels (see Table 4-2). The greatest HQs were for antimony (2193), arsenic (13265), and mercury (661). Sediment screening levels were not available for barium, beryllium, methylmercury, thallium, or vanadium, so these five metals also were retained as COPCs in sediment for the benthic community.

Potential risks to benthic macroinvertebrates from chemicals in surface water are discussed in the following section.

4.4 Fish and Other Aquatic Biota Screening Level Exposure Estimate and Risk Calculation

COPCs for fish, amphibians, attached algae, benthic macroinvertebrates, and other aquatic organisms in Red Devil Creek were selected by comparing maximum detected chemical concentrations in unfiltered surface water with chronic water criteria for protection of freshwater aquatic life. The results of the comparisons are shown in Table 4-3. The maximum concentrations of antimony, arsenic, barium, iron, manganese, and mercury exceeded the available criteria, suggesting that these six constituents are COPCs in surface water for fish and other aquatic organisms. The greatest HQs were for barium (26) and mercury (32).

COPCs for fish were also selected by comparing maximum chemical concentration in whole-body sculpin samples from Red Devil Creek with fish tissue screening concentrations. The results of the comparisons are shown in Table 4-3b. The maximum sculpin concentrations of arsenic, chromium, mercury, methylmercury, selenium, and zinc exceeded the available fish tissue screening concentrations. The greatest HQs were for arsenic (14) and mercury (8). Fish tissue screening concentrations are not identified for antimony, barium, manganese, or vanadium, so these analytes also were retained as COPCs for fish.

4.5 Wildlife Screening Level Exposure Estimate and Risk Calculation

COPCs for wildlife were selected by calculating screening-level exposure estimates and HQs in accordance with EPA (1997) guidance. This method is preferable to comparing media concentrations with screening levels for several reasons: (1) soil screening levels for effects on wildlife are not available for all chemicals that were detected in soil at the RDM site; (2) sediment screening levels for evaluating risks to aquatic-dependent wildlife are rare; and (3) the HQ approach makes maximal use of available site-specific data on chemicals in terrestrial vegetation, benthic invertebrates, and fish, thus reducing the uncertainty associated with excessive use of literature-based bioaccumulation factors and models.

4.5.1 Wildlife Screening Level Exposure Estimates

This section describes the receptors, data, and methods used to derive screening-level exposure point concentrations and exposure estimates for wildlife at the RDM site.

4.5.1.1 Summary of Datasets Used to Calculate Screening Level Exposure Estimates

Chemical analytical data for surface soil, sediment, surface water, and vegetation samples collected from the RDM site in 2010 and 2011 were used in the evaluation (see Tables 4-1 to 4-4, respectively). Also, metals data for benthic-macroinvertebrate and slimy-sculpin samples from Red Devil Creek collected by BLM were used to evaluate potential risks to aquatic-dependent wildlife. These data are summarized in Table 4-5 and 4-6, respectively.

4.5.1.2 Exposure Scenarios and Pathways

Screening-level exposure estimates were calculated for the 11 wildlife receptors identified in the final RAWP. These species are:

Herbivores:

- Spruce grouse (*Dendragapus canadensis*)
- Tundra vole (*Microtus oeconomus*)
- Beaver (*Castor canadensis*)
- Green-winged teal (*Anus crecca*)

Invertivores

- Common snipe (*Gallinago gallinag*)
- American robin (*Turdus migra*torius)
- Masked shrew (*Sorex cinereus*)

Carnivores

- Northern shrike (*Lanius excubitor*)
- Least weasel (*Mustela nivalis*)

Piscivores:

- Belted kingfisher (*Ceryle alcyon*)
- Mink (M*ustela vison*)

For these species, chemical exposure from diet, incidental ingestion of soil and/or sediment, and drinking was estimated. Exposure parameters for these wildlife species were taken from the final RAWP and are presented in Table 4-7.

4.5.1.3 Exposure Point Concentrations

For most receptors, maximum measured chemical concentrations in surface soil, sediment, surface water and biota were used to calculate the screening-level exposure estimates (see Table 4-8). However, for terrestrial wildlife species that prey on soil invertebrates (e.g., earthworms) and small mammals, literature-based models were used to estimate chemical concentration in prey. Maximum surface soil chemical concentrations were used as input to the models. Exposure point concentrations (EPCs) for the 11 wildlife species evaluated in the SLERA are presented in Tables 4-9 to 4-14. The models used to estimate chemical concentrations in earthworms and small mammals are provided in Tables 4-9 and 4-12.

4.5.1.4 Exposure Calculations

Chemical exposure was calculated as the sum of exposures from diet, incidental soil/sediment ingestion, and drinking. Dietary exposure was estimated using the following equation:

$$EE_{diet} = C_f \text{ x } IR/BW$$

Where:

EE_{diet}	=	Estimated exposure from diet (milligrams [mg] per kilogram [kg] per day)
C_f	=	Chemical concentration in food (mg/kg, wet or dry weight)
IR_f	=	Food ingestion rate of receptor (kg/day, wet or dry weight)
BW	=	Body weight of receptor (kg)

Food ingestion rates and body weights were evaluated were taken from EPA (1993a), Dunning (1993), or other credible references (see Table 4-7). The diet of each receptor was assumed to consist exclusively of its preferred prey (see Table 4-7). For example, the diets of the American robin and marked shrew were assumed to consist entirely of soil invertebrates (e.g., earthworms). A wet food ingestion rate was used for the common snipe, kingfisher, and mink because chemical concentration data for benthic invertebrates and fish (sculpin) were provided on a wet weight basis. A dry food ingestion rate was used for all other receptors because site-specific data on chemical concentrations in their preferred food were provided on a dry weight basis (spruce needles, blueberry leaves, alder back, and pond vegetation) or because the models used to estimate chemical concentration in their preferred food yielded a dry weigh concentration (earthworms and small mammals).

Wildlife exposure to chemicals through incidental soil/sediment ingestion was estimated in a manner similar to that used for dietary exposure, as shown in the following equation:

$$EE_{soil/sed} = C_s \times IR_s/BW$$

Where:

$EE_{soil/sed}$ = Estimated exposure from incidental soil/sediment ingestion (mg/kg/day)
C_s = Chemical concentration in soil/sediment (mg/kg, dry weight)
IR_s = Soil/sediment ingestion rate of receptor (kg/day, dry weight)

Soil/sediment ingestion rates were taken from pertinent literature (Beyer et al. 1994, 2008; Sample et al. 1997; Sample and Suter 1994) or based on professional judgment (if a literature value could not be found) (see Table 4-7).

Wildlife exposure to chemicals through drinking was estimated in a manner similar to that used for dietary exposure, as shown in the following equation:

$$EE_{drinking} = C_w \times IR_w/BW$$

Where:

$EE_{drinking}$ = Estimated exposure from drinking surface water (mg/kg/day)
C_w = Chemical concentration in surface water (milligrams/liter)
IR_w = Surface water ingestion rate (liters/day)

Surface water ingestion rates were taken from the literature or calculated using allometric relationships from Sample et al. (1996). The values are provided in Table 4-7.

The total exposure for a receptor was calculated as the sum of the exposure from diet, incidental soil/sediment ingestion, and drinking as represented by the following equation:

$$EE_{total} = EE_{diet} + EE_{soil/sed} + EE_{drinking}$$

Where:

EE_{total} = Total exposure (mg/kg/day)
EE_{diet} = Estimated exposure from diet (mg/kg/day)
$EE_{soil/sed}$ = Estimated exposure from incidental soil/sediment ingestion (mg/kg/day)
$EE_{drinking}$ = Estimated exposure from surface water consumption (mg/kg/day)

Lastly, all wildlife receptors evaluated in the SLERA were assumed to derive all of their food and water from the site and be year-round residents. That is, the site use factor (SUF) and exposure duration (ED) were assumed to be 1.0 for all receptors.

Tables 4-15 to 4-25 present the exposure estimates for the 11 wildlife species evaluated in the SLERA.

4.5.2 Wildlife Screening-Level Risk Calculation

Potential risks posed by site-related chemicals were determined by calculating an HQ for each chemical for each endpoint species. The HQs were calculated by dividing the total exposure (EE_{total}) by the appropriate no observed adverse effect level (NOAEL; see Table 3-2), as shown in the following equation:

$$HQ = EE_{total}/NOAEL$$

For a given receptor and chemical, an HQ greater than or equal to 1 indicates that a potential risk exists and that further evaluation is warranted in the BERA.

Tables 4-15 to 4-25 present the screening-level HQs for the 11 wildlife species evaluated in the SLERA. In general, the wildlife endpoint species potentially at risk from the greatest number of chemicals are those that feed extensively on invertebrates that live in soil, such as the American robin and masked shrew (see Tables 4-15 and Table 4-16, respectively), or sediment, such as the common snipe (see Table 4-21). For many receptors, the highest HQs typically were those for antimony, arsenic, and mercury, as would be expected given the nature and extent of contamination at the site. For the American robin, masked shrew, and spruce grouse, potential risks from lead also were high, largely due to an anomalously high maximum lead concentration in surface soil.

5 Uncertainties

Significant sources of uncertainty in this ERA include the following:

- **Bioavailability –** The bioavailability of chemicals in environmental media at the RDM +site is poorly understood. To be conservative, it was assumed that 100% of the chemicals in soil and sediment were bioavailable to all ecological receptors. If bioavailability is less than 100%, which seems likely, the potential risks to all categories of ecological receptors would be correspondingly lower. In the BERA, this issue will be examined by evaluating site-specific data for mercury and arsenic speciation in soil and sediment, as well as synthetic precipitation leaching procedure data for metals in soil.
- **Reliability of Soil Benchmarks –** Many of the available soil screening benchmarks for plants and soil invertebrates (i.e., earthworms) were developed from laboratory studies in which chemical solutions were added to clean soil to arrive at a range of test concentrations. In such studies, the added chemicals are highly bioavailable. Comparing total chemical concentrations in field samples to solution-based soil benchmarks is conservative and likely results in an overestimation of risk. For aluminum, the EPA (2003) has deemed that such a comparison is inappropriate.
- **Reliability of Sediment Benchmarks –** The available sediment benchmarks are based on total concentrations without consideration of chemical bioavailability. The sediment benchmarks used in the SLERA are expected to be overly conservative predictors of no-

effect levels for benthic organisms in Red Devil Creek, given that a large fraction of many site-related contaminants occur largely in an inert crystalline form.

- **Availability of Media Screening Levels and Wildlife TRVs –** As indicated in Tables 4-1 to 4-3, screening levels are not available for all chemicals in all media. For example, soil screening levels for plants and soil fauna are not available for SVOCs. Hence, potential risks to plants and soil fauna from many SVOCs could not be evaluated. Additionally, an avian TRV is not available for antimony. Hence, potential risks to birds from antimony, which is one of the principal contaminants at the RDM site, could not be evaluated.
- **Chemicals in Wildlife Prey –** Food-chain transfer of chemicals at the RDM site is poorly understood for terrestrial predatory wildlife (e.g., American Robin, masked shrew, northern shrike, and least weasel). The potential risks to these species are largely driven by estimated concentrations of chemicals in wildlife prey. For this assessment, prey concentrations were estimated from measured soil and sediment concentrations using bioaccumulation factors and models from the literature. Or, if a literature-based bioaccumulation factor was not available, it was assumed that the prey concentration was the same as the soil or sediment concentration. The uncertainty associated with this approach often is high because a number of site-specific factors affect food-chain transfer of chemicals. In general, the bioaccumulation factors and models used in this assessment are intended to provide a conservative estimate of chemicals in wildlife prey and are likely to result in an overestimation of risk.
- **Wildlife Diet –** Uncertainty may result from the assumptions made about the diets of the wildlife receptors evaluated in this assessment. For the shrew and robin, the assumption of a diet consisting entirely of earthworms is conservative. In addition to earthworms, shrews consume other invertebrates (i.e., slugs, snails, centipedes, and various insects), fungi, plant materials, and small mammals (EPA 1993a). Similarly, robins also consume other invertebrates (i.e., spiders, sowbugs, and various insects) and plant materials (EPA 1993a). These foods are less intimately associated with the soil matrix than earthworms, and thus accumulate lesser amounts of soil contamination. The diet assumed for the shrew and robin in this assessment likely overestimates exposure and risks from chemicals in soil.
- **Site Use Factor and Exposure Duration** – To provide a conservative estimate of wildlife exposure to site-related chemicals, the SUF and ED were assumed to be 1 for all receptors. That is, the site was assumed to be a closed system, and all wildlife species were assumed to derive all of their food and habitat requirements from the site on a year-round basis. These assumptions are highly conservative and often are used in screening-level ERAs to avoid overlooking chemicals that may be of concern for wildlife (EPA 1997). If realistic estimates of the SUF and ED were incorporated into the wildlife exposure calculation, the estimated exposure and risk would be substantially lower.
- **Reliability of Surface Water Criteria –** In general, the EPA's water quality criteria and State of Alaska water quality standards are considered to be among the most reliable

screening levels because they are based on a large body of testing data and sound derivation methods. However, there are exceptions. For example, the mercury water quality criterion of 0.012 micrograms per liter (µg/L) from EPA (1986) is a Final Residue Value that was derived from a bioconcentration factor of 81,700 for methylmercury with the fathead minnow and thus assumes that all discharged mercury is methylmercury. Use of this criterion as a screening level for total mercury is highly conservative, given that only a small fraction of total mercury in surface water is present as methylmercury.

- **Reliability of Other Surface Water Screening Levels –** The EPA and State of Alaska water quality criteria are not available for all chemicals. For such chemicals, surface water screening levels from other sources were used (see Table 4-3). These other surface water screening levels are based on less testing data than federal and state water quality criteria, and therefore the level of uncertainty associated with them is greater.

6 Summary of Chemicals of Potential Concern

The primary purpose of the SLERA was to select COPCs for the BERA. Table 4-26 provides a summary of the chemical and receptor combinations that will be evaluated in the BERA. For each assessment endpoint, chemicals were retained for evaluation in the BERA if the screening-level HQ equaled or exceeded 1 or if the chemical was detected in site media and no toxicity information was available for that chemical. The later group of chemicals includes several organic compounds that were detected infrequently at low (part per billion) levels in soil or sediment (see Table 4-26). These chemicals will be addressed qualitatively in the BERA.

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8 Acronyms and Abbreviations

°C	degrees centigrade
°F	degrees Fahrenheit
As_2S_3	orpiment
AsS	realgar
BERA	baseline ecological risk assessment
bgs	below ground surface
BLM	United States Department of the Interior Bureau of Land Management
cm	centimeters
COPCs	Contaminants of potential concern
CSM	conceptual site model
DBH	diameter at breast height
DRO	diesel range organics
Eco-SSLs	EPA Ecological Soil Screening Level
ED	exposure duration
ERAGS	United States Environmental Protection Agency Risk Assessment Guidance
FeS_2	pyrite
HgS	Cinnabar
HPAHs	high molecular weight PAHs
HQ	hazard quotient
kg	kilograms
LPAHs	low molecular weight PAHs
MDL	method detection limit
mg	milligrams
NHP	Natural Heritage Program
ORNL	Oak Ridge National Laboratory
PAHs	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
RAWP	Risk Assessment Work Plan
RDM	Red Devil Mine
RI/FS	Remedial Investigation/Feasibility Study
Sb_2S_3	stibnite
SLERA	Screening Level Ecological Risk Assessment
SUF	site use factor
SVOCs	semivolatile organic compounds
TRV	Toxicity reference value

Table ES-1 Summary of Chemical and Endpoint Combinations to be Evaluated in the Baseline Ecological Risk Assessment, Red Devil Mine Site

	Assessment Endpoint and Maximum HQ[a]															
						Terrestrial Wildlife[h]						Aquatic-Dependent Wildlife[i]				
Analyte[b]	Plants[c]	Soil Fauna[d]	Fish and Other Aquatic Biota[e]	Fish[f]	Benthos[g]	Robin	Shrew	Grouse	Vole	Shrike	Weasel	Snipe	Beaver	Teal	Kingfisher	Mink
Polychlorinated Biphenyls (PCBs)																
Sum of Aroclors (NDs = 0.5MDL)		x														
Metals																
Antimony	x	299	6.1	x	2,193	x	136,370	x	1,681	x		x	60	x	x	89
Arsenic	549	x	6.9	14	13,265	28	214	47	41	1.5	1.9	823	1.5	37	5.5	3.3
Barium	x	5.2	26	x	x	2.0	1.6	1.3				1.4				
Beryllium	x				x	x		x		x		x		x	x	
Cadmium						1.7	4.4									
Chromium	1.3	x		3.5	1.1	2.9	1.3									
Cobalt	3.0	x			1.0										1.1	
Copper	2.0	1.7			2.8	4.4	4.6					1.5				
Iron			2.5		16											
Lead	26	1.8				83	48	20	2.8	4.9	1.0					
Manganese	19	9.4	3.2	x	12		2.3	2.1	6.1							
Mercury	5,400	16,200	32	8	661	9.5	2.1	39				5.8		2.8	4.2	
Methylmercury				1	x										2.3	1.3
Nickel	2.6				11	3.7	21									
Selenium				2.7			1.2					5.7			5.2	2.9
Silver		x														
Thallium		x			x	x	3.3	x		x		x		x	x	3.8
Vanadium	26	x			x	1.9		1.7				2.5				
Zinc	2.4	3.2		1.3	1.1	2.2	2.7									
Polycyclic Aromatic Hydrocarbons (PAHs)																
HPAH sum																
LPAH sum						x		x		x		x			x	
Other Semivolatile Organic Compounds (SVOCs)																
4-Bromophenyl phenyl ether	x	x				x	x	x	x	x	x		x			
4-Methylphenol	x	x				x		x		x						
Benzoic acid	x	x				x	x	x	x	x	x		x			
Benzyl Alcohol	x	x				x	x	x	x	x	x	x	x		x	x
Bis(2-Ethylhexyl)phthalate	x	x														
Dibenzofuran						x	x	x	x	x	x		x			
Diethylphthalate		x				x		x		x		x			x	
Dimethylphthalate	x					x	x	x	x	x	x		x			
Di-n-butyl Phthalate																
Hexachlorobenzene	x															
Pentachlorophenol																
Phenol																

Key:
BERA = Baseline Ecological Risk Assessment
HPAH = high molecular weight PAH
HQ = hazard quotient
LPAH = low molecular weight PAH
TRV = toxicity reference value
Value (with or without shading) = HQ equal to or greater than 1. Chemical and receptor combination will be evaluated quantitatively in the BERA.
x = chemical detected in site samples but no screening level or TRV is available. Chemical will be evaluated qualitatively in the BERA.

Notes:
a. For plants, soil fauna, fish and other aquatic biota, fish (only), and benthos, shading indicates the percentage of site samples that exceed the screening level (SL):
Value = > 75%
Value = 50 - 75%
Value = 25 - 50%
Value = < 25%
For wildlife, the value of the maximum HQ (exposure estimate / TRV) is shown without shading because wildlife HQs were not calculated sample-by-sample.
b. Essential nutrients (calcium, magnesium, sodium, and potassium) and major soil /sediment constitutes (aluminum) were excluded from the evaluation as per USEPA guidance (USEPA 1989, 2003a). Organic chemicals detected in surface soil, sediment, or surface water are listed.
c. Based on comparing maximum soil chemical concentrations with soil screening levels for effects on plants (see Table 4-1).
d. Based on comparing maximum soil chemical concentrations with soil screening levels for effects on earthworms (see Table 4-1).
e. Based on comparing maximum surface water chemical concentrations with surface water criteria and standards for effects on fish and other aquatic biota (see Table 4-3).
f. Based on comparing maximum whole-body scuplin chemical concentrations with fish tissue screening concentrations (see Table 4-3b).
g. Based on comparing maximum sediment chemical concentrations with sediment screening levels for effects on benthic macroinvertebrates (see Table 4-2).
h. Based on screening-level exposure estimates and hazard quotients for the American robin (Table 4-15), masked shrew (Table 4-16), spruce grouse (Table 4-17), tundra vole (Table 4-18), northern shrike (Table 4-19), and least weasel (Table 4-20).
i. Based on screening-level exposure estimates and HQs for the common snipe (Table 4-21), beaver (Table 4-22), green-winged teal (Table 4-23), belted kingfisher (Table 4-24), and mink (Table 4-25).

Table 3-1 Assessment Endpoints and Measures for the Red Devil Mine Site Screening Level Ecological Risk Assessment

Assessment Endpoint	Risk Question	Measure Selected for SLERA	Analysis Approach
Terrestrial Vegetation			
Survival, growth, and reproduction or terrestrial plants	Are levels of contaminants in surface soil from the site greater than benchmarks for effects on survival, growth, or reproduction of terrestrial plants?	Chemical concentrations in soil.	Compare soil chemical concentrations with literature-based toxicity thresholds.
Soil Invertebrates			
Survival, growth, and reproduction or soil invertebrates	Are levels of contaminants in surface soil from the site greater than benchmarks for effects on survival, growth, or reproduction of soil invertebrates?	Chemical concentrations in soil.	Compare soil chemical concentrations with literature-based toxicity thresholds.
Birds			
	Does the daily dose of chemicals received by birds from consumption of prey and other media at the site exceed TRVs for survival, growth, or reproduction of birds?	Chemical concentration in surface water, sediment, soil, and modeled or measured tissue concentrations in prey species.	Modeled dose from diet, surface water ingestion, and incidental ingestion of soil or sediment compared with literature-based TRVs.
Mammals			
	Does the daily dose of chemicals received by mammals from consumption of prey and other media at the site exceed TRVs for survival, growth, or reproduction of mammals?	Chemical concentration in surface water, sediment, soil, and modeled or measured tissue concentrations in prey species.	Modeled dose from diet, surface water ingestion, and incidental ingestion of soil or sediment compared with literature-based TRVs.
Benthic Invertebrates			
Survival, growth, and reproduction or benthic invertebrates	Are levels of contaminants in sediment from Red Devil Creek and the Kuskokwim River greater than sediment benchmarks for survival, growth, or reproduction of benthic invertebrates?	Chemical concentrations in sediment.	Compare sediment chemical concentrations with literature-based toxicity thresholds.
	Are levels of contaminants in surface water from Red Devil Creek greater than water quality criteria for protection of aquatic life?	Chemical concentrations in surface water.	Compare surface water chemical concentrations with federal and state water quality criteria and standards.
Fish and Other Aquatic Biota (e.g., amphibians, attached algae, and aquatic invertebrates)			
Survival, growth, and reproduction of fish and other aquatic biota	Are levels of contaminants in surface water from Red Devil Creek greater than water quality criteria for protection of aquatic life?	Chemical concentrations in surface water.	Compare surface water chemical concentrations with federal and state water quality criteria and standards.
Fish			
Survival, growth, and reproduction or fish	Are levels of contaminants in fish from Red Devil Creek greater than critical tissue concentrations for effects on fish?	Whole-body chemical concentrations in slimy sculpin from Red Devil Creek.	Compare chemical concentrations in whole-body sculpin samples from Red Devil Creek with fish tissue screening concentrations.

Key:
SLERA = Screening Level Ecological Risk Assessment
TRVs = toxicity reference values

Table 3-2 Toxicity Reference Values for Birds and Mammals

Analyte	Wildlife Class	NOAEL (mg/kg-day)	Critical Effect	LOAEL (mg/kg-day)	Critical Effect	Reference and Comments
Polychlorinated Biphenyls						
Aroclors 1260	Birds	0.18	Reproduction	1.8	Reproduction	Sample et al. (1996) for Aroclor 1254.
	Mammals	0.14	Reproduction	0.69	Reproduction	Sample et al. (1996) for Aroclor 1254 effects on mink.
Metals						
Antimony	Birds	na	na	na	na	na
	Mammals	0.059	Reproduction	0.59	Reproduction	USEPA (2005i). Highest bounded NOAEL (0.059 mg/kg-d) for growth or reproduction below lowest bounded LOAEL (0.59 mg/kg-d) for growth or reproduction from 20 laboratory toxicity studies.
Arsenic	Birds	2.24	Reproduction	3.55	Growth	USEPA(2005b). Lowest NOAEL for growth, reproduction, or survival from nine laboratory toxicity studies. Lowest LOAEL for growth, reproduction, or survival greater than selected NOAEL.
	Mammals	1.04	Growth	1.66	Growth	USEPA (2005b). Highest bounded NOAEL for growth, reproduction, or survival less than lowest bounded LOAEL for growth, reproduction, or survival from 62 laboratory toxicity studies.
Barium	Birds	20.8	Survival	41.7	Survival	Sample et al. (1996).
	Mammals	51.8	Reproduction, growth, and survival	121	Growth and survival	USEPA (2005c). Geometric mean NOAEL for growth, reproduction, and survival from 12 laboratory toxicity studies. Lowest bounded LOAEL for reproduction, growth, or survival greater than geometric mean NOAEL.
Beryllium	Birds	na	na	na	na	na
	Mammals	0.532	Survival	na	na	USEPA (2005d). Lowest NOAEL for growth, reproduction, or survival from four laboratory toxicity studies.
Cadmium	Birds	1.47	Reproduction, growth, and survival	2.37	Reproduction	USEPA (2005e). Geometric mean NOAEL for growth, reproduction, and survival from 49 laboratory toxicity studies. Lowest bounded LOAEL for growth, reproduction, or survival greater than geometric mean NOAEL.
	Mammals	0.77	Growth	1	Growth	USEPA (2005e). Highest bounded NOAEL (0.77 mg/kg-d) for reproduction, growth, or survival less than the lowest bounded LOAEL (1.0 mg/kg-d) from 141 laboratory toxicity studies.
Chromium	Birds	2.66	Reproduction, growth, and survival	2.78	Survival	USEPA (2008). Geometric mean NOAEL for growth, reproduction, and survival from 17 laboratory toxicity studies. Lowest bounded LOAEL for reproduction, growth, or survival greater than geometric mean NOAEL.
	Mammals	9.24	Reproduction and growth	na	na	USEPA (2008). Geometric mean NOAEL for reproduction and growth from 10 studies with trivalent chromium.
Cobalt	Birds	7.61	Growth	7.8	Growth	USEPA (2005f). Geometric mean NOAEL for growth from 10 toxicity studies. Lowest bounded LOAEL for growth or reproduction greater than geometric mean NOAEL.
	Mammals	7.33	Reproduction and Growth	10.9	Reproduction	USEPA (2005f). Geometric mean NOAEL for reproduction and growth based on 21 laboratory toxicity studies. Lowest bounded LOAEL for growth or reproduction greater than geometric mean NOAEL.
Copper	Birds	4.05	Reproduction	4.68	Growth	USEPA (2007a). Highest bounded NOAEL for reproduction, growth, or survival (4.05 mg/kg-day) lower than the lowest bounded LOAEL for reproduction, growth, or survival (4.68 mg/kg-day).
	Mammals	5.6	Reproduction	6.79	Growth	USEPA (2007a). Highest bounded NOAEL for reproduction, growth, or survival (5.6 mg/kg-day) lower than the lowest bounded LOAEL for reproduction, growth, or survival (6.79 mg/kg-day).
Lead	Birds	1.63	Reproduction	1.94	Reproduction	USEPA (2005g). Highest bounded NOAEL (1.63 mg/kg-d) for growth, reproduction, or survival lower than the lowest bounded LOAEL (1.94 mg/kg-d) for growth, reproduction, or survival based on 57 laboratory toxicity studies.
	Mammals	4.7	Growth	5	Growth	USEPA (2005g). Highest bounded NOAEL (4.7 mg/kg-d) for growth, reproduction, or survival lower than the lowest bounded LOAEL (5 mg/kg-d) for growth, reproduction, or survival based on 220 laboratory toxicity studies.

Table 3-2 Toxicity Reference Values for Birds and Mammals

Analyte	Wildlife Class	NOAEL (mg/kg-day)	Critical Effect	LOAEL (mg/kg-day)	Critical Effect	Reference and Comments
Manganese	Birds	179	Reproduction and Growth	348	Growth	USEPA (2007b). Geometric mean NOAEL for reproduction and growth. Lowest bounded LOAEL for reproduction or growth greater than geometric mean NOAEL.
	Mammals	51.5	Reproduction and Growth	65	Growth	USEPA (2007b). Geometric mean NOAEL for reproduction and growth. Lowest bounded LOAEL for reproduction or growth greater than geometric mean NOAEL.
Mercury	Birds	0.45	Reproduction	0.9	Reproduction	Sample et al. (1996).
	Mammals	13.2	Reproduction and survival	na	na	Sample et al. (1996).
Methylmercury	Birds	0.068	Reproduction	0.37	Reproduction	CH2MHILL (2000).
	Mammals	0.032	Reproduction	0.16	Reproduction	CH2MHILL (2000).
Nickel	Birds	6.71	Growth and survival	11.5	Growth	USEPA (2007c). Geometric mean NOAEL for reproduction and growth. Lowest bounded LOAEL for reproduction or growth greater than geometric mean NOAEL.
	Mammals	1.7	Reproduction	2.71	Reproduction	USEPA (2007c). Highest bounded NOAEL for reproduction, growth, or survival below lowest bounded LOAEL for reproduction, growth, or survival.
Selenium	Birds	0.291	Survival	0.368	Reproduction	USEPA (2007d). Highest bounded NOAEL for reproduction, growth, or survival below lowest bounded LOAEL for reproduction, growth, or survival.
	Mammals	0.143	Growth	0.145	Reproduction	USEPA (2007d). Highest bounded NOAEL for reproduction, growth, or survival below lowest bounded LOAEL for reproduction, growth, or survival.
Silver	Birds	2.02	Growth	20.2	Growth	USEPA (2006). Lowest LOAEL for reproduction or growth divided by 10.
	Mammals	6.02	Growth	60.2	Growth	USEPA (2006). Lowest LOAEL for reproduction or growth divided by 10.
Thallium	Birds	NA	NA	NA	NA	NA
	Mammals	0.0074	Reproduction	0.074	Reproduction	Sample et al. (1996).
Vanadium	Birds	0.344	Growth	0.413	Reproduction	USEPA (2005h). Highest bounded NOAEL (0.344 mg/kg-d) for growth, reproduction, or survival less than lowest bounded LOAEL (0.413 mg/kg-d) for reproduction, growth, or survival based on 94 laboratory toxicity studies.
	Mammals	4.16	Reproduction and growth	5.11	Growth	USEPA (2005h). Highest bounded NOAEL (4.16 mg/kg-d) for growth or reproduction less than lowest bounded LOAEL (5.11 mg/kg-d) for growth, reproduction, or survival based on 94 laboratory toxicity studies.
Zinc	Birds	66.1	Reproduction and Growth	66.5	Reproduction	USEPA (2007e). Geometric mean NOAEL for reproduction and growth. Lowest bounded LOAEL for reproduction or growth greater than geometric mean NOAEL.
	Mammals	75.4	Reproduction and Growth	75.9	Reproduction	USEPA (2007e). Geometric mean NOAEL for reproduction and growth. Lowest bounded LOAEL for reproduction or growth greater than geometric mean NOAEL.
Polycyclic Aromatic Hydrocarbons						
LPAHs[a]	Birds	na	na	na	na	na
	Mammals	65.6	Growth	110	Growth	USEPA (2007f). Highest bounded NOAEL (65.5 mg/kg-d) below the lowest bounded LOAEL (110 mg/kg-d) for reproduction, growth, or survival.
HPAHs[b]	Birds	2	Growth	20	Growth	USEPA (2007f); from Appendix 5.2A for European starling.
	Mammals	0.615	Survival	3.07	Survival	USEPA (2007f). Highest bounded NOAEL (0.615 mg/kg-day) below the lowest bounded LOAEL (3.07 mg/kg-day) for reproduction, growth, or survival.
Other Semivolatile Organic Compounds						
4-Bromophenyl phenyl ether	Birds	na	na	na	na	na
	Mammals	na	na	na	na	na
4-Methylphenol	Birds	na	na	na	na	na
	Mammals	219	na	na	na	NYSDEC (2002).
Benzoic Acid	Birds	na	na	na	na	na
	Mammals	na	na	na	na	na
Benzyl Alcohol	Birds	na	na	na	na	na
	Mammals	na	na	na	na	na
Bis(2-ethylhexyl)phthalate	Birds	1.11	Reproduction	na	na	Sample et al. (1996).
	Mammals	18.33	Reproduction	183.3	Reproduction	Sample et al. (1996).
Butyl Benzyl Phthalate	Birds	na	na	na	na	na
	Mammals	na	na	na	na	na

Table 3-2 Toxicity Reference Values for Birds and Mammals

Analyte	Wildlife Class	NOAEL (mg/kg-day)	Critical Effect	LOAEL (mg/kg-day)	Critical Effect	Reference and Comments
Diethyl Phthalate	Birds	na	na	na	na	na
	Mammals	4583	Reproduction	na	na	Sample et al. (1996).
Dimethyl Phthalate	Birds	na	na	na	na	na
	Mammals	na	Reproduction	na	na	na
Di-n-butyl Phthalate	Birds	0.11	Reproduction	1.1	Reproduction	Sample et al. (1996).
	Mammals	550	Reproduction	1833	Reproduction	Sample et al. (1996).
Hexachlorobenzene	Birds	0.56	Reproduction	2.25	Reproduction	Sample et al. (1996) for BHC mixed isomers.
	Mammals	0.014	Reproduction	0.14	Reproduction	Sample et al. (1996) for BHC mixed isomers.
Pentachlorophenol	Birds	6.73	Reproduction	na	na	USEPA (2007g). Lowest NOAEL for reproduction, growth, or survival.
	Mammals	8.42	Reproduction and Growth	9.45	Reproduction	USEPA (2007g). NOAEL value is geometric mean of 25 NOAELs for reproduction and growth. LOAEL value is lowest LOAEL greater than geometric mean NOAEL.
Phenol	Birds	6	na	na	na	NYSDEC (2002).
	Mammals	523	na	na	na	NYSDEC (2002).

Key:
BHC = benzene hexachloride
HPAH = high molecular weight PAH
LOAEL = lowest observed adverse effect level
LPAH = low molecular weight PAH
mg/kg/day = milligrams per kilogram per day
na = no available
NOAEL = no observed adverse effect level
PAH = polycyclic aromatic hydrocarbon
TRV = toxicity reference value

Notes:
a. Sum of acenaphthylene, acenaphthene, anthracene, fluorene, methylnaphthalene, naphthalene, and phenanthrene.
b. Sum of benz(a)anthracene, total benzofluoranthenes, benzo(a)pyrene,chrysene, benzo(g,h,i)perylene, dibenzo(a,h)anthracene, indeno(1,2,3,-c,d)pyrene, fluoranthene, and pyrene.

Table 4-1 Surface Soil (0 to 2 feet) Ecological Screening Results, Red Devil Mine Site SLERA

Analyte[a]	Number of Samples[b]	Minimum Detected Concentration	Maximum Detected Concentration	FoD	Soil Ecological Screening Levels and Hazard Quotients									
					Plants					Soil Invertebrates				
					Value[c]	FoE	HQ[e]	COPC	Rationale[f]	Value[d]	FoE	HQ[e]	COPC	Rationale[f]
Metals (mg/kg)														
Aluminum	135	2410	21700	135/135	--	--	--	No	MSC	--	--	--	No	MSC
Antimony	135	0.708 J	23300 J	111/135	--	--	--	Yes	NSL	78	86/135	299	Yes	>SL
Arsenic	135	9	9880	134/135	18	126/134	549	Yes	>SL	--	--	--	Yes	NSL
Barium	135	76.2	1710	135/135	--	--	--	Yes	NSL	330	41/135	5.2	Yes	>SL
Beryllium	135	0.3	1.3	132/135	--	--	--	Yes	NSL	40	0/1354	0.03	No	<SL
Cadmium	135	0.18	1.3	38/135	32	0/36	0.04	No	<SL	140	0/135	0.01	No	<SL
Calcium	135	390	10400 J	135/135	--	--	--	No	NUT	--	--	--	No	NUT
Chromium	135	6	101	135/135	75	1/135	1.3	Yes	>SL	--	--	--	Yes	NSL
Cobalt	135	5.9	38.8	135/135	13	103/135	3.0	Yes	>SL	--	--	--	Yes	NSL
Copper	135	17	139	135/135	70	56/135	2.0	Yes	>SL	80	30/135	1.7	Yes	>SL
Iron	135	16800	59100	135/135	--	--	--	No	MSC	--	--	--	No	MSC
Lead	135	5	3090	126/135	120	6/126	26	Yes	>SL	1700	1/135	1.8	Yes	>SL
Magnesium	135	390	11400	135/135	--	--	--	No	NUT	--	--	--	No	NUT
Manganese	135	153	4230	135/135	220	133/135	19	Yes	>SL	450	111/135	9.4	Yes	>SL
Mercury	135	0.05 J	1620	135/135	0.3	126/135	5400	Yes	>SL	0.1	133/135	16200	Yes	>SL
Methylmercury	0	--	--	0/0	--	--	--	--	--	--	--	--	--	--
Nickel	135	18	97	135/135	38	101/135	2.6	Yes	>SL	280	0/135	0.35	No	<SL
Potassium	135	600	4720	135/135	--	--	--	No	NUT	--	--	--	No	NUT
Selenium	135	0.24	0.42	2/135	0.52	0/2	0.81	No	<SL	4.1	0/135	0.10	No	<SL
Silver	135	0.068	0.123	2/135	560	0/2	0.0002	No	<SL	--	--	--	Yes	NSL
Sodium	135	42.3	430	75/135	--	--	--	No	NUT	--	--	--	No	NUT
Thallium	135	0.065	0.071	2/135	1	0/135	0.07	No	<SL	--	--	--	Yes	NSL
Vanadium	135	15.3	51.9	135/135	2	135/135	26	Yes	>SL	--	--	--	Yes	NSL
Zinc	135	38	386	135/135	160	4/135	2.4	Yes	>SL	120	35/135	3.2	Yes	>SL
Polychlorinated Biphenyls (PCBs) (µg/kg)														
Aroclor-1260	18	0.021 J	0.021 J	1/18	40,000	0/1	0.0000	No	<SL	--	--	--	Yes	NSL
Sum of Aroclors (NDs = 0.5 MDL)	18	0.078 J	0.078 J	1/18	40,000	0/1	0.0000	No	<SL	--	--	--	Yes	NSL
Polycyclic Aromatic Hydrocarbons (PAHs) (µg/kg)														
HPAH sum (NDs = 0.5 MDL)	12	10.7	109	5/12	20,000	0/5	0.01	No	<SL	18000	0/5	0.01	No	<SL
LPAH sum (NDs = 0.5 MDL)	12	15.3	417	6/12	20,000	0/6	0.02	No	<SL	29000	0.6	0.01	No	<SL
Other Semivolatile Organic Compounds (SVOCs) (µg/kg)														
4-Bromophenyl Phenyl Ether	12	1.9 J	1.9 J	1/12	--	--	--	Yes	NSL	--	--	--	Yes	NSL
4-Methylphenol	12	4.9 J	4.9 J	1/12	--	--	--	Yes	NSL	--	--	--	Yes	NSL
Benzoic Acid	12	120 J	120 J	1/12	--	--	--	Yes	NSL	--	--	--	Yes	NSL
Benzyl Alcohol	12	12 J	12 J	1/12	--	--	--	Yes	NSL	--	--	--	Yes	NSL
bis(2-Ethylhexyl)phthalate	12	11 J	220	8/12	--	--	--	Yes	NSL	--	--	--	Yes	NSL
Dibenzofuran	12	2.4 J	10 J	2/12	--	--	--	Yes	NSL	--	--	--	Yes	NSL
Diethylphthalate	12	8	140 B	2/12	100,000	0/2	0.0014	No	<SL	--	--	--	Yes	NSL

Table 4-1 Surface Soil (0 to 2 feet) Ecological Screening Results, Red Devil Mine Site SLERA

Analyte[a]	Number of Samples[b]	Minimum Detected Concentration	Maximum Detected Concentration	FoD	Soil Ecological Screening Levels and Hazard Quotients									
					Plants					Soil Invertebrates				
					Value[c]	FoE	HQ[e]	COPC	Rationale[f]	Value[d]	FoE	HQ[e]	COPC	Rationale[f]
Dimethylphthalate	12	160	160	1/12	--	--	--	Yes	NSL	--	--	200,000	No	<SL
Hexachlorobenzene	12	1.3 J	1.3 J	1/12	--	--	--	Yes	NSL	1000000	0/1	0.0000013	No	<SL
Pentachlorophenol	12	38 J	38 J	1/12	3,000	0/1	0.0127	No	<SL	6,000	0/1	0.00633333	No	<SL
Phenol	12	4.6 J	4.6 J	1/12	70,000	0/1	0.0001	No	<SL	30,000	0/1	0.0002	No	<SL

Key:
- -- = not available or not applicable
- B = present in blank
- COPC = chemical of potential concern
- Eco-SSL = Ecological Soil Screening Level
- FoD = frequency of detection (number of detects / number of samples)
- FoE = frequency of exceedence (number of detects > screening level / number of detects)
- HPAH = high molecular weight PAH
- HQ = hazard quotient
- J = estimated value
- LPAH = low molecular weight PAH
- MDL = method detection limit
- mg/kg = milligrams per kilogram
- NDs = non detects
- PAH = polycyclic aromatic hydrocarbon
- SL = Screening level
- SLERA = screening level ecological risk assessment
- µg/kg = micrograms per kilogram
- Shading = HQ equals or exceeds 1, or no SL available. Chemical is a COPC.

Notes:
- a = Detected chemicals only are listed.
- b = For metals, 127 original site samples and 8 field duplicate samples. For PCB, 16 original site samples and 2 field duplicates. For PAHs and SVOCs, 11 original site samples and 1 field duplicate.
- c = Eco-SSLs (www.epa.gov/ecotox/ecossl/) for arsenic, cadmium, cobalt, copper, lead, manganese, nickel, selenium, silver, and zinc. Chromium plant screening level is from Alloway (1984). Other plant screening levels are from Efroymson et al. (1997a). Acenaphthene value from Efroymson et al. (1997a) used for LPAH and HPAH sums.
- d = Eco-SSLs (www.epa.gov/ecotox/ecossl/) except for SVOCs, which are from Efroymson et al. (1997b).
- e = Hazard quotient (maximum detected concentration divided by screening level)
- f = Rationale codes.
  - For Yes: >SL = maximum detected concentration exceeds screening level
    NSL = no screening level available.
  - For No: < SLs = maximum detected concentration less than screening levels
    MSC = Major soil constituent (of low toxicity; Gough et al. 1979, USEPA 2003).
    NUT = Essential nutrient (USEPA 1989).

Table 4-2 Sediment Ecological Screening Results for Red Devil Creek and Kuskokwim River Sediment, Red Devil Mine Site SLERA

Analyte[a]	Number of Samples[b]	Minimum Detected Concentration	Maximum Detected Concentration	FoD	Sediment Ecological Screening Levels		FoE	HQ[c]	COPC	Rationale[d]
					Value	Basis				
Metals (mg/kg)										
Aluminum	45	710	18400	45/45	58,000	MacDonald et al. (1999). ERM *Hyalella*	0/45	0.32	No	<SL
Antimony	45	0.237 J	6360 J	40/45	2.9	MacDonald et al. (1999). PAETA, WA	37/40	2193	Yes	>SL
Arsenic	45	0.57 J	130000	45/45	9.8	MacDonald et al. (2000). TEC.	43/45	13265	Yes	>SL
Barium	45	4.12	1990	45/45	--	--	--	--	Yes	NSL
Beryllium	45	0.008 J	0.9	43/45	--	--	--	--	Yes	NSL
Cadmium	45	0.017 J	0.663 J	32/45	0.99	MacDonald et al. (2000). TEC.	0/32	0.67	No	<SL
Calcium	45	1320	23400	45/45	--	--	--	--	No	NUT
Chromium	45	0.65 J	47.4 J	43/45	43.4	MacDonald et al. (2000). TEC.	1/43	1.1	Yes	>SL
Cobalt	45	0.369	50	45/45	50	MacDonald et al. (1999). Criterion, Ontario.	2/45	1.0	Yes	=SL
Copper	45	0.68	87.5	45/45	31.6	MacDonald et al. (2000). TEC.	14/45	2.8	Yes	>SL
Iron	45	19600	344000	45/45	21,200	MacDonald et al. (1999). LEL, B.C.	43/45	16	Yes	>SL
Lead	45	0.05	14.8	43/45	35.8	MacDonald et al. (2000). TEC.	0/43	0.41	No	<SL
Magnesium	45	990	11400 J	45/45	--	--	--	--	No	NUT
Manganese	45	404	5410	45/45	460	MacDonald et al. (1999). LEL, B.C.	42/45	12	Yes	>SL
Mercury	45	0.169 J	119 J	45/45	0.18	MacDonald et al. (2000). TEC.	44/45	661	Yes	>SL
Methylmercury	33	0.0001 J	0.0144 J	32/33	--	--	--	--	Yes	NSL
Nickel	45	0.78	240 J	45/45	22.7	MacDonald et al. (2000). TEC.	39/45	11	Yes	>SL
Potassium	45	510 J	2870 J	43/45	--	--	--	--	No	NUT
Selenium	45	0.16 J	2.11	28/45	5	MacDonald et al. (1999). Criterion, B.C.	0/28	0.42	No	<SL
Silver	45	0.04	0.41	29/45	3.9	MacDonald et al. (1999). PAETA, WA.	0/29	0.11	No	<SL
Sodium	45	21.1	270	39/45	--	--	--	--	No	NUT
Thallium	45	0.011 J	0.653	29/45	--	--	--	--	Yes	NSL
Vanadium	45	1.72	48.5	43/45	--	--	--	--	Yes	NSL
Zinc	45	1.2 J	132 J	45/45	121	MacDonald et al. (2000). TEC.	1/45	1.09	Yes	>SL
Semivolatile Organic Compounds (µg/kg)										
Benzo(b)fluoranthene	2	1.5 J	1.5 J	1/2	27	MacDonald et al (1999). TEL *Hyalella* 28-day test.	0/45	0.06	No	<SL
Benzyl Alcohol	2	3.1 J	3.1 J	1/2	52	Buchman (2008). AET, marine bivalve.	0/45	0.06	No	<SL
Diethyl Phthalate	2	1.7 J	1.7 J	1/2	320	MacDonald et al. (1999). Chronic EqP threshold.	0/45	0.01	No	<SL
Di-n-butyl Phthalate	2	9 J	9 J	1/2	42	MacDonald et al. (1999). PAETA, *Hyalella*, WA.	0/45	0.21	No	<SL
Pentachlorophenol	2	22 J	22 J	1/2	40	MacDonald et al. (1999). Ecotoxicological value.	0/45	0.55	No	<SL
Phenanthrene	2	1.9 J	2.1 J	2/2	204	MacDonald et al. (2000). TEC.	0/45	0.01	No	<SL
Phenol	2	4.1 J	4.1 J	1/2	48	MacDonald et al. (1999). PAETA, *Hyalella* , WA	0/45	0.09	No	<SL

Key:

-- = Not available or not applicable
AET = Apparent effect threshold
B.C. = British Columbia, Canada
COPC = Chemical of potential concern
ERM = Effects range median
FoD = frequency of detection (number of detects / number of samples)
FoE = frequency of exceedence of SL (number of detects > SL / number of detects)
HPAH = High molecular weight PAHs
LEL = Low effect level
LPAH = Low molecular weight PAHs
PAETA = Probable apparent effect threshold approach
SL = Screening level

PAHs = Polycyclic aromatic hydrocarbons
TEC = Threshold effect concentration
TEL = Threshold effect level
WA = Washington State
[shaded] = HQ equals or exceeds 1, or no SL available. Chemical is a COPC.

Notes:

a = Detected analytes only are listed.
b = 42 original samples and 3 field duplicates
c = Hazard quotient (maximum concentration / screening level)
d = Rationale codes.

For Yes: >SL = maximum detected concentration exceeds screening level
=SL = maximum concentration equals screening level
NSL = no screening level available.

For No: NUT = Essential nutrient (EPA 1989).
<SL = maximum detected concentration less than screening level

Table 4-3 Surface Water Ecological Screening Results for Unfiltered Samples from Red Devil Creek, Red Devil Mine Site SLERA

Analyte[a]	Number of Samples[b]	Minimum Detected Concentration	Maximum Detected Concentration	FoD	Surface Water Chronic Ecological Screening Levels		FoE	HQ[c]	COPC	Rationale[d]
					Value	Basis				
Metals (µg/L)										
Aluminum	22	6.5 J	30.9 J	13/22	87	ADEC (2008) and EPA(2008)	0/13	0.36	No	<SL
Antimony	22	1.3	184	22/22	30	Suter and Tsao (1996), Tier II SCV	12/22	6.1	Yes	>SL
Arsenic	22	0.8	1030	22/22	150	ADEC (2008) and EPA(2008)	2/22	6.9	Yes	>SL
Barium	22	20.6	103	22/22	4	Suter and Tsao (1996), Tier II SCV	22/22	26	Yes	>SL
Beryllium	22	0.009 J	0.009 J	1/22	0.66	Suter and Tsao (1996), Tier II SCV	0/1	0.01	No	<SL
Cadmium	22	0.005 J	0.008 J	3/22	0.25	ADEC (2008) and EPA(2008)	0/3	0.03	No	<SL
Calcium	22	8580	36000	22/22	--	--	--	--	No	NUT
Chromium	22	0.15 J	0.57	13/22	74	ADEC (2008) and EPA(2008)	0/13	0.01	No	<SL
Cobalt	22	0.046	5.3	19/22	23	Suter and Tsao (1996), Tier II SCV	0/19	0.23	No	<SL
Copper	22	0.28	0.71	14/22	9	ADEC (2008) and EPA(2008)	0/14	0.08	No	<SL
Iron	22	118	2470	22/22	1,000	ADEC (2008) and EPA(2008)	3/22	2.5	Yes	>SL
Lead	22	0.008 J	0.079	13/22	2.5	ADEC (2008) and EPA(2008)	0/13	0.03	No	<SL
Magnesium	22	4460	37100	22/22	--	--	--	--	No	NUT
Manganese	22	11.2	379	22/22	120	Suter and Tsao (1996), Tier II SCV	2/22	3.2	Yes	>SL
Mercury	21	0.00192	0.385	21/21	0.77	ADEC (2008) and EPA(2008)	0/21	0.50	No	<SL
Mercury	21	0.00192	0.385	21/21	0.012	EPA (1986)e	15/21	32	Yes	>SL
Methylmercury	21	0.00008 J	0.00062	21/21	0.0028	Suter and Tsao (1996), Tier II SCV	0/22	0.22	No	<SL
Nickel	22	0.36	19.2	19/22	52	ADEC (2008) and EPA(2008)	0.19	0.37	No	<SL
Potassium	22	172	1210	13/22	--	--	--	--	No	NUT
Selenium	22	0.3 J	0.5 J	9/22	5	ADEC (2008) and EPA(2008)	0/9	0.10	No	<SL
Silver	22	0.008 J	0.026	3/22	3.2	ADEC (2008) and EPA(2008)	0/3	0.008	No	<SL
Sodium	22	1440	12900	22/22	--	--	--	--	No	NUT
Thallium	22	0.007 J	0.01 J	2/22	12	Suter and Tsao (1996), Tier II SCV	0/2	0.001	No	<SL
Vanadium	22	0.1 J	0.22 J	13/22	20	Suter and Tsao (1996), Tier II SCV	0/13	0.011	No	<SL
Zinc	22	0.3 J	2.1	9/22	118	ADEC (2008)	0/9	0.018	No	<SL
Semivolatile Organic Compounds (µg/L)										
Naphthalene	20	0.68 J	0.68 J	1/20	12	Suter and Tsao (1996), Tier II SCV	0/1	0.06	No	<SL
1-Methylnaphthalene	8	1.5	1.5	1/8	2.1	Suter and Tsao (1996), Tier II SCV	0/1	0.71	No	<SL
2-Methylnaphthalene	20	1.2 J	1.5	2/20	2.1	Suter and Tsao (1996), Tier II SCV [f]	0/2	0.71	No	<SL
Other Chemicals (mg/L)										
Alkalinity (Bicarbonate)	19	72.4	243	19/19	20	EPA (2009); minimum acceptable valueg	0/19	12	No	>SL
Chloride	11	0.35 J	0.6	11/11	230	EPA (2009)	0/11	0.00	No	<SL
Fluoride	19	0.04 J	0.13 J	12/19	0.3	MacDonald et al. (1999), tentative criterion, B.C.	0/12	0.43	No	<SL
Sulfate	19	8.63	28.5	19/19	100	MacDonald et al. (1999), criterion max., B.C.	0/19	0.29	No	<SL
Total Suspended Solids	19	3.6	3.6	1/19	Narrative	EPA (2009)	0/1	--	No	<SL

Key:

-- = Not available or not applicable
ADEC = Alaska Department of Environmental Conservation
B.C. = British Columbia
COPC = chemical of potential concern
FoD = frequency of detection (number of detects / number of samples)
FoE = frequency of exceedence of SL (number of detects > SL / number of detects)
J = estimated quantity
SCV = secondary chronic value
SL = screening level
SEPA = United States Environmental Protection Agency
(shaded) = HQ equals or exceeds 1 or no screening level available. Chemical is a COPC.

Notes:

a = Detected analytes only are listed.
b = 17 original samples and 3 field duplicates.
c = Hazard quotient (maximum concentration / screening level)
d = Rationale codes.
For Yes: >SL = maximum detected concentration exceeds screening level
NSL = no screening level available.
For No: NUT = Essential nutrient (EPA 1989).
<SL = maximum detected concentration less than screening level
e = Criterion derived using a bioconcentration factor of 81,700 for methylmercury for fathead minnow. Assumes all mercury is present in water as methylmercury.
f = For 1-methylnaphthalene
g = Criterion reflects a minimum level of alkalinity to be present in surface water. Alkalinity levels greater than the criterion are desireable.

Table 4-3b Maximum Chemical Concentrations in Scuplin Whole-Body Samples from Red Devil Creek Compared With Fish Tissue Screening Concentrations

Analyte	Maximum Detected Concentration (mg/kg wet weight)[a]		Tissue Screening Concentration (mg/kg wet weight)[b]	FoE	HQ[c]	COPC	Rationale[d]
Antimony	38.1		--	--	--	Yes	NSL
Arsenic	24.1		1.7	18/21	14	Yes	>SL
Barium	5.40		--	--	--	Yes	NSL
Beryllium	ND[e]		--	--	--	No	ND
Cadmium	0.103		0.15	0/11	0.7	No	<SL
Chromium	2.431		0.69	1/21	3.5	Yes	>SL
Copper	2.263	J-	3.1	0/21	0.7	No	<SL
Lead	0.079		2.2	0/13	0.04	No	<SL
Manganese	21.3		--	--	--	Yes	>SL
Mercury	3.70		0.46	13/21	8.0	Yes	>SL
Methylmercury	0.312		0.3 - 0.7	1/2	1.0	Yes	= SL
Nickel	0.263		18.4	0/21	0.01	No	<SL
Selenium	2.98		1.1	16/21	2.7	Yes	>SL
Vanadium	0.40		--	--	--	Yes	NSL
Zinc	35.4		27	7/21	1.3	Yes	>SL

Key:
-- not available or not applicable.
FoE = frequency of exceedence of SL (number of detects > SL / number of detects)
HQ = hazard quotient
J- = estimated value with low bias.
J+ = estimated value with high bias.
ND = not detected.
SL = screening level

Notes:
a = See Table 4-6.
b = Dyer et al. (2000), except for methylmercury, which is from Sandheinrich and Weiner (2011).
c = Hazard quotient (maximum concentration / screening level)
d = Rationale codes.
For Yes: >SL = maximum detected concentration exceeds SL
= SL = maximum detected concentration equals SL
NSL = no screening level available.
For No: ND = not detected
<SL = maximum detected concentration less than SL
e = Beryllium method detection limits = 0.025 mg/kg wet weight.

Table 4-4 Summary of 2011 Vegetation Sample Data from Red Devil Mine Site

	Number of Samples[a]	Minimum Concentration (mg/kg dry weight)	Maximum Concentration (mg/kg dry weight)	Frequency of Detection
Green Alder Bark				
Aluminum	9	3.7	24.2	8/9
Antimony	9	0.165 J	3.35 J	8/9
Arsenic	9	0.06	0.91	7/9
Barium	9	2.35	203	8/9
Beryllium	9	0.005 J	0.015 J	4/9
Cadmium	9	0.014 J	0.129	6/9
Calcium	9	4560	10800	8/9
Chromium	9	0.3 J	1.4 J	3/9
Cobalt	9	0.064	0.528	8/9
Copper	9	4.33	6.64	8/9
Iron	9	17.6	34.9	8/9
Lead	9	0.06	0.113	8/9
Magnesium	9	529	967	8/9
Manganese	9	91.2	1140	8/9
Mercury	9	0.017 J	0.289 J	8/9
Methylmercury	5	0.0037 U	0.004 U	0/5
Nickel	9	0.72	4.15	8/9
Potassium	9	1530	2610	8/9
Selenium	9	0.22 J	0.22 J	1/9
Silver	9	0.016	0.193	2/9
Sodium	9	9.8	17	8/9
Thallium	9	0.006 J	0.03	4/9
Vanadium	9	0.03 J	0.07	8/9
Zinc	9	35.9 J	108 J	8/9
Blueberry Leaves and Stems				
Aluminum	2	59.7	64.6	2/2
Antimony	2	0.096 J	0.131 J	2/2
Arsenic	2	0.08 J	0.15 J	2/2
Barium	2	50.4	68	2/2
Beryllium	2	0.003 U	0.003 J	1/2
Cadmium	2	0.332	1.2	2/2
Calcium	2	2400	2430	2/2
Chromium	2	0.2 U	0.2 J	1/2
Cobalt	2	0.035	0.099	2/2
Copper	2	3.58	5.97	2/2
Iron	2	20.3	25.6	2/2
Lead	2	0.061	0.067	2/2
Magnesium	2	902	1120	2/2
Manganese	2	1430	1630	2/2
Mercury	2	0.023 J	0.034 J	2/2
Methylmercury	2	0.004 U	0.004 U	0/2
Nickel	2	1.89	6.68	2/2
Potassium	2	3930	4340	2/2
Selenium	2	0.15 U	0.15 U	2/2
Silver	2	0.008 U	0.008 U	2/2
Sodium	2	12.2 J	12.9 J	2/2
Thallium	2	0.005 J	0.006 J	2/2
Vanadium	2	0.03 J	0.03 J	2/2
Zinc	2	31.6 J	42.6 J	2/2
Spruce Needles				
Aluminum	9	5.1	172	8/9
Antimony	9	0.20 J	15.1 J	7/9
Arsenic	9	0.11 J	11.1	7/9
Barium	9	4.16	85.3	7/9
Beryllium	9	0.008 J	0.008 J	1/9
Cadmium	9	0.01 J	0.191	7/9

Table 4-4 Summary of 2011 Vegetation Sample Data from Red Devil Mine Site

	Number of Samples[a]	Minimum Concentration (mg/kg dry weight)	Maximum Concentration (mg/kg dry weight)	Frequency of Detection
Calcium	9	3320	9920	8/9
Chromium	9	0.4 J	1.3 J	5/9
Cobalt	9	0.05	0.303	8/9
Copper	9	0.93	4.42	8/9
Iron	9	20.1	206	8/9
Lead	9	0.009	0.466	8/9
Magnesium	9	548	958	8/9
Manganese	9	130	2990	8/9
Mercury	9	0.03	5.64	8/9
Methylmercury	5	0.0037 U	0.004 U	0/5
Nickel	9	0.67	6.35	8/9
Potassium	9	3450	7740	8/9
Selenium	9	0.15 U	0.15 U	0/9
Silver	9	0.016 J	0.114	6/9
Sodium	9	4.1 J	24.8 J	8/9
Thallium	9	0.005 J	0.021 J	2/9
Vanadium	9	0.03 J	0.47	7/9
Zinc	9	13.9	53.2 J	8/9
Pond Vegetation				
Aluminum	5	8.3	94.2	4/5
Antimony	5	4.92 J	97.4 J	4/5
Arsenic	5	32.1	309	4/5
Barium	5	18.2	36.2	4/5
Beryllium	5	0.003 J	0.006 J	4/5
Cadmium	5	0.009 J	0.22	4/5
Calcium	5	13300	15700	4/5
Chromium	5	0.2 J	0.6 J	2/5
Cobalt	5	0.308	0.886	4/5
Copper	5	3.4	9.62	4/5
Iron	5	124	282	4/5
Lead	5	0.32	1.18	4/5
Magnesium	5	6340	13400	4/5
Manganese	5	46.8	199	4/5
Mercury	5	0.78 J	5.28 J	4/5
Methylmercury	5	0.0069 J	0.0069 J	1/1
Nickel	5	1.11	3.21	4/5
Potassium	5	15400	39500	4/5
Selenium	5	0.81	0.81	1/5
Silver	5	0.008 U	0.008 U	0/5
Sodium	5	52.5	377	4/5
Thallium	5	0.017 J	0.083	4/5
Vanadium	5	0.05 J	0.29	4/5
Zinc	5	36 J	55.7 J	4/5

Key:
-- = Not available or not applicable
J = estimated value
U = undetected (reported value is method detection limit)

Notes:
a = Number of original site samples and field duplicates.
Green alder bark: 8 original site samples and 1 field duplicate.
Blueberry leaves and stems: 2 original site samples and 0 field duplicates.
Blueberry fruit: 0 original site samples and 0 field duplicates.
Spruce needles: 8 original site samples and 1 field duplicate.
Pond vegetation: 4 original site samples and 1 field duplicate.

Table 4-5 Summary of 2010 Benthic Macroinvertebrate Composite Sample Data for Red Devil Creek, Red Devil Mine Site SLERA

Analyte	August 2010 Samples[a]				June 2010 Samples[b]			
	Number of Samples	Minimum Detected Concentration (mg/kg wet weight)	Maximum Detected Concentration (mg/kg wet weight)	Frequency of Detection	Number of Samples	Minimum Detected Concentration (mg/kg wet weight)	Maximum Detected Concentration (mg/kg wet weight)	Frequency of Detection
Aluminum	--	--	--	--	3	118.4	**125**	3/3
Antimony	--	--	--	--	3	18.95	**21.44**	3/3
Arsenic	--	--	--	--	3	81.24	**126.44**	3/3
Barium	--	--	--	--	3	4.84	**6.61**	3/3
Beryllium	--	--	--	--	3	ND[c]	ND[c]	0/3
Boron	--	--	--	--	3	0.67 J+	**1.011** J+	3/3
Cadmium	--	--	--	--	3	0.082	**0.166**	3/3
Calcium	--	--	--	--	3	--	--	--
Chromium	--	--	--	--	3	0.327	**0.441**	3/3
Cobalt	--	--	--	--	3	--	--	--
Copper	--	--	--	--	3	6.564	**12.405**	3/3
Iron	--	--	--	--	3	761.3 J-	**974** J-	3/3
Lead	--	--	--	--	3	0.131	**0.154**	3/3
Magnesium	--	--	--	--	3	162	**376**	3/3
Manganese	--	--	--	--	3	27.84	**50.8**	3/3
Mercury	--	--	--	--	3	1.60	**2.38**	3/3
Methylmercury	3	0.0587	**0.131**	3/3	3	0.0238	0.0594	3/3
Molybdenum	--	--	--	--	3	0.1	**0.19**	3/3
Nickel	--	--	--	--	3	0.557	**1.409**	3/3
Potassium	--	--	--	--	3	--	--	--
Selenium	--	--	--	--	3	1.002	**4.046**	3/3
Silver	--	--	--	--	3	--	--	--
Sodium	--	--	--	--	3	--	--	--
Strontium	--	--	--	--	3	1.3 J+	**2.2** J+	3/3
Thallium	--	--	--	--	3	--	--	--
Vanadium	--	--	--	--	3	0.40	**0.47**	3/3
Zinc	--	--	--	--	3	22.6 J-	**44.9** J-	3/3

Source: Matt Varner, BLM Anchorage Field Office, Anchorage, AK.

Key:
-- (double dash) = not analyzed.
BLM = Bureau of Land Management
Bold = maximum detected concentration across both sampling events.
J- = estimated value with low bias.
J+ = estimated value with high bias.
ND = not detected.

Notes:
a = Ephemeroptera, Heptageniidae, *Cinygmula* (mayfly) composite samples with 125 to 176 individuals per sample.
b = Ephemeroptera, Baetidae, *Baetis* (mayfly) composite samples with 270 to 425 individuals per sample.
c = Beryllium method detection limits = 0.025 mg/kg wet weight.

Table 4-6 Summary of 2010 Sculpin Data from Red Devil Creek, Red Devil Mine Site SLERA

Analyte	August 2010 Samples				June 2010 Samples			
	Number of Samples	Minimum Detected Concentration (mg/kg wet weight)	Maximum Detected Concentration (mg/kg wet weight)	Frequency of Detection	Number of Samples	Minimum Detected Concentration (mg/kg wet weight)	Maximum Detected Concentration (mg/kg wet weight)	Frequency of Detection
Aluminum	12	11.7	**72.5**	12/12	9	3.6	20.9	9/9
Antimony	12	6.51	**38.1**	12/12	9	0.40	4.04	9/9
Arsenic	12	6.86	**24.1**	12/12	9	1.10	4.49	9/9
Barium	12	2.83	**5.40**	12/12	9	2.01	4.35	9/9
Beryllium	12	ND[b]	ND[b]	0/12	9	ND[b]	ND[b]	0/9
Boron	12	0.031	0.088	5/12	9	0.142 J+	**0.843** J	9/9
Cadmium	12	0.029	0.056	5/12	9	0.027	**0.103**	6/9
Calcium	--	--	--	--	9	--	--	--
Chromium	12	0.038	0.188	12/12	9	0.028	**2.431**	9/9
Cobalt	--	--	--	--	9	--	--	--
Copper	12	0.72	1.164	12/12	9	0.27 J-	**2.263** J-	9/9
Iron	12	63.7	**184**	12/12	9	18.9 J-	61 J-	9/9
Lead	12	0.027	**0.079**	11/12	9	0.025 J	0.026	2/9
Magnesium	12	280	368	12/12	9	251	**423**	9/9
Manganese	12	6.65	**21.3**	12/12	9	8.44	16.0	9/9
Mercury	12	0.68	**3.70**	12/12	9	0.05	0.63	9/9
Methylmercury	1	0.16	0.16	1/1	1[a]	0.312	**0.312**	1/1
Molybdenum	12	0.028	**0.038**	7/12	9	0.03	0.03	1/9
Nickel	12	0.083	**0.263**	12/12	9	0.039	0.113	9/9
Potassium	--	--	--	--	9	--	--	--
Selenium	12	1.53	**2.98**	12/12	9	0.834	1.43	9/9
Silver	--	--	--	--	9	--	--	--
Sodium	--	--	--	--	9	--	--	--
Strontium	12	10.6	30.0	12/12	9	15.5 J+	**32.8** J+	9/9
Thallium	--	--	--	--	9	--	--	--
Vanadium	12	0.15	0.32	12/12	9	0.10	**0.40**	9/9
Zinc	12	20.6	**35.4**	12/12	9	17.1 J-	30.2 J-	9/9

Source: Matt Varner, BLM Anchorage Field Office, Anchorage, AK.

Key:
-- (double dash) = not analyzed.
BLM = Bureau of Land Management
Bold = maximum detected concentration across both sampling events.
J- = estimated value with low bias.
J+ = estimated value with high bias.
ND = not detected.

Notes:
a = Composite sample. In June 2010, methylmercury was measured only in a composite sample of three sculpin.
b = Beryllium method detection limits = 0.025 mg/kg wet weight.

Table 4-7 Exposure Parameters for Wildlife Receptors, Red Devil Mine Site SLERA

Species	Assumed Diet	Soil or Sediment Ingestion (kg/d) dry	Surface Water Ingestion (L/day)	Food Ingestion Rate (kg/d) wet	Percent Water in Diet	Food Ingestion Rate (kg/d) dry	Body Weight (kg)
Terrestrial Wildlife							
American Robin[a]	100% soil invertebrates	0.00019	0.011	0.093	80%	0.0186	0.077
Masked Shrew[b]	100% soil invertebrates	0.00011	0.0011	--	--	0.0021	0.0064
Spruce Grouse[c]	100% conifer foliage	0.0056	0.038	--	--	0.06	0.53
Tundra Vole[b]	100% herbaceous plants	0.0002	0.0063	--	--	0.0085	0.047
Northern Shrike[d]	100% small mammals	0	0.0095	--	--	0.0139	0.0656
Least Weasel[e]	100% small mammals	0	0.0053	--	--	0.0048	0.039
Aquatic-Dependent Wildlife							
Common Snipe[b, h]	100% benthic invertebrates	0.0016	0.014	0.047	68%	0.015	0.116
Beaver[f]	100% alder bark	0.0037	1.76	--	--	0.186	24.5
Green Winged Teal[b]	100% pond vegetation	0.001	0.027	--	--	0.053	0.32
Belted Kingfisher[g]	100% forage fish	0	0.016	0.075	68%	0.024	0.148
Mink[g]	100% forage fish	0	0.099	0.137	68%	0.044	1

Key:
-- = not applicable
kg = kilogram
kg/d = kilograms per day
L/d = liters per day
SLERA = screening level ecological risk assessment

Notes:
a. Sample and Suter (1994).
b. Exponent (2007).
c. Exponent (2007) for willow ptarmigan.
d. Dunning (1993) for body weight. Food ingestion rate calculated from body weight using allometric relationship for passerine birds from Sample et al. (1996). Soil ingestion typically is negligible for predatory wildlife.
e. EPA (1993a) for body weight. Food ingestion rate calculated from body weight using allometric relationship for placental mammals from Sample et al. (1996). Soil ingestion typically is negligible for predatory wildlife.
f. Body weight from www.Alaskan-Adventures.com (accessed 6-7-11). Food and water ingestion rates calculated from body weight using allometric relationships from Sample et al. (1996). Soil ingestion rate assumed to be 2% of food ingestion rate.
g. Sample and Suter (1994).
h. Food moisture content of 68% based on EPA (1999) for carnivores. Wet food Ingestion rate = dry food ingestion rate / (1- food moisture content).

Table 4-8 Data Used to Estimate Exposure Point Concentrations for Calculating Screening Level Exposure Estimates for Wildlife

	Exposure Point Concentration											
	Maximum Measured Chemical Concentration										Modeled Concentration[a]	
			Sediment									
Receptor	RDC Surface Water	Surface Soil	RDC and KR	Settling Ponds	Spruce Needles[b]	Blueberry Stems and Leaves[b]	Green Alder Bark[b]	Settling Pond Plants[b]	Sculpin[b]	Mayfly[b]	Earthworm	Small Mammal
Terrestrial Wildlife												
American Robin	X	X									X	
Masked Shrew	X	X									X	
Spruce Grouse	X	X			X							
Tundra Vole	X	X				X						
Northern Shrike	X											X
Least Weasel	X											X
Aquatic-Dependent Wildlife												
Common Snipe	X		X							X		
Beaver	X	X					X					
Green Winged Teal				X				X				
Belted Kingfisher	X								X			
Mink	X								X			

Key:
KR = Kuskokwim River
RDC = Red Devil Creek

Notes:
a = Based on maximum surface soil concentration. For chemicals with no available model, the chemical concentration in earthworms and small mammals was set equal to the maximum surface soil chemical concentration.
b = If a chemical was detected in soil or sediment but not analyzed for in biota, the biota chemical concentration was assumed to be equal to the maximum soil or sediment chemical concentration.

Table 4-9 American Robin and Masked Shrew Exposure Point Concentrations, Red Devil Mine Site SLERA

Analyte[a]	Surface Water EPC (µg/L)[b]	Surface Soil EPC[c, d]	Soil-to-Earthworm Bioaccumulation Equation[e]	Earthworm EPC[d]
Polychlorinated Biphenyls (PCBs)				
Sum of Aroclors (NDs = 0.5MDL)	--	0.078	$\ln(C_e) = 1.361 * \ln(C_s) - 1.410$	0.011
Metals				
Antimony	184	23300	$C_e = C_s$	23300
Arsenic	1,030	9880	$\ln(C_e) = 0.706 * \ln(C_s) - 1.421$	160
Barium	103	1710	$C_e = 0.091 * C_s$	156
Beryllium	0.009	1.3	$C_e = 0.045 * C_s$	0.059
Cadmium	0.008	1.3	$\ln(C_e) = 0.795 * \ln(C_s) + 2.114$	10.2
Chromium	0.57	101	$C_e = 0.306 * C_s$	30.9
Cobalt	5.3	38.8	$C_e = 0.122 * C_s$	4.7
Copper	0.71	139	$C_e = 0.5\ 15 * C_s$	71.6
Lead	0.079	3090	$\ln(C_e) = 0.807 * \ln(C_s) - 0.218$	527
Manganese	379	4230	$\ln(C_e) = 0.682 * \ln(C_s) - 0.809$	132
Mercury	0.385	1620	$\ln(C_e) = 0.118 * \ln(C_s) - 0.684$	1.21
Methylmercury	0.00062	--	3 x (blueberry stem/leaf concentration)	0.006
Nickel	19.2	97	$C_e = 1.059 * C_s$	103
Selenium	0.5	0.42	$\ln(C_e) = 0.733 * \ln(C_s) - 0.075$	0.49
Silver	0.026	0.123	$C_e = 2.045 * C_s$	0.25
Thallium	0.01	0.071	$C_e = C_s$	0.071
Vanadium	0.22	51.9	$C_e = 0.042 * C_s$	2.18
Zinc	2.1	386	$\ln(C_e) = 0.328 * \ln(C_s) + 4.449$	603
Polycyclic Aromatic Hydrocarbons (PAHs)				
HPAH sum (NDs = 0.5 MDL)	3.6	109	$C_e = 2.6 * C_s$	282
LPAH sum (NDs = 0.5 MDL)	2.9	417	$C_e = 3.0 * C_s$	1252
Other Semivolatile Organic Compounds (SVOCs)				
4-Bromophenyl Phenyl Ether	0.21	1.9	$C_e = C_s$	1.9
4-Methylphenol	0.26	4.9	$C_e = C_s$	4.9
Benzoic Acid	0.30	120	$C_e = C_s$	120
Benzyl Alcohol	1.0	12	$C_e = C_s$	12
Bis(2-ethylhexyl)phthalate	0.95	220	$C_e = C_s$	220
Dibenzofuran	0.24	10	$C_e = C_s$	10
Diethylphthalate	0.29	140	$C_e = C_s$	140
Dimethylphthalate	0.27	160	$C_e = C_s$	160
Hexachlorobenzene	0.32	1.3	$C_e = C_s$	1.3
Pentachlorophenol	1.25	38	$C_e = C_s$	38
Phenol	0.26	4.6	$C_e = C_s$	4.6

Key:
-- = not analyzed
C_e = chemical concentration in earthworm
C_s = chemical concentration in soil
EPC = Exposure Point Concentration
HPAH = high molecular weight PAH
LPAH = low molecular weight PAH
MDL = method detection limit
mg/kg = milligrams per kilogram
NDs = non detects
PAH = polycyclic aromatic hydrocarbon
PCB = polychlorinated biphenyls
SLERA = screening level ecological risk assessment
SVOC = semivolatile organic compound
µg/kg = micrograms per kilogram
µg/L = micrograms per liter

Notes:

a. Essential nutrients (calcium, iron, magnesium, sodium, and potassium) and major soil constitutes (aluminum) were excluded from the evaluation as per EPA guidance (EPA 1989, 2003). Aroclors, PAHs, and SVOCs detected in surface soil are listed.

b. Maximum surface water concentration from Table 4-3. HPAHs, 4-bromophenyl phenyl ether, 4-methylphenol, benzoic acid, benzyl alcohol, bis(2-ethylhexyl)phthalate, dibenzofuran, diethylphthalate, hexachlorobenzene, pentachlorophenol, and phenol were not detected in surface water. For these chemicals, the surface water EPC is one-half of the MDL in surface water.

c. Maximum surface soil concentration from Table 4-1.

d. mg/kg for metals and µg/kg for PCBs and SVOCs.

e. Soil-to-earthworm bioacumulation equations from EPA (2005a), except for PCBs and nickel, which are from Sample et al. (1998a). For chemicals with no available model, the chemical concentration in earthworms was set equal to the maximum surface soil chemical concentration.

Table 4-10 Spruce Grouse, Tundra Vole, and Beaver Exposure Point Concentrations, Red Devil Mine Site SLERA

Analyte[a]	Surface Water EPC (µg/L)[b]	Surface Soil EPC[c, d]	Spruce Needles[e]	Blueberry Stems and Leaves[e]	Alder Bark[e]
Polychlorinated Biphenyls					
Sum of Aroclors (NDs = 0.5 MDL)	--	0.078	0.078	0.078	0.078
Metals					
Antimony	184	23300	15.1	0.131	3.35
Arsenic	1,030	9880	11.1	0.15	0.91
Barium	103	1710	85.3	68.0	203
Beryllium	0.009	1.3	0.008	0.003	0.015
Cadmium	0.008	1.3	0.19	1.20	0.13
Chromium	0.57	101	1.30	0.20	1.40
Cobalt	5.3	38.8	0.303	0.10	0.53
Copper	0.71	139	4.42	5.97	6.64
Lead	0.079	3090	0.47	0.067	0.113
Manganese	379	4230	2990	1630	1140
Mercury	0.385	1620	5.64	0.034	0.29
Methylmercury	0.00062	--	0.002	0.002	0.002
Nickel	19.2	97	6.35	6.68	4.15
Selenium	0.5	0.42	0.075	0.075	0.22
Silver	0.026	0.123	0.114	0.004	0.193
Thallium	0.01	0.071	0.021	0.006	0.03
Vanadium	0.22	51.9	0.47	0.03	0.07
Zinc	2.1	386	53.2	42.6	108
Polycyclic Aromatic Hydrocarbons (PAHs)					
HPAH sum (NDs = 0.5 MDL)	3.6	109	109	109	109
LPAH sum (NDs = 0.5 MDL)	2.9	417	417	417	417
Other Semivolatile Organic Compounds (SVOCs)					
4-Bromophenyl Phenyl Ether	0.21	1.9	1.9	1.9	1.9
4-Methylphenol	0.26	4.9	4.9	4.9	4.9
Benzoic Acid	0.30	120	120	120	120
Benzyl Alcohol	1.0	12	12	12	12
Bis(2-ethylhexyl)phthalate	0.95	220	220	220	220
Dibenzofuran	0.24	10	10	10	10
Diethylphthalate	0.29	140	140	140	140
Dimethylphthalate	0.27	160	160	160	160
Hexachlorobenzene	0.32	1.3	1.3	1.3	1.3
Pentachlorophenol	1.25	38	38	38	38
Phenol	0.26	4.6	4.6	4.6	4.6

Key:
-- = not available
EPC = Exposure Point Concentration
HPAH = high molecular weight PAH
LPAH = low molecular weigjht PAH
MDL = method detection limit
mg/kg = milligrams per kilogram
NDs = non detects
PAH = polycyclic aromatic hydrocarbon
SLERA = screening level ecological risk assessment
SVOCs = semivolatile organic compounds
µg/kg = micrograms per kilogram
µg/L = micrograms per liter

Notes:
a. Essential nutrients (calcium, iron, magnesium, sodium, and potassium) and major soil constitutes (aluminum) were excluded from the evaluation as per EPA guidance (EPA 1989, 2003). Aroclors, PAHs, and SVOCs detected in surface soil are listed.
b. Maximum surface water concentration from Table 4-3. HPAHs, 4-bromophenyl phenyl ether, 4-methylphenol, benzoic acid, benzyl alcohol, bis(2-ethylhexyl)phthalate, dibenzofuran, diethylphthalate, hexachlorobenzene, pentachlorophenol, and phenol were not detected in surface water. For these chemicals, the surface water EPC is one-half of the MDL in surface water.
c. Maximum surface soil concentration from Table 4-1.
d. mg/kg for metals and µg/kg for PCBs and SVOCs.
e. Maximum detected concentration or one-half maximum detection limit (if not detected in all samples). See Table 4-4 for summary of 2011 vegetation data. Aroclor 1260 and several SVOCs were detected in soil but not analyzed for in vegetation. For these chemicals, the vegetation chemical concentration was assumed to be equal to the maximum soil chemical concentration.

Table 4-11 Green-Winged Teal Exposure Point Concentrations, Red Devil Mine Site SLERA

Analyte[a]	Surface Water EPC (µg/L)[b]	Settling Pond "Sediment" EPC[c, d]	Settling Pond Vegetation EPC	
			Value[d]	Basis
Metals				
Antimony	184	1430	97.4	Maximum measured concentration (Table 4-5).
Arsenic	1,030	9880	309	Maximum measured concentration (Table 4-5).
Barium	103	145	36.2	Maximum measured concentration (Table 4-5).
Beryllium	0.009	0.8	0.006	Maximum measured concentration (Table 4-5).
Cadmium	0.008	0.06	0.22	Maximum measured concentration (Table 4-5).
Chromium	0.57	19	0.6	Maximum measured concentration (Table 4-5).
Cobalt	5.3	18.1	0.886	Maximum measured concentration (Table 4-5).
Copper	0.71	73	9.62	Maximum measured concentration (Table 4-5).
Lead	0.079	198	1.18	Maximum measured concentration (Table 4-5).
Manganese	379	1090	199	Maximum measured concentration (Table 4-5).
Mercury	0.385	127	5.28	Maximum measured concentration (Table 4-5).
Methylmercury	0.00062	--	0.0069	Maximum measured concentration (Table 4-5).
Nickel	19.2	58	3.21	Maximum measured concentration (Table 4-5).
Selenium	0.5	1.75	0.81	Maximum measured concentration (Table 4-5).
Silver	0.026	0.12	0.004	One-half method detection limit (Table 4-5).
Thallium	0.01	0.75	0.083	Maximum measured concentration (Table 4-5).
Vanadium	0.22	25.3	0.29	Maximum measured concentration (Table 4-5).
Zinc	2.1	112	55.7	Maximum measured concentration (Table 4-5).
Semivolatile Organic Compounds (SVOCs)				
Bis(2-ethylhexyl)phthalate	0.5	220	220	Not analyzed in pond vegetation. See note e.

Key:
-- = Not analyzed.
EPC = Exposure point concentration
MDL = method detection limit
mg/kg = milligrams per kilogram
SVOC = Semivolatile organic compound.
SLERA = Screening level ecological risk assessment.
µg/kg = micrograms per kilogram
µg/L = micrograms per kilogram

Notes:

a. Essential nutrients (calcium, iron, magnesium, sodium, and potassium) and major soil/sediment constitutes (aluminum) were excluded from the evaluation as per USEPA guidance (USEPA 1989, 2003). SVOCs detected in pond surface soil are listed.
b. Maximum surface water concentrations for Red Devil Creek from Table 4-3. Surface water was not present in the settling ponds during sampling activities. Water concentration for bis(2-ethylhexyl)phthalate is one-half method detection limit (1 ug/L).
c. Maximum concentration from three original surface soil samples (10MP32SS, 10MP34SS, and 10MP36SS) and one field duplicate surface soil sample (10MP84SS) collected from the settling ponds. Cadmium, selenium, silver and thallium were undetected in pond surface soil so one-half of the MDL was used as the EPC.
d. mg/kg for metals and µg/kg for SVOCs.
e. The concentration in vegetation was assumed to equal the maximum surface soil concentration.

Table 4-12 Northern Shrike and Least Weasel Exposure Point Concentrations, Red Devil Mine Site

Analyte[a]	Surface Water EPC (μg/L)[b]	Surface Soil EPC[c, d]	Soil- or Diet-to-Small Mammal Bioaccumulation Equation[e]	Small Mammal EPC[d]
Polychlorinated Biphenyls (PCBs)				
Sum of Aroclors (NDs = 0.5MDL)	--	0.078	$C_m = C_s$	0.078
Metals				
Antimony	184	23300	$C_m = 0.001 * 50 * C_d$	0.007
Arsenic	1,030	9880	$\ln(C_m) = 0.8188 * \ln(C_s) – 4.8471$	14.7
Barium	103	1710	$C_m = 0.00015 * 50 * C_d$	0.51
Beryllium	0.009	1.3	$C_m = 0.001 * 50 * C_d$	0.0002
Cadmium	0.008	1.3	$\ln(C_m) = 0.4723 * \ln(C_s) – 1.2571$	0.32
Chromium	0.57	101	$\ln(C_m) = 0.7338 * \ln(C_s) – 1.4599$	6.87
Cobalt	5.3	38.8	$\ln(C_m) = 1.307 * \ln(C_s) – 4.4669$	1.37
Copper	0.71	139	$\ln(C_m) = 0.1444 * \ln(C_s) + 2.042$	15.7
Lead	0.079	3090	$\ln(C_m) = 0.4422 * \ln(C_s)+0.0761$	38
Manganese	379	4230	$C_m = 0.0205 * C_s$	86.7
Mercury	0.385	1620	$C_m = 0.25 * 50 * C_d$	0.43
Methylmercury	0.00062	--	3 x (blueberry stem/leaf concentration)	0.006
Nickel	19.2	97	$\ln(C_m) = 0.4658 * \ln(C_s) – 0.2462$	6.6
Selenium	0.5	0.42	$\ln(C_m) = 0.3764 * \ln(C_s) – 0.4158$	0.48
Silver	0.026	0.123	$C_m = 0.004 * C_s$	0.0005
Thallium	0.01	0.071	$C_m = 0.1124 * C_s$	0.008
Vanadium	0.22	51.9	$C_m = 0.0123 * C_s$	0.64
Zinc	2.1	386	$\ln(C_m) = 0.0706 * \ln(C_s) + 4.3632$	120
Polycyclic Aromatic Hydrocarbons (PAHs)				
HPAH sum (NDs = 0.5 MDL)	3.6	109	$C_m = 0$	0
LPAH sum (NDs = 0.5 MDL)	2.9	417	$C_m = 0$	0
Other Semivolatile Organic Compounds (SVOCs)				
4-Bromophenyl Phenyl Ether	0.21	1.9	$C_m = C_s$	1.9
4-Methylphenol	0.26	4.9	$C_m = C_s$	4.9
Benzoic Acid	0.30	120	$C_m = C_s$	120
Benzyl Alcohol	1.0	12	$C_m = C_s$	12
Bis(2-ethylhexyl)phthalate	0.95	220	$C_m = C_s$	220
Dibenzofuran	0.24	10	$C_m = C_s$	10
Diethylphthalate	0.29	140	$C_m = C_s$	140
Dimethylphthalate	0.27	160	$C_m = C_s$	160
Hexachlorobenzene	0.32	1.3	$C_m = C_s$	1.3
Pentachlorophenol	1.25	38	$C_m = C_s$	38
Phenol	0.26	4.6	$C_m = C_s$	4.6

Key:
-- = not analyzed
C_d = chemical concentration in diet (maximum concentration in blueberry stems/leaves)
C_m = chemical concentration in small mammal tissue
C_s = chemical concentration in soil
EPC = Exposure Point Concentration
HPAH = high molecular weight PAH
LPAH = low molecular weight PAH
MDL = method detection limit
mg/kg = milligrams per kilogram
NDs = non detects
PAH = polycyclic aromatic hydrocarbon
PCB = polychlorinated biphenyl
SLERA = screening level ecological risk assessment
SVOC = semivolatile organic compound
μg/kg = micrograms per kilogram
μg/L = micrograms per liter

Notes:

a. Essential nutrients (calcium, iron, magnesium, sodium, and potassium) and major soil constitutes (aluminum) were excluded from the evaluation as per EPA guidance (EPA 1989, 2003). Aroclors and SVOCs detected in surface soil or surface water are listed.

b. Maximum surface water concentration from Table 4-3. HPAHs, benzyl alcohol, diethylphthalate, di-n-butylphthalate, pentachlorophenol, and phenol were not detected in surface water. For these chemicals, the surface water EPC is one-half of the MDL. One-half MDL also used when summing undetected LPAHs.

c. Maximum surface soil concentration from Table 4-1.

d. mg/kg for metals and μg/kg for PCBs and SVOCs.

e. EPA (2005a) except for thallium, which is from Sample et al. (1998b). For chemicals with no available model, the chemical concentration in small mammals was set equal to the maximum surface soil chemical concentration.

Table 4-13 Common Snipe Exposure Point Concentrations, Red Devil Mine Site SLERA

Analyte[a]	Surface Water EPC (µg/L)[b]	Sediment EPC[c, d]	Benthic Macroinvertebrate EPC	
			Value[d]	Basis
Metals				
Antimony	184	6,360	21.44	Maximum measured mayfly concentration (Table 4-5).
Arsenic	1,030	130,000	126.4	Maximum measured mayfly concentration (Table 4-5).
Barium	103	1,990	6.61	Maximum measured mayfly concentration (Table 4-5).
Beryllium	0.009	0.09	0.013	One-half method detection limit (Table 4-5).
Cadmium	0.008	0.663	0.166	Maximum measured mayfly concentration (Table 4-5).
Chromium	0.57	47.4	0.441	Maximum measured mayfly concentration (Table 4-5).
Cobalt	5.3	50	50	Not analyzed in benthic invertebrates. See note e.
Copper	0.71	87.5	12.4	Maximum measured mayfly concentration (Table 4-5).
Lead	0.079	14.8	0.154	Maximum measured mayfly concentration (Table 4-5).
Manganese	379	5,410	50.8	Maximum measured mayfly concentration (Table 4-5).
Mercury	0.385	119	2.38	Maximum measured mayfly concentration (Table 4-5).
Methylmercury	0.00062	0.0144	0.131	Maximum measured mayfly concentration (Table 4-5).
Nickel	19.2	240	1.41	Maximum measured mayfly concentration (Table 4-5).
Selenium	0.5	2.11	4.05	Maximum measured mayfly concentration (Table 4-5).
Silver	0.026	0.41	0.41	Not analyzed in benthic invertebrates. See note e.
Thallium	0.01	0.653	0.653	Not analyzed in benthic invertebrates. See note e.
Vanadium	0.22	48.5	0.47	Maximum measured mayfly concentration (Table 4-5).
Zinc	2.1	132	44.9	Maximum measured mayfly concentration (Table 4-5).
Polycyclic Aromatic Hydrocarbons (PAHs)				
HPAH sum (NDs = 0.5 MDL)	3.6	8.5	8.5	Not analyzed in benthic invertebrates. See note e.
LPAH sum (NDs = 0.5 MDL)	2.9	7.0	7.0	Not analyzed in benthic invertebrates. See note e.
Semivolatile Organic Compounds (SVOCs)				
Benzyl Alcohol	1.00	3.1	3.1	Not analyzed in benthic invertebrates. See note e.
Diethyl Phthalate	0.29	1.7	1.7	Not analyzed in benthic invertebrates. See note e.
Di-n-butyl Phthalate	0.27	9	9	Not analyzed in benthic invertebrates. See note e.
Pentachlorophenol	1.25	22	22	Not analyzed in benthic invertebrates. See note e.
Phenol	0.26	4.1	4.1	Not analyzed in benthic invertebrates. See note e.

Key:
EPC = Exposure Point Concentration
HPAH = high molecular weight PAH
LPAH = low molecular weigjht PAH
MDL = method detection limit
mg/kg = milligrams per kilogram
SLERA = screening levels ecological risk assessment
SVOC = Semivolatile organic compound.
µg/kg = micrograms per kilogram
µg/L = micrograms per kilogram

Notes:

a. Essential nutrients (calcium, iron, magnesium, sodium, and potassium) and major soil/sediment constitutes (aluminum) were excluded from the evaluation as per EPA guidance (EPA 1989, 2003). SVOCs that were detected in sediment or surface water are listed.

b. Maximum concentration from Table 4-3. HPAHs, benzyl alcohol, diethylphthalate, di-n-butylphthalate, pentachlorophenol, and phenol were not detected in surface water. For these chemicals, the surface water EPC is one-half of the method detection limit. One-half method detection limit also used for undetected LPAHs.

c. Maximum concentration from Table 4-2.

d. mg/kg for metals and µg/kg for PAHs and SVOCs.

e. Chemical concentration in benthic macroinvertebrate assumed equal to maximum chemical concentration in sediment.

Table 4-14 Belted Kingfisher and Mink Exposure Point Concentrations, Red Devil Mine Site SLERA

Analyte[a]	Surface Water EPC (µg/L)[b]	Sediment EPC[c, d]	Slimy Sculpin EPC	
			Value[d]	Basis
Metals				
Antimony	184	6,360	38.1	Maximum measured sculpin concentration (Table 4-6).
Arsenic	1,030	130,000	24.1	Maximum measured sculpin concentration (Table 4-6).
Barium	103	1,990	5.4	Maximum measured sculpin concentration (Table 4-6).
Beryllium	0.009	0.09	0.0125	One-half method detection limit (Table 4-6).
Cadmium	0.008	0.663	0.103	Maximum measured sculpin concentration (Table 4-6).
Chromium	0.57	47.4	2.431	Maximum measured sculpin concentration (Table 4-6).
Cobalt	5.3	50	50	Not analyzed in sculpin. See note e.
Copper	0.71	87.5	2.263	Maximum measured sculpin concentration (Table 4-6).
Lead	0.079	14.8	0.079	Maximum measured sculpin concentration (Table 4-6).
Manganese	379	5,410	21.3	Maximum measured sculpin concentration (Table 4-6).
Mercury	0.385	119	3.7	Maximum measured sculpin concentration (Table 4-6).
Methylmercury	0.00062	0.0144	0.312	Maximum measured sculpin concentration (Table 4-6).
Nickel	19.2	240	0.263	Maximum measured sculpin concentration (Table 4-6).
Selenium	0.5	2.11	2.98	Maximum measured sculpin concentration (Table 4-6).
Silver	0.026	0.41	0.41	Not analyzed in sculpin. See note e.
Thallium	0.01	0.653	0.635	Not analyzed in sculpin. See note e.
Vanadium	0.22	48.5	0.4	Maximum measured sculpin concentration (Table 4-6).
Zinc	2.1	132	35.4	Maximum measured sculpin concentration (Table 4-6).
Polycyclic Aromatic Hydrocarbons (PAHs)				
HPAH sum (NDs = 0.5 MDL)	3.6	8.5	8.5	Not analyzed in sculpin. See note e.
LPAH sum (NDs = 0.5 MDL)	2.9	7.0	7.0	Not analyzed in sculpin. See note e.
Semivolatile Organic Compounds (SVOCs)				
Benzyl Alcohol	1.00	3.1	3.1	Not analyzed in sculpin. See note e.
Diethyl Phthalate	0.29	1.7	1.7	Not analyzed in sculpin. See note e.
Di-n-butyl Phthalate	0.27	9	9	Not analyzed in sculpin. See note e.
Pentachlorophenol	1.25	22	22	Not analyzed in sculpin. See note e.
Phenol	0.26	4.1	4.1	Not analyzed in sculpin. See note e.

Key:
EPC = Exposure Point Concentration
HPAH = high molecular weight PAH
LPAH = low molecular weight PAH
MDL = method detection limit
mg/kg = milligrams per kilogram
SLERA = screening levels ecological risk assessment
SVOC = Semivolatile organic compound.
µg/kg = micrograms per kilogram
µg/L = micrograms per kilogram

Notes:
a. Essential nutrients (calcium, iron, magnesium, sodium, and potassium) and major sediment constitutes (aluminum) were excluded from the evaluation as per EPA guidance (EPA 1989, 2003). PAHs and SVOCs detected in sediment are listed.
b. Maximum concentrations from Table 4-3. HPAHs, benzyl alcohol, diethylphthalate, di-n-butylphthalate, pentachlorophenol, and phenol were not detected in surface water. For these chemicals, the surface water EPC is one-half of the method detection limit. One-half method detection limit also used for undetected LPAHs.
c. Maximum concentrations from Table 4-2.
d. mg/kg for metals and µg/kg for PAHs and SVOCs.
e. Sculpin chemical concentration assumed equal to maximum concentration in sediment.

Table 4-15 American Robin Screening-Level Exposure Estimates and Hazard Quotients, Red Devil Mine Site SLERA

Analyte[a]	EE-soil (mg/kg/d)	EE-water (mg/kg/d)	EE-diet (mg/kg/d)	EE-total (mg/kg/d)	NOAEL (mg/kg/d)	HQ-NOAEL
Polychlorinated Biphenyls (PCBs)						
Sum of Aroclors (NDs = 0.5MDL)	1.9E-07	--	2.5E-06	2.7E-06	0.18	1.5E-05
Metals						
Antimony	5.7E+01	2.6E-02	5.6E+03	5.7E+03	--	--
Arsenic	2.4E+01	1.5E-01	3.9E+01	6.3E+01	2.24	28
Barium	4.2E+00	1.5E-02	3.8E+01	4.2E+01	20.8	2.0
Beryllium	3.2E-03	1.3E-06	1.4E-02	1.7E-02	--	--
Cadmium	3.2E-03	1.1E-06	2.5E+00	2.5E+00	1.47	1.7
Chromium	2.5E-01	8.1E-05	7.5E+00	7.7E+00	2.66	2.9
Cobalt	9.6E-02	7.6E-04	1.1E+00	1.2E+00	7.61	0.16
Copper	3.4E-01	1.0E-04	1.7E+01	1.8E+01	4.05	4.4
Lead	7.6E+00	1.1E-05	1.3E+02	1.3E+02	1.63	83
Manganese	1.0E+01	5.4E-02	3.2E+01	4.2E+01	179	0.24
Mercury	4.0E+00	5.5E-05	2.9E-01	4.3E+00	0.45	9.5
Methylmercury	--	8.9E-08	1.4E-03	1.4E-03	0.068	0.02
Nickel	2.4E-01	2.7E-03	2.5E+01	2.5E+01	6.71	3.7
Selenium	1.0E-03	7.1E-05	1.2E-01	1.2E-01	0.291	0.41
Silver	3.0E-04	3.7E-06	6.1E-02	6.1E-02	2.02	0.03
Thallium	1.8E-04	1.4E-06	1.7E-02	1.7E-02	--	--
Vanadium	1.3E-01	3.1E-05	5.3E-01	6.5E-01	0.344	1.9
Zinc	9.5E-01	3.0E-04	1.5E+02	1.5E+02	66.1	2.2
Polycyclic Aromatic Hydrocarbons (PAHs)						
HPAH sum (NDs = 0.5 MDL)	2.7E-04	5.1E-04	6.8E-02	6.9E-02	2	0.034
LPAH sum (NDs = 0.5 MDL)	1.0E-03	4.1E-04	3.0E-01	3.0E-01	--	--
Other Semivolatile Organic Compounds (SVOCs)						
4-Bromophenyl phenyl ether	4.7E-06	3.0E-05	4.6E-04	4.9E-04	--	--
4-Methylphenol	1.2E-05	3.7E-05	1.2E-03	1.2E-03	--	--
Benzoic acid	3.0E-04	4.2E-05	2.9E-02	2.9E-02	--	--
Benzyl alcohol	3.0E-05	1.4E-04	2.9E-03	3.1E-03	--	--
Bis(2-ethylhexyl)phthalate	5.4E-04	1.4E-04	5.3E-02	5.4E-02	1.11	0.05
Dibenzofuran	2.5E-05	3.4E-05	2.4E-03	2.5E-03	--	--
Diethylphthalate	3.5E-04	4.1E-05	3.4E-02	3.4E-02	--	--
Dimethylphthalate	3.9E-04	3.8E-05	3.9E-02	3.9E-02	--	--
Hexachlorobenzene	3.2E-06	4.5E-05	3.1E-04	3.6E-04	0.56	0.0006
Pentachlorophenol	9.4E-05	1.8E-04	9.2E-03	9.5E-03	6.73	0.001
Phenol	1.1E-05	3.7E-05	1.1E-03	1.2E-03	6	0.0002

Key:
-- = not available
EE-diet = estimated chemical exposure from diet
EE-soil = estimated chemical exposure from incidental soil ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
EPC = exposure point concentration
HPAH = high molecular weight PAH
HQ = hazard quotient
LOAEL = lowest observed adverse effect level
LPAH = low molecular weight PAH
mg/kg/day = milligrams per kilogram per day
MDL = method detection limit
NDs = non detects
NOAEL = no observed adverse effect level
SLERA = screening level ecological risk assessment
SVOC = semivolatile organic compound
Grey shading = HQ > 1

Note:

a = Essential nutrients (calcium, iron, magnesium, sodium, and potassium) and major soil constitutes (aluminum) were excluded from the evaluation as per EPA guidance (EPA 1989, 2003). Aroclors, PAHs, and SVOCs detected in surface soil are listed.

Table 4-16 Masked Shrew Screening-Level Exposure Estimates and Hazard Quotients, Red Devil Mine Site SLERA

Analyte[a]	EE-soil (mg/kg/d)	EE-water (mg/kg/d)	EE-diet (mg/kg/d)	EE-total (mg/kg/d)	NOAEL (mg/kg/d)	HQ-NOAEL
Polychlorinated Biphenyls						
Sum of Aroclors (NDs = 0.5MDL)	1.3E-06	--	3.4E-06	4.8E-06	0.14	3.4E-05
Metals						
Antimony	4.0E+02	3.2E-02	7.6E+03	8.0E+03	0.059	136370
Arsenic	1.7E+02	1.8E-01	5.2E+01	2.2E+02	1.04	214
Barium	2.9E+01	1.8E-02	5.1E+01	8.0E+01	51.8	1.6
Beryllium	2.2E-02	1.5E-06	1.9E-02	4.2E-02	0.532	0.08
Cadmium	2.2E-02	1.4E-06	3.3E+00	3.4E+00	0.77	4.4
Chromium	1.7E+00	9.8E-05	1.0E+01	1.2E+01	9.24	1.29
Cobalt	6.7E-01	9.1E-04	1.6E+00	2.2E+00	7.33	0.30
Copper	2.4E+00	1.2E-04	2.3E+01	2.6E+01	5.6	4.6
Lead	5.3E+01	1.4E-05	1.7E+02	2.3E+02	4.7	48
Manganese	7.3E+01	6.5E-02	4.3E+01	1.2E+02	51.5	2.3
Mercury	2.8E+01	6.6E-05	4.8E-03	2.8E+01	13.2	2.1
Methylmercury	--	1.1E-07	2.0E-03	2.0E-03	0.032	0.06
Nickel	1.7E+00	3.3E-03	3.4E+01	3.5E+01	1.7	21
Selenium	7.2E-03	8.6E-05	1.6E-01	1.7E-01	0.143	1.2
Silver	2.1E-03	4.5E-06	8.3E-02	8.5E-02	6.02	0.014
Thallium	1.2E-03	1.7E-06	2.3E-02	2.5E-02	0.0074	3.3
Vanadium	8.9E-01	3.8E-05	7.2E-01	1.6E+00	4.16	0.39
Zinc	6.6E+00	3.6E-04	2.0E+02	2.0E+02	75.4	2.7
Polycyclic Aromatic Hydrocarbons						
HPAH sum (NDs = 0.5 MDL)	1.9E-03	6.1E-04	9.3E-02	9.5E-02	0.615	0.15
LPAH sum (NDs = 0.5 MDL)	7.2E-03	4.9E-04	4.1E-01	4.2E-01	65.6	0.006
Other Semivolatile Organic Compounds (SVOCs)						
4-Bromophenyl phenyl ether	3.3E-05	3.6E-05	6.2E-04	6.9E-04	--	--
4-Methylphenol	8.4E-05	4.5E-05	1.6E-03	1.7E-03	219	7.9E-06
Benzoic acid	2.1E-03	5.1E-05	3.9E-02	4.1E-02	--	--
Benzyl alcohol	2.1E-04	1.7E-04	3.9E-03	4.3E-03	--	--
Bis(2-Ethylhexyl)phthalate	3.8E-03	1.6E-04	7.2E-02	7.6E-02	18.33	0.004
Dibenzofuran	1.7E-04	4.1E-05	3.3E-03	3.5E-03	--	--
Diethylphthalate	2.4E-03	5.0E-05	4.6E-02	4.8E-02	4583	1.1E-05
Dimethylphthalate	2.8E-03	4.6E-05	5.3E-02	5.5E-02	--	--
Hexachlorobenzene	2.2E-05	5.4E-05	4.3E-04	5.0E-04	0.014	0.036
Pentachlorophenol	6.5E-04	2.1E-04	1.2E-02	1.3E-02	8.42	0.002
Phenol	7.9E-05	4.5E-05	1.5E-03	1.6E-03	523	3.1E-06

Key:
-- = not available
EE-diet = estimated chemical exposure from diet
EE-soil = estimated chemical exposure from incidental soil ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
EPC = exposure point concentration
HPAH = high molecular weight PAH
HQ = hazard quotient
LPAH = low molecular weight PAH
mg/kg/day = milligrams per kilogram per day
MDL = method detection limit
NDs = non detects
NOAEL = no observed adverse effect level
SLERA = screening level ecological risk assessment
SVOC = semivolatile organic compound
Grey shading = HQ > 1

Note:
a. Essential nutrients (calcium, iron, magnesium, sodium, and potassium) and major soil constitutes (aluminum) were excluded from the evaluation as per EPA guidance (EPA 1989, 2003). Aroclors, PAHs, and SVOCs detected in surface soil are listed.

Table 4-17 Spruce Grouse Screening-Level Exposure Estimates and Hazard Quotients, Red Devil Mine Site SLERA

Analyte[a]	EE-soil (mg/kg/d)	EE-water (mg/kg/d)	EE-diet (mg/kg/d)	EE-total (mg/kg/d)	NOAEL (mg/kg/d)	HQ-NOAEL
Polychlorinated Biphenyls (PCBs)						
Sum of Aroclors (NDs = 0.5MDL)	8.2E-07	--	8.8E-06	9.7E-06	0.18	5.4E-05
Metals						
Antimony	2.5E+02	1.3E-02	1.7E+00	2.5E+02	--	--
Arsenic	1.0E+02	7.4E-02	1.3E+00	1.1E+02	2.24	47
Barium	1.8E+01	7.4E-03	9.7E+00	2.8E+01	20.8	1.3
Beryllium	1.4E-02	6.5E-07	9.1E-04	1.5E-02	--	--
Cadmium	1.4E-02	5.7E-07	2.2E-02	3.5E-02	1.47	0.0
Chromium	1.1E+00	4.1E-05	1.5E-01	1.2E+00	2.66	0.46
Cobalt	4.1E-01	3.8E-04	3.4E-02	4.4E-01	7.61	0.058
Copper	1.5E+00	5.1E-05	5.0E-01	2.0E+00	4.05	0.49
Lead	3.3E+01	5.7E-06	5.3E-02	3.3E+01	1.63	20
Manganese	4.5E+01	2.7E-02	3.4E+02	3.8E+02	179	2.1
Mercury	1.7E+01	2.8E-05	6.4E-01	1.8E+01	0.45	39
Methylmercury	--	4.4E-08	2.3E-04	2.3E-04	0.068	0.003
Nickel	1.0E+00	1.4E-03	7.2E-01	1.7E+00	6.71	0.26
Selenium	4.4E-03	3.6E-05	8.5E-03	1.3E-02	0.291	0.04
Silver	1.3E-03	1.9E-06	1.3E-02	1.4E-02	2.02	0.007
Thallium	7.5E-04	7.2E-07	2.4E-03	3.1E-03	NA	NA
Vanadium	5.5E-01	1.6E-05	5.3E-02	6.0E-01	0.344	1.7
Zinc	4.1E+00	1.5E-04	6.0E+00	1.0E+01	66.1	0.15
Polycyclic Aromatic Hydrocarbons (PAHs)						
HPAH sum (NDs = 0.5 MDL)	0.001	2.6E-04	1.2E-02	1.4E-02	2	0.007
LPAH sum (NDs = 0.5 MDL)	0.004	2.1E-04	4.7E-02	5.2E-02	--	--
Other Semivolatile Organic Compounds (SVOCs)						
4-Bromophenyl phenyl ether	2.0E-05	1.5E-05	2.2E-04	2.5E-04	--	--
4-Methylphenol	5.2E-05	1.9E-05	5.5E-04	6.3E-04	--	--
Benzoic acid	1.3E-03	2.1E-05	1.4E-02	1.5E-02	--	--
Benzyl alcohol	1.3E-04	7.2E-05	1.4E-03	1.6E-03	--	--
Bis(2-Ethylhexyl)phthalate	2.3E-03	6.8E-05	2.5E-02	2.7E-02	1.11	0.02
Dibenzofuran	1.1E-04	1.7E-05	1.1E-03	1.3E-03	--	--
Diethylphthalate	1.5E-03	2.1E-05	1.6E-02	1.7E-02	--	--
Dimethylphthalate	1.7E-03	1.9E-05	1.8E-02	2.0E-02	--	--
Hexachlorobenzene	1.4E-05	2.3E-05	1.5E-04	1.8E-04	0.56	0.0003
Pentachlorophenol	4.0E-04	9.0E-05	4.3E-03	4.8E-03	6.73	0.001
Phenol	4.9E-05	1.9E-05	5.2E-04	5.9E-04	6	0.0001

Key:
-- = not available
EE-diet = estimated chemical exposure from diet
EE-soil = estimated chemical exposure from incidental soil ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
EPC = exposure point concentration
HPAH = high molecular weight PAH
HQ = hazard quotient
LOAEL = lowest observed adverse effect level
LPAH = low molecular weight PAH
MDL = method detection limit
mg/kg/day = milligrams per kilogram per day
NDs = non detects
NOAEL = no observed adverse effect level
SLERA = screening level ecological risk assessment
SVOC = semivolatile organic compound
Grey shading = HQ > 1

Note:

a. Essential nutrients (calcium, iron, magnesium, sodium, and potassium) and major soil constitutes (aluminum) were excluded from the evaluation as per EPA guidance (EPA 1989, 2003). Aroclors, PAHs, and SVOCs detected in surface soil are listed.

Table 4-18 Tundra Vole Screening-Level Exposure Estimates and Hazard Quotients, Red Devil Mine Site SLERA

Analyte[a]	EE-soil (mg/kg/d)	EE-water (mg/kg/d)	EE-diet (mg/kg/d)	EE-total (mg/kg/d)	NOAEL (mg/kg/d)	HQ-NOAEL
Polychlorinated Biphenyls (PCBs)						
Sum of Aroclors (NDs = 0.5MDL)	3.3E-07	--	1.4E-05	1.4E-05	0.14	1.0E-04
Metals						
Antimony	9.9E+01	2.5E-02	2.4E-02	9.9E+01	0.059	1681
Arsenic	4.2E+01	1.4E-01	2.7E-02	4.2E+01	1.04	41
Barium	7.3E+00	1.4E-02	1.2E+01	2.0E+01	51.8	0.38
Beryllium	5.5E-03	1.2E-06	5.4E-04	6.1E-03	0.532	0.01
Cadmium	5.5E-03	1.1E-06	2.2E-01	2.2E-01	0.77	0.29
Chromium	4.3E-01	7.6E-05	3.6E-02	4.7E-01	9.24	0.05
Cobalt	1.7E-01	7.1E-04	1.8E-02	1.8E-01	7.33	0.025
Copper	5.9E-01	9.5E-05	1.1E+00	1.7E+00	5.6	0.3
Lead	1.3E+01	1.1E-05	1.2E-02	1.3E+01	4.7	2.8
Manganese	1.8E+01	5.1E-02	2.9E+02	3.1E+02	51.5	6.1
Mercury	6.9E+00	5.2E-05	6.1E-03	6.9E+00	13.2	0.52
Methylmercury	--	8.3E-08	3.6E-04	3.6E-04	0.032	0.011
Nickel	4.1E-01	2.6E-03	1.2E+00	1.6E+00	1.7	0.95
Selenium	1.8E-03	6.7E-05	1.4E-02	1.5E-02	0.143	0.11
Silver	5.2E-04	3.5E-06	7.2E-04	1.3E-03	6.02	0.00
Thallium	3.0E-04	1.3E-06	1.1E-03	1.4E-03	0.0074	0.19
Vanadium	2.2E-01	2.9E-05	5.4E-03	2.3E-01	4.16	0.05
Zinc	1.6E+00	2.8E-04	7.7E+00	9.3E+00	75.4	0.12
Polycyclic Aromatic Hydrocarbons (PAHs)						
HPAH sum (NDs = 0.5 MDL)	4.6E-04	4.8E-04	2.0E-02	2.1E-02	0.615	0.03
LPAH sum (NDs = 0.5 MDL)	1.8E-03	3.8E-04	7.5E-02	7.8E-02	65.6	0.001
Other Semivolatile Organic Compounds (SVOCs)						
4-Bromophenyl phenyl ether	8.1E-06	2.8E-05	3.4E-04	3.8E-04	--	--
4-Methylphenol	2.1E-05	3.5E-05	8.9E-04	9.4E-04	219	4.3E-06
Benzoic acid	5.1E-04	4.0E-05	2.2E-02	2.2E-02	--	--
Benzyl alcohol	5.1E-05	1.3E-04	2.2E-03	2.4E-03	--	--
Bis(2-Ethylhexyl)phthalate	9.4E-04	1.3E-04	4.0E-02	4.1E-02	18.33	0.002
Dibenzofuran	4.3E-05	3.2E-05	1.8E-03	1.9E-03	--	--
Diethylphthalate	6.0E-04	3.9E-05	2.5E-02	2.6E-02	4583	5.7E-06
Dimethylphthalate	6.8E-04	3.6E-05	2.9E-02	3.0E-02	--	--
Hexachlorobenzene	5.5E-06	4.2E-05	2.4E-04	2.8E-04	0.014	0.020
Pentachlorophenol	1.6E-04	1.7E-04	6.9E-03	7.2E-03	8.42	0.001
Phenol	2.0E-05	3.5E-05	8.3E-04	8.9E-04	523	1.7E-06

Key:
-- = not available
EE-diet = estimated chemical exposure from diet
EE-soil = estimated chemical exposure from incidental soil ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
EPC = exposure point concentration
HPAH = high molecular weight PAH
HQ = hazard quotient
LOAEL = lowest observed adverse effect level
LPAH = low molecular weight PAH
mg/kg/day = milligrams per kilogram per day
MDL = method detection limit
NDs = non detects
NOAEL = no observed adverse effect level
SLERA = screening level ecological risk assessment
SVOC = semivolatile organic compound
Grey shading = HQ > 1

Note:

a. Essential nutrients (calcium, iron, magnesium, sodium, and potassium) and major soil constitutes (aluminum) were excluded from the evaluation as per EPA guidance (EPA 1989, 2003). Aroclors, PAHs, and SVOCs detected in surface soil are listed.

Table 4-19 Northern Shrike Screening-Level Exposure Estimates and Hazard Quotients, Red Devil Mine Site SLERA

Analyte[a]	EE-soil (mg/kg/d)	EE-water (mg/kg/d)	EE-diet (mg/kg/d)	EE-total (mg/kg/d)	NOAEL (mg/kg/d)	HQ-NOAEL
Polychlorinated Biphenyls (PCBs)						
Sum of Aroclors (NDs = 0.5MDL)	0.0E+00	--	1.7E-05	1.7E-05	0.18	9.2E-05
Metals						
Antimony	0.0E+00	2.7E-02	1.4E-03	2.8E-02	--	--
Arsenic	0.0E+00	1.5E-01	3.1E+00	3.3E+00	2.24	1.45
Barium	0.0E+00	1.5E-02	1.1E-01	1.2E-01	20.8	0.01
Beryllium	0.0E+00	1.3E-06	3.2E-05	3.3E-05	--	--
Cadmium	0.0E+00	1.2E-06	6.8E-02	6.8E-02	1.47	0.05
Chromium	0.0E+00	8.3E-05	1.5E+00	1.5E+00	2.66	0.5
Cobalt	0.0E+00	7.7E-04	2.9E-01	2.9E-01	7.61	0.038
Copper	0.0E+00	1.0E-04	3.3E+00	3.3E+00	4.05	0.8
Lead	0.0E+00	1.1E-05	8.0E+00	8.0E+00	1.63	4.9
Manganese	0.0E+00	5.5E-02	1.8E+01	1.8E+01	179	0.10
Mercury	0.0E+00	5.6E-05	9.0E-02	9.0E-02	0.45	0.20
Methylmercury	--	9.0E-08	1.3E-03	1.3E-03	0.068	0.02
Nickel	0.0E+00	2.8E-03	1.4E+00	1.4E+00	6.71	0.21
Selenium	0.0E+00	7.2E-05	1.0E-01	1.0E-01	0.291	0.35
Silver	0.0E+00	3.8E-06	1.0E-04	1.1E-04	2.02	0.0001
Thallium	0.0E+00	1.4E-06	1.7E-03	1.7E-03	--	--
Vanadium	0.0E+00	3.2E-05	1.4E-01	1.4E-01	0.344	0.39
Zinc	0.0E+00	3.0E-04	2.5E+01	2.5E+01	66.1	0.38
Polycyclic Aromatic Hydrocarbons (PAHs)						
HPAH sum (NDs = 0.5 MDL)	0.0E+00	5.2E-04	0.0E+00	5.2E-04	2	0.0003
LPAH sum (NDs = 0.5 MDL)	0.0E+00	4.2E-04	0.0E+00	4.2E-04	--	--
Other Semivolatile Organic Compounds (SVOCs)						
4-Bromophenyl phenyl ether	0.0E+00	3.0E-05	4.0E-04	4.3E-04	--	--
4-Methylphenol	0.0E+00	3.8E-05	1.0E-03	1.1E-03	--	--
Benzoic acid	0.0E+00	4.3E-05	2.5E-02	2.5E-02	--	--
Benzyl alcohol	0.0E+00	1.4E-04	2.5E-03	2.7E-03	--	--
Bis(2-Ethylhexyl)phthalate	0.0E+00	1.4E-04	4.7E-02	4.7E-02	1.11	0.04
Dibenzofuran	0.0E+00	3.5E-05	2.1E-03	2.2E-03	--	--
Diethylphthalate	0.0E+00	4.2E-05	3.0E-02	3.0E-02	--	--
Dimethylphthalate	0.0E+00	3.8E-05	3.4E-02	3.4E-02	--	--
Hexachlorobenzene	0.0E+00	4.6E-05	2.8E-04	3.2E-04	0.56	0.0006
Pentachlorophenol	0.0E+00	1.8E-04	8.1E-03	8.2E-03	6.73	0.001
Phenol	0.0E+00	3.8E-05	9.7E-04	1.0E-03	6	0.0002

Key:
-- = not available.
EE-diet = estimated chemical exposure from diet
EE-soil = estimated chemical exposure from incidental soil ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
EPC = exposure point concentration
HPAH = high molecular weight PAH
HQ = hazard quotient
LPAH = low molecular weight PAH
mg/kg/day = milligrams per kilogram per day
MDL = method detection limit
NOAEL = no observed adverse effect level
mg/kg = Milligrams per kilogram
mg/kg/day = Milligrams per kilogram per day
SLERA = screening level ecological risk assessment
Grey shading = HQ > 1

Note:

a = Essential nutrients (calcium, iron, magnesium, sodium, and potassium) and major soil constitutes (aluminum) were excluded from the evaluation as per EPA guidance (EPA 1989, 2003). Aroclors, PAHs, and SVOCs detected in surface soil are listed.

Table 4-20 Least Weasel Screening-Level Exposure Estimates and Hazard Quotients, Red Devil Mine Site SLERA

Analyte[a]	EE-soil (mg/kg/d)	EE water (mg/kg/d)	EE-diet (mg/kg/d)	EE-total (mg/kg/d)	NOAEL (mg/kg/d)	HQ-NOAEL
Polychlorinated Biphenyls						
Sum of Aroclors (NDs = 0.5MDL)	0.0E+00	--	9.6E-06	9.6E-06	0.14	6.9E-05
Metals						
Antimony	0.0E+00	2.5E-02	8.1E-04	2.6E-02	0.059	0.44
Arsenic	0.0E+00	1.4E-01	1.8E+00	1.9E+00	1.04	1.9
Barium	0.0E+00	1.4E-02	6.3E-02	7.7E-02	51.8	0.0015
Beryllium	0.0E+00	1.2E-06	1.8E-05	2.0E-05	0.532	3.7E-05
Cadmium	0.0E+00	1.1E-06	4.0E-02	4.0E-02	0.77	0.051
Chromium	0.0E+00	7.7E-05	8.5E-01	8.5E-01	9.24	0.091
Cobalt	0.0E+00	7.2E-04	1.7E-01	1.7E-01	7.33	0.023
Copper	0.0E+00	9.6E-05	1.9E+00	1.9E+00	5.6	0.3
Lead	0.0E+00	1.1E-05	4.6E+00	4.6E+00	4.7	1.0
Manganese	0.0E+00	5.2E-02	1.1E+01	1.1E+01	51.5	0.21
Mercury	0.0E+00	5.2E-05	5.2E-02	5.2E-02	13.2	0.004
Methylmercury	--	8.4E-08	7.4E-04	7.4E-04	0.032	0.02
Nickel	0.0E+00	2.6E-03	8.1E-01	8.1E-01	1.7	0.5
Selenium	0.0E+00	6.8E-05	5.9E-02	5.9E-02	0.143	0.41
Silver	0.0E+00	3.5E-06	6.1E-05	6.4E-05	6.02	1.1E-05
Thallium	0.0E+00	1.4E-06	9.8E-04	9.8E-04	0.0074	0.13
Vanadium	0.0E+00	3.0E-05	7.9E-02	7.9E-02	4.16	0.02
Zinc	0.0E+00	2.9E-04	1.5E+01	1.5E+01	75.4	0.20
Polycyclic Aromatic Hydrocarbons						
HPAH sum (NDs = 0.5 MDL)	0.0E+00	4.9E-04	0.0E+00	4.9E-04	0.615	0.0008
LPAH sum (NDs = 0.5 MDL)	0.0E+00	3.9E-04	0.0E+00	3.9E-04	65.6	5.9E-06
Other Semivolatile Organic Compounds (SVOCs)						
4-Bromophenyl phenyl ether	0.0E+00	2.9E-05	2.3E-04	2.6E-04	--	--
4-Methylphenol	0.0E+00	3.5E-05	6.0E-04	6.4E-04	219	2.9E-06
Benzoic acid	0.0E+00	4.0E-05	1.5E-02	1.5E-02	--	--
Benzyl alcohol	0.0E+00	1.4E-04	1.5E-03	1.6E-03	--	--
Bis(2-Ethylhexyl)phthalate	0.0E+00	1.3E-04	2.7E-02	2.7E-02	18.33	0.001
Dibenzofuran	0.0E+00	3.3E-05	1.2E-03	1.3E-03	--	--
Diethylphthalate	0.0E+00	3.9E-05	1.7E-02	1.7E-02	4583	3.8E-06
Dimethylphthalate	0.0E+00	3.6E-05	2.0E-02	2.0E-02	--	--
Hexachlorobenzene	0.0E+00	4.3E-05	1.6E-04	2.0E-04	0.014	0.014
Pentachlorophenol	0.0E+00	1.7E-04	4.7E-03	4.8E-03	8.42	0.001
Phenol	0.0E+00	3.5E-05	5.7E-04	6.0E-04	523	1.2E-06

Key:
-- = not available
EE-diet = estimated chemical exposure from diet
EE-soil = estimated chemical exposure from incidental soil ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
EPC = exposure point concentration
HPAH = high molecular weight PAH
HQ = hazard quotient
LOAEL = lowest observed adverse effect level
LPAH = low molecular weight PAH
mg/kg/day = milligrams per kilogram per day
MDL = method detection limit
NDs = not detects
NOAEL = no observed adverse effect level
SLERA = screening level ecological risk assessment
Grey shading = HQ > 1

Note:
a. Essential nutrients (calcium, iron, magnesium, sodium, and potassium) and major soil constitutes (aluminum) were excluded from the evaluation as per EPA guidance (EPA 1989, 2003). Aroclors and SVOCs detected in surface soil or surface water are listed.

Table 4-21 Common Snipe Screening-Level Exposure Estimates and Hazard Quotients, Red Devil Mine Site SLERA

Analyte[a]	EE-sediment (mg/kg/d)	EE-water (mg/kg/d)	EE-diet (mg/kg/d)	EE-total (mg/kg/d)	NOAEL (mg/kg/d)	HQ-NOAEL
Metals						
Antimony	8.8E+01	2.2E-02	8.7E+00	9.6E+01	--	--
Arsenic	1.8E+03	1.2E-01	5.1E+01	1.8E+03	2.24	823
Barium	2.7E+01	1.2E-02	2.7E+00	3.0E+01	20.8	1.4
Beryllium	1.2E-03	1.1E-06	5.1E-03	6.3E-03	--	--
Cadmium	9.1E-03	9.7E-07	6.7E-02	7.6E-02	1.47	0.05
Chromium	6.5E-01	6.9E-05	1.8E-01	8.3E-01	2.66	0.31
Cobalt	6.9E-01	6.4E-04	6.5E+00	7.2E+00	7.61	0.94
Copper	1.2E+00	8.6E-05	5.0E+00	6.2E+00	4.05	1.5
Lead	2.0E-01	9.5E-06	6.2E-02	2.7E-01	1.63	0.16
Manganese	7.5E+01	4.6E-02	2.1E+01	9.5E+01	179	0.5
Mercury	1.6E+00	4.6E-05	9.6E-01	2.6E+00	0.45	5.8
Methylmercury	2.0E-04	7.5E-08	5.3E-02	5.3E-02	0.068	0.78
Nickel	3.3E+00	2.3E-03	5.7E-01	3.9E+00	6.71	0.58
Selenium	2.9E-02	6.0E-05	1.6E+00	1.7E+00	0.291	5.72
Silver	5.7E-03	3.1E-06	5.3E-02	5.9E-02	2.02	0.03
Thallium	9.0E-03	1.2E-06	8.4E-02	9.3E-02	--	--
Vanadium	6.7E-01	2.7E-05	1.9E-01	8.6E-01	0.344	2.50
Zinc	1.8E+00	2.5E-04	1.8E+01	2.0E+01	66.1	0.30
Polycyclic Aromatic Hydrocarbons (PAHs)						
HPAH sum (NDs = 0.5 MDL)	1.2E-04	4.3E-04	1.1E-03	1.6E-03	2	0.0008
LPAH sum (NDs = 0.5 MDL)	9.7E-05	3.5E-04	9.1E-04	1.3E-03	--	--
Semivolatile Organic Compounds (SVOCs)						
Benzyl Alcohol	4.3E-05	1.2E-04	4.0E-04	5.6E-04	--	--
Diethyl Phthalate	2.3E-05	3.5E-05	2.2E-04	2.8E-04	--	--
Di-n-butyl Phthalate	1.2E-04	3.3E-05	1.2E-03	1.3E-03	0.11	0.0120
Pentachlorophenol	3.0E-04	1.5E-04	2.8E-03	3.3E-03	6.73	0.0005
Phenol	5.7E-05	3.1E-05	5.3E-04	6.2E-04	6	0.0001

Key:
-- = not available
EE-diet = estimated chemical exposure from diet
EE-sediment = estimated chemical exposure from incidental sediment ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
EPC = exposure point concentration
HPAH = high molecular weight PAH
HQ = hazard quotient
LPAH = low molecular weight PAH
MDL = method detection limit
mg/kg = milligrams per kilogram
mg/kg/day = milligrams per kilogram per day
NA = Not available
NDs = non detects
NOAEL = no observed adverse effect level
SLERA = screening level ecological risk assessment
Grey shading = HQ > 1.0

Note:

a. Essential nutrients (calcium, iron, magnesium, sodium, and potassium) and major soil /sediment constitutes (aluminum) were excluded from the evaluation as per EPA guidance (EPA 1989, 2003). PAHs and SVOCs detected in sediment are listed.

Table 4-22 Beaver Screening-Level Exposure Estimates and Hazard Quotients, Red Devil Mine Site SLERA

Analyte[a]	Surface Soil EPC[b]	Surface Water EPC (µg/L)	EE-soil (mg/kg/d)	EE-water (mg/kg/d)	EE-diet (mg/kg/d)	EE-total (mg/kg/d)	NOAEL (mg/kg/d)	HQ-NOAEL
Polychlorinated Biphenyls (PCBs)								
Sum of Aroclors (NDs = 0.5MDL)	0.078	--	1.2E-08	--	5.9E-07	6.0E-07	0.14	4.3E-06
Metals								
Antimony	23300	184	3.5E+00	1.3E-02	2.5E-02	3.6E+00	0.059	60
Arsenic	9880	1,030	1.5E+00	7.4E-02	6.9E-03	1.6E+00	1.04	1.5
Barium	1710	103	2.6E-01	7.4E-03	1.5E+00	1.8E+00	51.8	0.03
Beryllium	1.3	0.009	2.0E-04	6.5E-07	1.1E-04	3.1E-04	0.532	0.001
Cadmium	1.3	0.008	2.0E-04	5.7E-07	9.8E-04	1.2E-03	0.77	0.002
Chromium	101	0.57	1.5E-02	4.1E-05	1.1E-02	2.6E-02	9.24	0.003
Cobalt	38.8	5.3	5.9E-03	3.8E-04	4.0E-03	1.0E-02	7.33	0.001
Copper	139	0.71	2.1E-02	5.1E-05	5.0E-02	7.1E-02	5.6	0.013
Lead	3090	0.079	4.7E-01	5.7E-06	8.6E-04	4.7E-01	4.7	0.099
Manganese	4230	379	6.4E-01	2.7E-02	8.7E+00	9.3E+00	51.5	0.18
Mercury	1620	0.385	2.4E-01	2.8E-05	2.2E-03	2.5E-01	13.2	0.019
Methylmercury	--	0.00062	--	4.5E-08	1.5E-05	1.5E-05	0.032	0.0005
Nickel	97	19.2	1.5E-02	1.4E-03	3.2E-02	4.8E-02	1.7	0.028
Selenium	0.42	0.5	6.3E-05	3.6E-05	1.7E-03	1.8E-03	0.143	0.012
Silver	0.123	0.026	1.9E-05	1.9E-06	1.5E-03	1.5E-03	6.02	0.0002
Thallium	0.071	0.01	1.1E-05	7.2E-07	2.3E-04	2.4E-04	0.0074	0.032
Vanadium	51.9	0.22	7.8E-03	1.6E-05	5.3E-04	8.4E-03	4.16	0.002
Zinc	386	2.1	5.8E-02	1.5E-04	8.2E-01	8.8E-01	75.4	0.012
Polycyclic Aromatic Hydrocarbons (PAHs)								
HPAH sum (NDs = 0.5 MDL)	109	3.6	1.6E-02	2.6E-04	8.2E-04	1.7E-02	0.615	0.028
LPAH sum (NDs = 0.5 MDL)	417	2.9	6.3E-02	2.1E-04	3.2E-03	6.6E-02	65.6	0.0010
Semivolatile Organic Compounds (SVOCs)								
4-Bromophenyl phenyl ether	1.9	0.21	2.9E-07	1.5E-05	1.4E-05	3.0E-05	--	--
4-Methylphenol	4.9	0.26	7.4E-07	1.9E-05	3.7E-05	5.7E-05	219	2.6E-07
Benzoic acid	120	0.30	1.8E-05	2.1E-05	9.1E-04	9.5E-04	--	--
Benzyl alcohol	12	1.0	1.8E-06	7.2E-05	9.1E-05	1.6E-04	--	--
Bis(2-Ethylhexyl)phthalate	220	0.95	3.3E-05	6.8E-05	1.7E-03	1.8E-03	18.33	0.0001
Dibenzofuran	10	0.24	1.5E-06	1.7E-05	7.6E-05	9.5E-05	--	--
Diethylphthalate	140	0.29	2.1E-05	2.1E-05	1.1E-03	1.1E-03	4583	2.4E-07
Dimethylphthalate	160	0.27	2.4E-05	1.9E-05	1.2E-03	1.3E-03	--	--
Hexachlorobenzene	1.3	0.32	2.0E-07	2.3E-05	9.9E-06	3.3E-05	0.014	0.002
Pentachlorophenol	38	1.25	5.7E-06	9.0E-05	2.9E-04	3.8E-04	8.42	0.000
Phenol	4.6	0.26	6.9E-07	1.9E-05	3.5E-05	5.4E-05	523	1.0E-07

Key:
-- = not available
EE-diet = estimated chemical exposure from diet
EE-soil = estimated chemical exposure from incidental soil ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
EPC = exposure point concentration
HPAH = high molecular weight PAH
HQ = hazard quotient
LPAH = low molecular weight PAH
MDL = method detection limit
mg/kg = milligrams per kilogram
mg/kg/day = milligrams per kilogram per day
NDs = non detects
NOAEL = no observed adverse effect level
SLERA = screening level ecological risk assessment
Grey shading = HQ > 1

Note:

a. Essential nutrients (calcium, iron, magnesium, sodium, and potassium) and major soil/sediment constitutes (aluminum) were excluded from the evaluation as per EPA guidance (EPA 1989, 2003). Aroclors, PAHs, and SVOCs detected in surface soil are listed.

Table 4-23 Green Winged Teal Screening-Level Exposure Estimates and Hazard Quotients, Red Devil Mine Site SLERA

Analyte[a]	EE-sediment (mg/kg/d)	EE-water (mg/kg/d)	EE-diet (mg/kg/d)	EE-total (mg/kg/d)	NOAEL (mg/kg/d)	HQ-NOAEL
Metals						
Antimony	4.5E+00	1.6E-02	1.6E+01	2.1E+01	--	--
Arsenic	3.1E+01	8.7E-02	5.1E+01	8.2E+01	2.24	37
Barium	4.5E-01	8.7E-03	6.0E+00	6.5E+00	20.8	0.31
Beryllium	2.5E-03	7.6E-07	9.9E-04	3.5E-03	--	--
Cadmium	1.9E-04	6.8E-07	3.6E-02	3.7E-02	1.47	0.02
Chromium	5.9E-02	4.8E-05	9.9E-02	1.6E-01	2.66	0.06
Cobalt	5.7E-02	4.5E-04	1.5E-01	2.0E-01	7.61	0.03
Copper	2.3E-01	6.0E-05	1.6E+00	1.8E+00	4.05	0.4
Lead	6.2E-01	6.7E-06	2.0E-01	8.1E-01	1.63	0.50
Manganese	3.4E+00	3.2E-02	3.3E+01	3.6E+01	179	0.2
Mercury	4.0E-01	3.2E-05	8.7E-01	1.3E+00	0.45	2.8
Methylmercury	0.0E+00	5.2E-08	1.1E-03	1.1E-03	0.068	0.02
Nickel	1.8E-01	1.6E-03	5.3E-01	7.1E-01	6.71	0.11
Selenium	5.5E-03	4.2E-05	1.3E-01	1.4E-01	0.291	0.48
Silver	3.8E-04	2.2E-06	6.6E-04	1.0E-03	2.02	0.001
Thallium	2.3E-03	8.4E-07	1.4E-02	1.6E-02	--	--
Vanadium	7.9E-02	1.9E-05	4.8E-02	1.3E-01	0.344	0.37
Zinc	3.5E-01	1.8E-04	9.2E+00	9.6E+00	66.1	0.14
Semivolatile Organic Compounds (SVOCs)						
Bis(2-ethylhexyl)phthalate	6.9E-04	4.2E-05	3.6E-02	3.7E-02	1.1	0.03

Key:
-- = Not available
EE-diet = estimated chemical exposure from diet
EE-sediment = estimated exposure from incidental sediment (i.e., dry surface soil) ingestion
EE-total = total chemical exposure
HQ = hazard quotient
NOAEL = no observed adverse effect level
mg/kg = milligrams per kilogram
mg/kg/day = milligrams per kilogram per day
SLERA = screening level ecological risk assessment
SVOC = semivolatile organic compound
Grey shading = HQ > 1

Note:
a. Essential nutrients (calcium, iron, magnesium, sodium, and potassium) and major soil/sediment constitutes (aluminum) were excluded from the evaluation as per EPA guidance (EPA 1989, 2003). SVOCs detected in settling pond surface soil (i.e., dry sediment) are listed.

Table 4-24 Belted Kingfisher Screening-Level Exposure Estimates and Hazard Quotients, Red Devil Mine Site SLERA

Analyte[a]	EE-sediment (mg/kg/d)	EE-water (mg/kg/d)	EE-diet (mg/kg/d)	EE-total (mg/kg/d)	NOAEL (mg/kg/d)	HQ-NOAEL
Metals						
Antimony	0.00	0.02	19.31	19.33	--	--
Arsenic	0.00	0.11	12.21	12.32	2.24	5.5
Barium	0.00	0.01	2.74	2.75	20.8	0.13
Beryllium	0.00	9.7E-07	0.01	0.01	--	--
Cadmium	0.00	8.6E-07	0.05	0.05	1.47	0.04
Chromium	0.00	6.2E-05	1.23	1.23	2.66	0.46
Cobalt	0.00	5.7E-04	8.11	8.11	7.61	1.07
Copper	0.00	7.7E-05	1.15	1.15	4.05	0.3
Lead	0.00	8.5E-06	0.04	0.04	1.63	0.02
Manganese	0.00	0.041	10.79	10.83	179	0.1
Mercury	0.00	4.2E-05	1.88	1.88	0.45	4.2
Methylmercury	0.00	6.7E-08	0.16	0.16	0.068	2.3
Nickel	0.00	2.1E-03	0.13	0.14	6.71	0.02
Selenium	0.00	5.4E-05	1.51	1.51	0.291	5.2
Silver	0.00	2.8E-06	0.07	0.07	2.02	0.03
Thallium	0.00	1.1E-06	0.10	0.10	--	--
Vanadium	0.00	2.4E-05	0.20	0.20	0.344	0.59
Zinc	0.00	2.3E-04	17.94	17.94	66.1	0.27
Polycyclic Aromatic Hydrocarbons (PAHs)						
HPAH sum (NDs = 0.5 MDL)	0.00	3.9E-04	1.4E-03	1.8E-03	2	0.0009
LPAH sum (NDs = 0.5 MDL)	0.00	3.1E-04	1.1E-03	1.4E-03	--	--
Semivolatile Organic Compounds (SVOCs)						
Benzyl Alcohol	0.00	1.1E-04	5.0E-04	5.0E-04	--	--
Diethyl Phthalate	0.00	3.1E-05	2.8E-04	2.8E-04	--	--
Di-n-butyl Phthalate	0.00	2.9E-05	1.5E-03	1.5E-03	0.11	1.3E-02
Pentachlorophenol	0.00	1.4E-04	3.6E-03	3.6E-03	6.73	5.3E-04
Phenol	0.00	2.8E-05	6.6E-04	6.6E-04	6	1.1E-04

Key:
-- = not available
EE-diet = estimated chemical exposure from diet
EE-sediment = estimated chemical exposure from incidental sediment ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
EPC = exposure point concentration
HPAH = high molecular weight PAH
HQ = hazard quotient
LPAH = low molecular weight PAH
MDL = method detection limit
mg/kg = milligrams per kilogram
mg/kg/day = milligrams per kilogram per day
NDs = non detects
NOAEL = no observed adverse effect level
SLERA = screening level ecological risk assessment
Grey shading = HQ > 1.0

Note:
a. Essential nutrients (calcium, iron, magnesium, sodium, and potassium) and major soil /sediment constitutes (aluminum) were excluded from the evaluation as per EPA guidance (EPA 1989, 2003). PAHs and SVOCs detected in sediment are listed.

Table 4-25 Mink Screening-Level Exposure Estimates and Hazard Quotients, Red Devil Mine Site SLERA

Analyte[a]	EE-sediment (mg/kg/d)	EE-water (mg/kg/d)	EE-diet (mg/kg/d)	EE-total (mg/kg/d)	NOAEL (mg/kg/d)	HQ-NOAEL
Metals						
Antimony	0.00	1.8E-02	5.22	5.24	0.059	89
Arsenic	0.00	1.0E-01	3.30	3.40	1.04	3.3
Barium	0.00	1.0E-02	0.74	0.75	51.8	0.014
Beryllium	0.00	8.9E-07	0.002	0.002	0.532	0.003
Cadmium	0.00	7.9E-07	0.014	0.014	0.77	0.018
Chromium	0.00	5.6E-05	0.33	0.33	9.24	0.036
Cobalt	0.00	5.2E-04	2.19	2.19	7.33	0.30
Copper	0.00	7.0E-05	0.31	0.31	5.6	0.055
Lead	0.00	7.8E-06	0.011	0.011	4.7	0.002
Manganese	0.00	3.8E-02	2.92	2.96	51.5	0.057
Mercury	0.00	3.8E-05	0.51	0.51	13.2	0.038
Methylmercury	0.00	6.1E-08	0.043	0.043	0.032	1.3
Nickel	0.00	1.9E-03	0.036	0.038	1.7	0.02
Selenium	0.00	5.0E-05	0.41	0.41	0.143	2.9
Silver	0.00	2.6E-06	0.018	0.018	6.02	0.00
Thallium	0.00	9.9E-07	0.028	0.028	0.0074	3.8
Vanadium	0.00	2.2E-05	0.05	0.055	4.16	0.013
Zinc	0.00	2.1E-04	4.85	4.85	75.4	0.064
Polycyclic Aromatic Hydrocarbons (PAHs)						
HPAH sum (NDs = 0.5 MDL)	0.00	3.5E-04	3.7E-04	3.7E-04	0.615	0.0006
LPAH sum (NDs = 0.5 MDL)	0.00	2.8E-04	3.1E-04	3.1E-04	65.6	4.7E-06
Semivolatile Organic Compounds (SVOCs)						
Benzyl Alcohol	0.00	9.9E-05	1.4E-04	1.4E-04	--	--
Diethyl Phthalate	0.00	2.9E-05	7.5E-05	7.5E-05	4583	1.6E-08
Di-n-butyl Phthalate	0.00	2.7E-05	3.9E-04	3.9E-04	550	7.2E-07
Pentachlorophenol	0.00	1.2E-04	9.6E-04	9.6E-04	8.42	1.1E-04
Phenol	0.00	2.6E-05	1.8E-04	1.8E-04	523	3.4E-07

Key:
-- = not available
EE-diet = estimated chemical exposure from diet
EE-sediment = estimated chemical exposure from incidental sediment ingestion
EE-total = total chemical exposure
EE-water = estimated chemical exposure from surface water consumption
EPC = exposure point concentration
HPAH = high molecular weight PAH
HQ = hazard quotient
LPAH = low molecular weight PAH
MDL = method detection limit
mg/kg = milligrams per kilogram
mg/kg/day = milligrams per kilogram per day
NOAEL = no observed adverse effect level
SLERA = screening level ecological risk assessment
Grey shading = HQ > 1.0

Note:
a. Essential nutrients (calcium, iron, magnesium, sodium, and potassium) and major soil /sediment constitutes (aluminum) were excluded from the evaluation as per USEPA guidance (USEPA 1989, 2003). PAHs and SVOCs detected in sediment are listed.

Table 4-26 Summary of Chemical and Endpoint Combinations to be Evaluated in the Baseline Ecological Risk Assessment, Red Devil Mine Site

	Assessment Endpoint and Maximum HQ[a]															
						Terrestrial Wildlife[h]						Aquatic-Dependent Wildlife[i]				
Analyte[b]	Plants[c]	Soil Fauna[d]	Fish and Other Aquatic Biota[e]	Fish[f]	Benthos[g]	Robin	Shrew	Grouse	Vole	Shrike	Weasel	Snipe	Beaver	Teal	Kingfisher	Mink
Polychlorinated Biphenyls (PCBs)																
Sum of Aroclors (NDs = 0.5MDL)		x														
Metals																
Antimony	x	299	6.1	x	2,193	x	**136,370**	x	**1,681**	x		x	**60**	x	x	**89**
Arsenic	549	x	6.9	14	13,265	**28**	**214**	**47**	**41**	**1.5**	**1.9**	**823**	**1.5**	**37**	**5.5**	**3.3**
Barium	x	5.2	26	x	x	**2.0**	**1.6**	**1.3**				**1.4**				
Beryllium	x				x	x		x		x		x		x	x	
Cadmium						**1.7**	**4.4**									
Chromium	1.3	x		3.5	1.1	**2.9**	**1.3**									
Cobalt	3.0	x			1.0										**1.1**	
Copper	2.0	1.7			2.8	**4.4**	**4.6**					**1.5**				
Iron			2.5		16											
Lead	26	1.8				**83**	**48**	**20**	**2.8**	**4.9**	**1.0**					
Manganese	19	9.4	3.2	x	12		**2.3**	**2.1**	**6.1**							
Mercury	5,400	16,200	32	8	661	**9.5**	**2.1**	**39**				**5.8**		**2.8**	**4.2**	
Methylmercury				1	x										**2.3**	**1.3**
Nickel	2.6				11	**3.7**	**21**									
Selenium				2.7			**1.2**					**5.7**			**5.2**	**2.9**
Silver		x														
Thallium		x			x	x	**3.3**	x		x		x		x	x	**3.8**
Vanadium	26	x			x	**1.9**		**1.7**				**2.5**				
Zinc	2.4	3.2		1.3	1.1	**2.2**	**2.7**									
Polycyclic Aromatic Hydrocarbons (PAHs)																
HPAH sum																
LPAH sum						x		x		x		x			x	
Other Semivolatile Organic Compounds (SVOCs)																
4-Bromophenyl phenyl ether	x	x				x	x	x	x	x	x		x			
4-Methylphenol	x	x				x		x		x						
Benzoic acid	x	x				x	x	x	x	x	x		x			
Benzyl Alcohol	x	x				x	x	x	x	x	x	x	x		x	x
Bis(2-Ethylhexyl)phthalate	x	x														
Dibenzofuran						x	x	x	x	x	x		x			
Diethylphthalate		x				x		x		x		x			x	
Dimethylphthalate	x					x	x	x	x	x	x		x			
Di-n-butyl Phthalate																
Hexachlorobenzene	x															
Pentachlorophenol																
Phenol																

Key:

BERA = Baseline Ecological Risk Assessment

HPAH = high molecular weight PAH

HQ = hazard quotient

LPAH = low molecular weight PAH

TRV = toxicity reference value

Value (with or without shading) = HQ equal to or greater than 1. Chemical and receptor combination will be evaluated quantitatively in the BERA.

x = chemical detected in site samples but no screening level or TRV is available. Chemical will be evaluated qualitatively in the BERA.

Notes:

a. For plants, soil fauna, fish and other aquatic biota, fish (only), and benthos, shading indicates the percentage of site samples that exceed the screening level (SL):

Value = > 75% (black shading)
Value = 50 - 75% (dark grey shading)
Value = 25 - 50% (light grey shading)
Value = < 25% (no shading)

For wildlife, the value of the maximum HQ (exposure estimate / TRV) is shown without shading because wildlife HQs were not calculated sample-by-sample.

b. Essential nutrients (calcium, magnesium, sodium, and potassium) and major soil /sediment constitutes (aluminum) were excluded from the evaluation as per EPA guidance (EPA 1989, 2003a). Organic chemicals detected in surface soil, sediment, or surface water are listed.

c. Based on comparing maximum soil chemical concentrations with soil screening levels for effects on plants (see Table 4-1).

d. Based on comparing maximum soil chemical concentrations with soil screening levels for effects on earthworms (see Table 4-1).

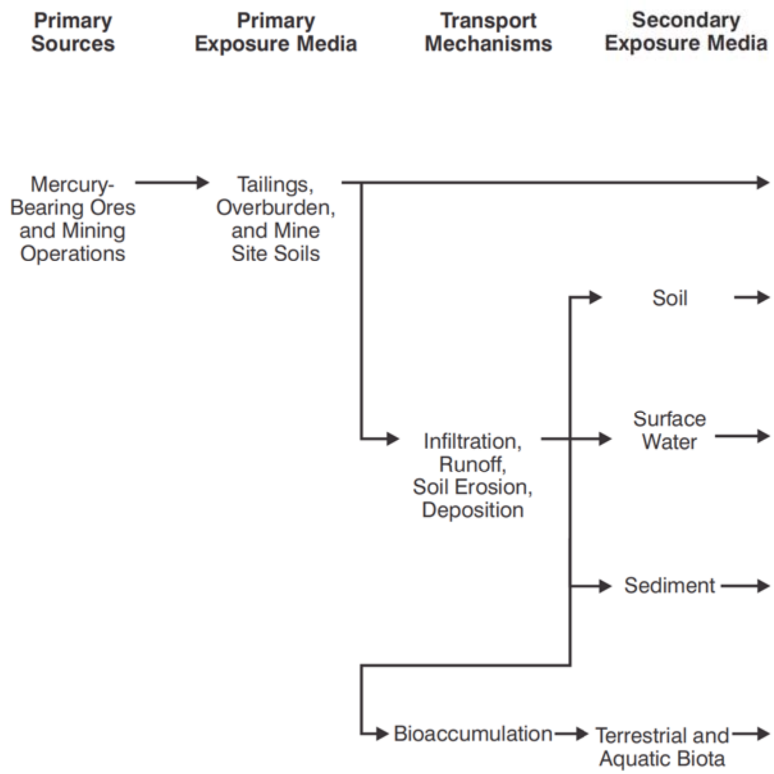
e. Based on comparing maximum surface water chemical concentrations with surface water criteria and standards for effects on fish and other aquatic biota (see Table 4-3).

f. Based on comparing maximum whole-body sculpin chemical concentrations with fish tissue screening concentrations (see Table 4-3b).

g. Based on comparing maximum sediment chemical concentrations with sediment screening levels for effects on benthic macroinvertebrates (see Table 4-2).

h. Based on screening-level exposure estimates and hazard quotients for the American robin (Table 4-15), masked shrew (Table 4-16), spruce grouse (Table 4-17), tundra vole (Table 4-18), northern shrike (Table 4-19), and least weasel (Table 4-20).

i. Based on screening-level exposure estimates and HQs for the common snipe (Table 4-21), beaver (Table 4-22), green-winged teal (Table 4-23), belted kingfisher (Table 4-24), and mink (Table 4-25).



Potential Ecological Receptors

Exposure Media	Exposure Routes	Plants	Terrestrial Invertebrates	Birds and Mammals	Benthos	Fish and Other Aquatic Biota
Tailings, Overburden, and Mine Site Soils	Direct Contact	+	+	−	−	−
Tailings, Overburden, and Mine Site Soils	Ingestion	−	+	+	−	−
Soil	Direct Contact	+	+	−	−	−
Soil	Ingestion	−	+	+	−	−
Surface Water	Direct Contact	+	−	−	+	+
Surface Water	Ingestion	−	−	−	+	+
Sediment	Direct Contact	+	−	−	+	−
Sediment	Ingestion	−	−	+	+	+
Terrestrial and Aquatic Biota	Ingestion (Food Chain)	−	+	+	+	+

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LEGEND
+ = Complete Pathway
− = Incomplete or Insignificant Pathway

Figure 3-1
PRELIMINARY ECOLOGICAL CONCEPTUAL SITE MODEL FOR RED DEVIL MINE SITE

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