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HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT FOR THE MT. NANSEN MINE

Prepared for:

Yukon Government
Assessment and Abandoned Mines Branch

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1.0 INTRODUCTION

The Assessment and Abandoned Mines Branch of the Yukon Government commissioned SENES Consultants Limited to carry out a Preliminary Quantitative Risk Assessment (PQRA) ecological and human health risk assessment for the Mt. Nansen Mine site to support the remediation planning process. The assessment considered the effects of measured chemical levels in the aquatic and terrestrial environment at the site. This report details the methodology and critical assumptions used for the assessment.

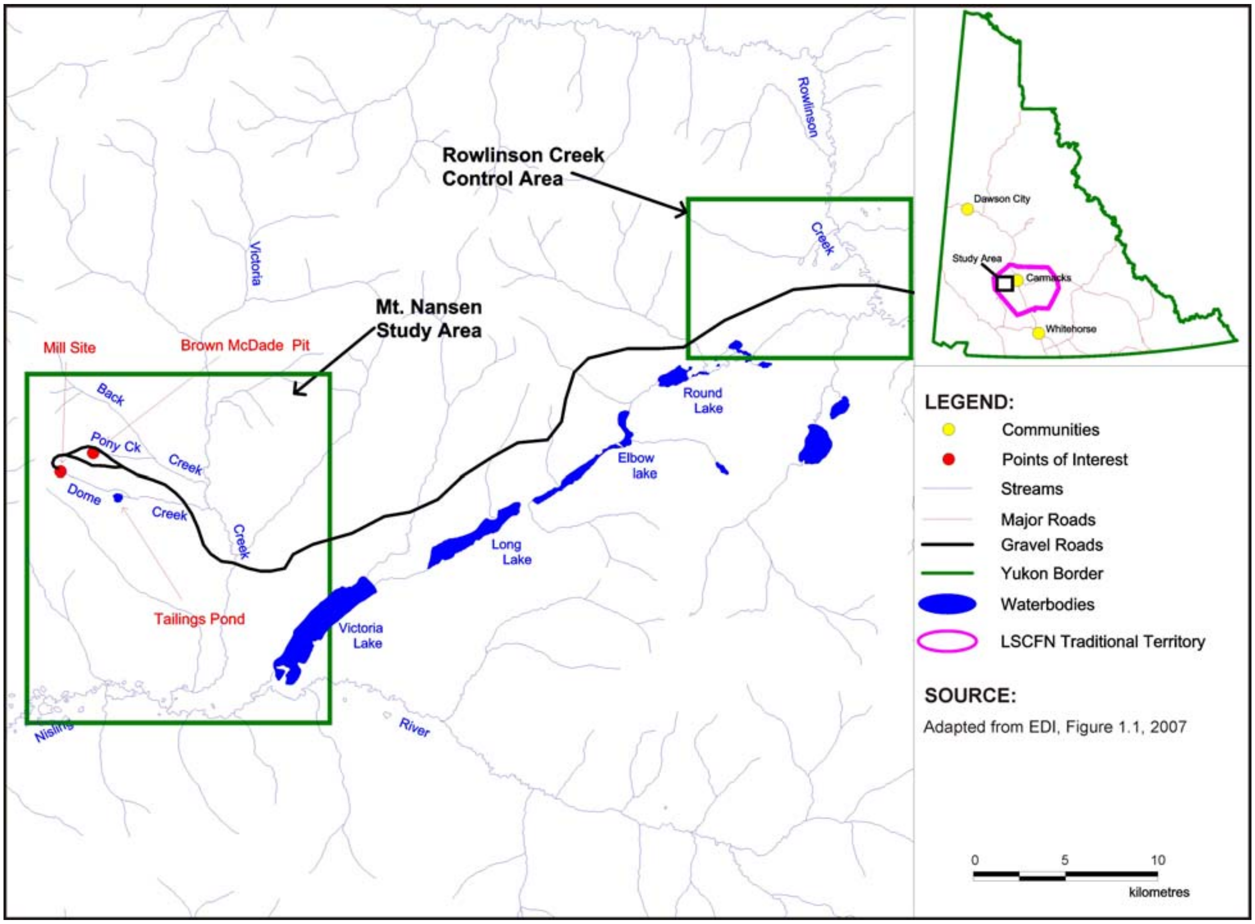
The risk assessment process is iterative in nature and is typically revisited over the course of a project as remediation options are developed in greater detail and environmental conditions become better defined. A Preliminary Quantitative Risk Assessment (PQRA) was carried out by SENES in 2003 in support of funding for site remediation work. Since the time of the initial PQRA, significant site investigations have been completed and are summarized in the EDI (2007) report "*Mt. Nansen Terrestrial and Aquatic Effects Study 2005-2006*", which provides a large database of measured concentrations in the aquatic and terrestrial environments. This site-specific data is used to refine the assumptions of the initial PQRA and more accurately quantify the risks associated with the existing site conditions. This report presents the results of the assessment of ecological and human health risks for the existing site conditions. Thus, the focus of the risk assessment was on the effects associated with measured chemical levels in the aquatic and terrestrial environments.

This risk assessment for the existing conditions at the site will be followed by an evaluation of the residual effects associated with the range of remedial options that have been proposed for the site. Once the final remediation plan is developed, the final step in the process will be to carry out a comprehensive risk assessment of the residual effects and ecological and human health risks for the preferred remediation alternative.

1.1 EXISTING CONDITIONS

The Mt. Nansen Mine site, a former gold mine, is located about 60 km west of Carmacks, Yukon Territory, as shown in Figure 1.1-1. A comprehensive site history is provided in EDI (2007). Currently, the site is comprised of an old mill site with nearby low-grade ore stockpile, an accumulation of water in the Brown-McDade Pit, and a tailings pond and containment system (Figure 1.1-1). Upland areas that transition to high standing outcrops dominate the surrounding area. The area is used by the Little Salmon Carmacks First Nation (LSCFN) and the general Yukon community for subsistence and recreational purposes.

Figure 1.1-1 Mt. Nansen Site Location



The existing conditions are evaluated using current water quality collected from various monitoring locations around the site. The results from the existing conditions will provide a point of reference against which the effects of potential remediation can be compared at a future time. The existing conditions do not take into account any of the soluble chemical loads that are currently being produced on the site, but which have not yet reached the receiving waters (i.e. chemical loads associated with groundwater plumes). It is assumed that the current water quality is representing these loads for the existing conditions.

Existing conditions were based on data collected between 1999 to 2008 during various sampling campaigns. The current contaminant loads measured in the receiving waters are significantly less than what is anticipated to occur in the future because some sources have not reached peak oxidation rates and some contaminants have not emerged from their source due to attenuation and/or long travel times. This means that the current management approach would have to be modified in the future in order to achieve an equivalent level of environmental protection as is currently realized.

1.2 SELECTION OF CHEMICALS OF POTENTIAL CONCERN

A selection process was used to identify the chemicals of potential concern (COPC) at the Mt. Nansen Mine as described in Appendix A. To summarize, the concentrations in water and soils in the affected area were compared to background/baseline concentrations in the study area. Those chemicals that were found to be different from background/baseline were then compared to CCME guidelines for water (for protection of aquatic life) and/or for soil (the lowest of agricultural and residential/parkland use). The CCME aquatic life guidelines were lower than the CCME drinking water guidelines for the chemicals considered in this assessment. If the measured levels exceeded the guideline value, the chemicals were considered COPC and carried through the risk assessment. If guidelines were not available then a check was made to determine whether the chemical had available toxicity values. Chemicals with no available toxicity data were dropped from the assessment, since toxicity information is a necessary component to quantify risk. This adds to the uncertainty in the assessment and is discussed in Section 6.5. Therefore, chemicals for which CCME guidelines did not exist and which had toxicity data were considered to be COPC and were carried through the assessment.

Sediment and vegetation samples were screened using a secondary screening process completed to identify chemicals that were possibly not selected in the general screening process for the aquatic and terrestrial environments. For sediments, the measured concentrations were compared to background/baseline concentrations in the study area. Chemicals found at levels above background were then compared to sediment quality criteria. Chemicals with concentrations above the available sediment quality criteria were added to the list of COPC for the aquatic environment. For the vegetation samples, the measured concentrations in forage, browse and berry were compared to background/baseline concentrations in the study area. Once again, those chemicals that were found to be different from background/baseline were then compared to reported phytotoxic levels in plants. This was done to determine whether chemical levels in the plant had the potential to be toxic to the plant. Chemicals with concentrations above phytotoxic levels were added to the list of COPCs for the terrestrial environment.

Based on this screening procedure, the following chemicals were identified as COPC:

Aquatic COPCs	**Terrestrial COPCs**
Chloride	Arsenic
Sulphate	Boron
Ammonia	Cadmium
Cyanate	Copper
Thiocyanate	Lead
Antimony	Manganese
Arsenic	Selenium
Barium	Strontium
Boron	Tin
Cadmium	Zinc
Chromium	
Cobalt	
Copper	
Iron	
Lead	
Manganese	
Selenium	
Silver	
Strontium	
Vanadium	
Zinc	

Hydrocarbon and volatile organic compound (VOC) data were not available for the receiving environment as these have never been identified as a significant issue at the site. There is past evidence of very localized soil staining, however, it has never been considered as a general site problem with the potential to affect the larger area or receiving environment. All unused or waste containerized products have been removed and fuel containment has not been an issue under government care. The historic site spills are believed to have been cleaned up around the time they occurred. There is no reason to believe that the tailings would be contaminated with hydrocarbons, as they are a mill process waste and with the exception of lubricants in the machinery, there is no process function that would input hydrocarbons. Additionally, there have been no spills to warrant the testing of water or sediments for hydrocarbons. Therefore, hydrocarbons and VOCs were not considered in the selection of COPCs for the risk assessment.

1.3 REPORT STRUCTURE

The report has been structured into several chapters, each of which describes specific aspects of the risk assessment. These aspects include:

Chapter 2 – Site Characterization: Describes the main features of the Mt. Nansen Mine Site. A summary of the most pertinent information from recent surveys of surface water quality, sediment quality, and fish communities in Dome Creek, Pony Creek and Victoria Creek is provided to establish current (baseline) conditions. Similarly, metals levels measured in soils and vegetation in the study area were evaluated and input to the ecological and human health risk assessments.

Chapter 3 – Receptor Characterization: Identifies the aquatic and terrestrial ecological receptors selected for inclusion in the risk assessment, as well as, the human receptors (i.e. adults and children) that may spend time in the study area.

Chapter 4 – Exposure Assessment: Describes the pathways model used to predict the fate of chemicals in the environment including their uptake by aquatic and terrestrial species. The pathways of exposure of human receptors and their respective dietary characteristics are described.

Chapter 5 – Hazard Assessment: Details the toxicity reference values used in the assessment for each of the COPC to characterize the risks of potential effects on the health of ecological species and humans.

Chapter 6 – Risk Characterization: Presents the results of the pathways modelling and risk assessments.

Chapter 7 – Summary and Conclusions: Provides a synopsis of the basis used for the ERA and HHRA and the findings of these assessments.

Chapter 8 – References: Lists the reference sources used in this study.

This pathways modelling and report has been prepared by Ms. Katherine Woolhouse and reviewed by Dr. Harriet Phillips.

2.0 SITE CHARACTERIZATION

This chapter provides a brief description of the Mt. Nansen Mine site and a summary of the measured data for the chemicals of potential concern (COPC) used in the assessment. The detailed discussion of all the data is provided in Appendix B. This chapter also provides the methodology for the calculation of the concentrations of COPC in environmental media for which no measured data were available.

2.1 MT. NANSEN MINE SITE

The Mt. Nansen Mine site, a former gold mine, is located about 60 km west of Carmacks and 180 km north of Whitehorse, Yukon Territory, as shown in Figure 1.1-1. The Mt. Nansen Mine has had some form of placer gold mining since the Klondike gold rush, over 100 years ago. No mining or mineral exploration has occurred at the site since 1999, although some placer activity may have occurred in the area. The Mt. Nansen Mine is located within the Victoria Creek watershed. Victoria Creek is a tributary to the Nisling River, a medium sized river in the Donjek/White Rivers drainage basin. Two small streams drain the majority of the mine site. Dome Creek flows from above the mill site, past the tailings facility and into Victoria Creek. Therefore Dome Creek is directly impacted by the Mt. Nansen Mine site. Pony Creek drains a small portion of the mine site north of the Brown-McDade Pit and eventually flows into Back Creek and on to Victoria Creek and thus may be potentially impacted by the mine site. This assessment considered Dome Creek, Pony Creek, and Victoria Creek, as well as the Tailings Pond and Brown-McDade Pit water. There are a number of fish species found downstream of the minesite such as Arctic grayling, burbot, northern pike, round whitefish, and slimy sculpin (EDI 2007).

The terrain consists of rounded ridges and shallow valleys with a light covet of vegetation and small trees. Permafrost is found at depths of about 0.4m and is discontinuous and ranges from 30 to 60 meters thick. Vegetation consists of black and white spruce, birch, willow shrubs and trembling aspen. The high slopes at the mine site are generally devoid of vegetation. Labrador tea is the dominant understory and mosses and lichens are the common ground vegetation (Conor Pacific 2000).

2.2 AQUATIC ENVIRONMENT

This section discusses surface water and sediment quality for the COPC within the Dome Creek, Pony Creek, and Victoria Creek, as well as the Tailings Pond and the Brown-McDade Pit water, which were obtained from various sampling campaigns by Environmental Dynamics Incorporated (EDI). Measured concentrations of COPC in fish flesh (muscle) are also provided in this section.

As indicated in EDI (2008), the Department of Indian and Northern Affairs (DIAND) began water quality sampling at the Mt. Nansen mine site in 1999 and in 2003 this sampling program was assumed by the Yukon Government Abandoned Mines Branch (AMB). Since 2005, EDI (under contract with AMB) has carried out sampling at the Mt. Nansen site at semi-regular frequencies. This frequency has been weekly, bi-weekly or monthly depending on activities at the mine site (i.e. discharge of water into Dome Creek) and water quality results. Some sites are not sampled in the winter when locations are frozen to the substrate.

The total metals concentrations in surface water measured at the Mt. Nansen Mine between January 1999 and November 2008 were used in the assessment, and Dome Creek, Pony Creek, Victoria Creek, Tailings Pond, and Brown-McDade Pit were assessed separately. Measurements from reference sampling locations at the Victoria Creek Reference and Dry Creek were used to determine the background concentrations. Reference locations were sampled in 2007 and 2008.

The total metals concentrations in sediment measured at the Mt. Nansen Mine between 1988 and 2006 were used in the assessment. Dome Creek (sampling locations D1, D2, D3, D4, D5, D5_1, "at final discharge of tailings dam"), Pony Creek (B1, B1_1, P1, P2, P3), and Victoria Creek (V1, V2, V3, V4, V5) were assessed separately. Sediment data were not available for the Tailings Pond or Brown-McDade Pit, so site-specific distribution coefficients were developed to estimate sediment concentrations in these areas. Measurements from a reference sampling location "upstream of mine development" were used to determine the background concentrations. The three samples from the reference location were collected in 1988.

Data from slimy sculpin (whole body) and burbot (muscle) collected during a field investigation conducted in 2005 and 2006 (EDI 2007) were used to provide fish tissue concentrations. Fish sampled from Victoria Creek between Dome Creek and road crossing (VIC3) and Victoria Creek downstream of road crossing (VIC4) were considered.

2.2.1 Water Quality

Water quality data collected between 1999 and 2008 within the Dome Creek, Pony Creek, and Victoria Creek are summarized below. Tailings Pond and Brown-McDade Pit water concentrations are also summarized. A detailed list of the water quality data is provided in Appendix B.

Surface water data prior to November 2007 has high detection limits. An analysis completed during the screening process and selection of COPC (Appendix A) found that more COPC were identified using the complete data set (i.e. including high detection limits), and therefore, the concentrations in the full data set are considered in the assessment as a conservative assumption. For the purpose of calculating summary statistics for these data, concentrations measured as less than the detection limit (“<”) were considered as equal to ½ the detection limit. This is typically accepted by regulatory agencies such as Health Canada and Environment Canada.

The summaries provided below present the results for the COPC that were identified in the aquatic environment.

2.2.1.1 Dome Creek

Surface water quality data were collected from different sampling locations in Dome Creek (sampling locations Dome-X, Dome 1, Dome 2, Dome 3, Upper Dome, Dome @ Road) and are summarized in Table 2.2-1.

2.2.1.2 Pony Creek

Surface water quality data were collected from different sampling locations in Pony Creek (Pony D/S, Back Creek) and are summarized in Table 2.2-2.

2.2.1.3 Victoria Creek

Surface water quality data were collected from different sampling locations in Victoria Creek (Upper Victoria Creek and Victoria Creek @ Road) and are summarized in Table 2.2-3.

2.2.1.4 Reference Locations

Surface water quality data were collected from reference locations on Victoria Creek (upstream of impacts from the mine site) and Dry Creek and are summarized in Table 2.2-4.

2.2.1.5 Tailings Pond

Surface water quality data were collected from the Tailings Pond and are summarized in Table 2.2-5.

2.2.1.6 Brown-McDade Pit

Surface water quality data were collected from the Brown-McDade Pit and the water quality from the “Top” samples are summarized in Table 2.2-6.

Table 2.2-1 Summary of Water Quality Data for COPC in Dome Creek

Dome Creek **Routine Parameters and Nutrients**		**N**	**N<MDL**	**Min**	**Median**	**95th Percentile**	**Max**	**Mean**	**St Dev**	**CCME WQ Guideline**
Chloride	mg/L	47	5	0.07	0.9	2.86	3.6	1.02	0.81	-
Sulphate	mg/L	254	0	16.2	389	996.5	3830	449	328	-
Ammonia-N	mg/L	256	21	0.005	0.8875	7.89	46.2	2.1	4.2	2.2
Cyanide Compounds										
Cyanate	mg/L	241	154	0.005	0.3	4.6	143	2.1	10.5	-
Thiocyanate	mg/L	240	10	0.025	1.3	6.2	68.7	3.1	8.3	-
Total Metals										
Antimony	mg/L	254	200	0.000005	0.10	0.10	0.5	0.06	0.06	-
Arsenic	mg/L	257	138	0.0018	0.10	0.18	0.5	0.08	0.06	0.005
Barium	mg/L	258	1	0.01	0.06	0.17	0.317	0.07	0.05	-
Boron	mg/L	198	134	0.001	0.05	0.11	0.57	0.05	0.05	-
Cadmium	mg/L	258	184	0.00001	0.005	0.005	0.025	0.003	0.003	0.000017
Chromium	mg/L	258	175	0.00025	0.005	0.008	0.148	0.005	0.01	0.0089
Cobalt	mg/L	258	138	0.00005	0.01	0.03	0.073	0.01	0.01	-
Copper	mg/L	258	116	0.001	0.01	0.27	1.1	0.04	0.13	0.004
Iron	mg/L	258	3	0.04	2.3	12.1	58.4	4.1	6.5	0.3
Lead	mg/L	258	175	0.00005	0.03	0.03	0.15	0.02	0.01	0.007
Manganese	mg/L	258	2	0.0025	0.9	5.6	29.7	1.6	2.4	-
Selenium	mg/L	254	221	0.000005	0.10	0.10	0.5	0.06	0.06	0.001
Silver	mg/L	258	218	0.000005	0.005	0.005	0.03	0.003	0.003	0.0001
Strontium	mg/L	258	2	0.01	0.38	0.80	3.06	0.41	0.26	-
Tin	mg/L	258	241	0.000005	0.02	0.80	0.079	0.01	0.01	-
Vanadium	mg/L	254	154	0.000005	0.02	0.02	0.1	0.01	0.01	-
Zinc	mg/L	258	4	0.0025	0.02	0.18	1.4	0.06	0.15	0.03

Note: - indicates no data available.

Table 2.2-2 Summary of Water Quality Data for COPC in Pony Creek

Pony Creek										
Routine Parameters and Nutrients		**N**	**N<MDL**	**Min**	**Median**	**95th Percentile**	**Max**	**Mean**	**St Dev**	**CCME WQ Guideline**
Chloride	mg/L	21	3	0.09	0.50	2.40	2.6	0.68	0.66	-
Sulphate	mg/L	21	0	9.41	62.3	129.00	146	68.2	31.1	-
Ammonia-N	mg/L	21	15	0.005	0.03	0.03	0.039	0.02	0.01	2.2
Cyanide Compounds										
Cyanate	mg/L	21	18	0.1	0.1	0.20	0.2	0.11	0.04	-
Thiocyanate	mg/L	21	0	0.4	0.8	1.40	2.1	0.9	0.4	-
Total Metals										
Antimony	mg/L	22	0	0.0002	0.00115	0.004	0.0242	0.003	0.005	-
Arsenic	mg/L	22	0	0.0024	0.0048	0.24	0.352	0.03	0.09	0.005
Barium	mg/L	22	0	0.025	0.0555	0.10	0.857	0.1	0.2	-
Boron	mg/L	22	9	0.001	0.002	0.00	0.01	0.002	0.002	-
Cadmium	mg/L	22	0	0.0001	0.0004	0.0061	0.006	0.001	0.002	0.000017
Chromium	mg/L	22	10	0.00025	0.0005	0.0033	0.0492	0.003	0.010	0.0089
Cobalt	mg/L	22	4	0.00005	0.0003	0.00	0.0294	0.002	0.006	-
Copper	mg/L	22	0	0.002	0.0075	0.09	0.135	0.018	0.033	0.004
Iron	mg/L	22	1	0.05	0.415	8.28	59.1	3.6	12.6	0.3
Lead	mg/L	22	0	0.0002	0.00165	0.17	0.205	0.02	0.06	0.007
Manganese	mg/L	22	0	0.011	0.204	0.77	3.03	0.355	0.627	-
Selenium	mg/L	22	18	0.0001	0.0001	0.0006	0.001	0.0002	0.0002	0.001
Silver	mg/L	22	4	0.000005	0.000055	0.0016	0.00287	0.0003	0.0007	0.0001
Strontium	mg/L	22	0	0.072	0.2585	0.36	0.371	0.3	0.1	-
Vanadium	mg/L	22	0	0.0001	0.0005	0.01	0.125	0.007	0.026	-
Tin	mg/L	22	22	0.0005	0.0005	0.0005	0.0010	0.0005	0.0001	-
Zinc	mg/L	22	0	0.006	0.041	0.42	0.506	0.1	0.1	0.03

Note: - indicates no data available.

Table 2.2-3 Summary of Water Quality Data for COPC in Victoria Creek

Victoria Creek										
Routine Parameters and Nutrients		**N**	**N<MDL**	**Min**	**Median**	**95th Percentile**	**Max**	**Mean**	**St Dev**	**CCME WQ Guideline**
Chloride	mg/L	28	4	0.1	0.4	1.2	2.6	0.50	0.51	-
Sulphate	mg/L	262	1	2.13	23.8	95.3	636	32.9	48.3	-
Ammonia-N	mg/L	259	111	0.0025	0.025	0.14	8.3	0.10	0.68	2.2
Cyanide Compounds										
Cyanate	mg/L	259	235	0.0025	0.25	0.46	1.5	0.22	0.16	-
Thiocyanate	mg/L	257	145	0.015	0.25	2.2	23.9	0.75	1.71	-
Total Metals										
Antimony	mg/L	261	236	0.00005	0.1	0.10	0.2	0.06	0.05	-
Arsenic	mg/L	263	193	0.0001	0.1	0.10	0.2	0.06	0.05	0.005
Barium	mg/L	263	0	0.035	0.068	0.12	0.581	0.08	0.05	-
Boron	mg/L	204	173	0.001	0.05	0.05	0.1	0.04	0.02	-
Cadmium	mg/L	263	215	0.000005	0.005	0.01	0.01	0.003	0.002	0.000017
Chromium	mg/L	263	226	0.000025	0.005	0.005	0.010	0.003	0.002	0.0089
Cobalt	mg/L	263	223	0.00005	0.005	0.01	0.012	0.003	0.002	-
Copper	mg/L	263	153	0.0005	0.005	0.02	0.066	0.01	0.01	0.004
Iron	mg/L	263	37	0.015	0.18	1.84	12.1	0.49	1.27	0.3
Lead	mg/L	263	219	0.000025	0.025	0.03	0.055	0.02	0.01	0.007
Manganese	mg/L	263	9	0.0025	0.043	0.18	5.64	0.09	0.35	-
Selenium	mg/L	261	243	0.0001	0.10	0.10	0.2	0.06	0.05	0.001
Silver	mg/L	263	241	0.000005	0.005	0.01	0.011	0.003	0.002	0.0001
Strontium	mg/L	263	0	0.079	0.25	0.37	2.28	0.26	0.17	-
Tin	mg/L	262	256	0.00005	0.02	0.37	0.03	0.01	0.007	-
Vanadium	mg/L	260	175	0.0002	0.015	0.02	0.03	0.01	0.01	-
Zinc	mg/L	263	133	0.0005	0.0025	0.02	0.328	0.01	0.02	0.03

Note: - indicates no data available.

Table 2.2-4 Summary of Water Quality Data for COPC in Reference Locations

Reference Routine Parameters and Nutrients		N	N<MDL	Min	Median	95th Percentile	Max	Mean	St Dev	CCME WQ Guideline
Chloride	mg/L	6	0	0.40	0.60	1.05	1.10	0.67	0.31	-
Sulphate	mg/L	8	0	0.70	2.05	2.50	2.60	1.84	0.61	-
Ammonia-N	mg/L	8	6	0.01	0.02	0.03	0.03	0.02	0.01	2.2
Cyanide Compounds										
Cyanate	mg/L	8	8	0.1	0.1	0.25	0.25	0.1375	0.0694	-
Thiocyanate	mg/L	8	2	0.25	0.95	1.665	1.7	0.975	0.5385	-
Total Metals										
Antimony	mg/L	8	5	0.0001	0.000	0.1	0.1	0.025	0.046	-
Arsenic	mg/L	8	2	0.0002	0.002	0.1	0.1	0.026	0.046	0.005
Barium	mg/L	8	0	0.032	0.055	0.06	0.066	0.052	0.012	-
Boron	mg/L	8	5	0.001	0.003	0.05	0.05	0.014	0.022	-
Cadmium	mg/L	8	4	0.000005	0.000	0.005	0.005	0.001	0.002	0.000017
Chromium	mg/L	8	6	0.00025	0.001	0.005715	0.0061	0.002	0.003	0.0089
Cobalt	mg/L	8	6	0.00005	0.000	0.005	0.005	0.001	0.002	-
Copper	mg/L	8	2	0.001	0.002	0.0076	0.009	0.003	0.003	0.004
Iron	mg/L	8	2	0.015	0.120	1.30	1.7	0.392	0.566	0.3
Lead	mg/L	8	5	0.00005	0.000	0.025	0.025	0.007	0.011	0.007
Manganese	mg/L	8	2	0.0025	0.015	0.05	0.072	0.019	0.022	-
Selenium	mg/L	8	8	0.0001	0.000	0.1	0.1	0.025	0.046	0.001
Silver	mg/L	8	6	0.000005	0.000	0.005	0.005	0.001	0.002	0.0001
Strontium	mg/L	8	0	0.066	0.112	0.26	0.269	0.148	0.083	-
Tin	mg/L	8	8	0.00005	0.0001	0.02	0.015	0.004	0.007	-
Vanadium	mg/L	8	2	0.0004	0.001	0.015	0.015	0.005	0.007	-
Zinc	mg/L	8	2	0.0025	0.007	0.0139	0.016	0.007	0.004	0.03

Note: - indicates no data available.

Table 2.2-5 Summary of Water Quality Data for COPC in the Tailings Pond

Tailings Pond						**95th**				**CCME**
Routine Parameters and Nutrients		**N**	**N<MDL**	**Min**	**Median**	**Percentile**	**Max**	**Mean**	**St Dev**	**WQ Guideline**
Chloride	mg/L	13	0	1.2	2.1	3.1	3.8	2.1	0.66	-
Sulphate	mg/L	180	0	187	1285	2191	6000	1380	647	-
Ammonia-N	mg/L	182	2	0.025	11	35.1	49	11.2	9.9	2.2
Cyanide Compounds										
Cyanate	mg/L	171	56	0.015	1.2	88	168	12.5	28.2	-
Thiocyanate	mg/L	171	5	0.25	5.21	107	817	28.0	72.5	-
Total Metals										
Antimony	mg/L	176	136	0.01	0.08395	0.1	2.18	0.08	0.17	-
Arsenic	mg/L	180	107	0.01	0.0937	0.20	1.86	0.09	0.18	0.005
Barium	mg/L	183	3	0.005	0.031	0.05	0.258	0.03	0.02	-
Boron	mg/L	102	5	0.05	0.15	0.31	0.36	0.17	0.07	-
Cadmium	mg/L	183	113	0.00025	0.0025	0.005	0.028	0.0030	0.0028	0.000017
Chromium	mg/L	183	155	0.00025	0.002	0.005	0.013	0.0027	0.0023	0.0089
Cobalt	mg/L	183	40	0.0012	0.022	0.14	0.174	0.05	0.05	-
Copper	mg/L	183	2	0.005	0.086	19.1	105	4.38	11.71	0.004
Iron	mg/L	183	2	0.0025	1.05	4.0	38.3	1.66	3.32	0.3
Lead	mg/L	183	112	0.0025	0.025	0.08	1.44	0.04	0.15	0.007
Manganese	mg/L	183	0	0.123	3.87	10.2	26.6	4.45	3.53	-
Selenium	mg/L	176	163	0.0001	0.01	0.1	0.23	0.05	0.05	0.001
Silver	mg/L	183	115	0.00011	0.005	0.06	0.238	0.02	0.03	0.0001
Strontium	mg/L	183	0	0.08	0.761	1.5	1.73	0.86	0.32	-
Tin	mg/L	183	163	0.00025	0.015	0.025	0.12	0.011	0.013	-
Vanadium	mg/L	180	130	0.0002	0.015	0.029	0.054	0.010	0.010	-
Zinc	mg/L	183	0	0.004	0.058	0.25	5.01	0.14	0.43	0.03

Note: - indicates no data available.

Table 2.2-6 Summary of Water Quality Data for COPC in the Brown-McDade Pit

Brown-McDade Pit Routine Parameters and Nutrients		N	N<MDL	Min	Median	95th Percentile	Max	Mean	St Dev	CCME WQ Guideline
Chloride	mg/L	5	0	0.28	0.5	1.3	1.5	0.644	0.487	-
Sulphate	mg/L	18	0	111	658.5	1146	1290	675	263	-
Ammonia-N	mg/L	19	8	0.005	0.025	0.14	0.21	0.054	0.057	2.2
Cyanide Compounds										
Cyanate	mg/L	-	-	-	-	-	-	-	-	-
Thiocyanate	mg/L	6	1	0.25	0.84	1.1	1.13	0.815	0.305	-
Total Metals										
Antimony	mg/L	19	11	0.0046	0.1	0.1	0.1	0.061	0.047	-
Arsenic	mg/L	19	11	0.0081	0.1	0.1	0.1	0.064	0.044	0.005
Barium	mg/L	19	3	0.005	0.016	0.02	0.02	0.014	0.005	-
Boron	mg/L	19	11	0.004	0.05	0.05	0.05	0.031	0.023	-
Cadmium	mg/L	19	11	0.00305	0.005	0.015	0.015	0.006	0.003	0.000017
Chromium	mg/L	19	18	0.000025	0.005	0.005	0.005	0.003	0.002	0.0089
Cobalt	mg/L	19	12	0.00005	0.005	0.005	0.005	0.003	0.002	-
Copper	mg/L	19	6	0.005	0.016	0.04	0.05	0.018	0.013	0.004
Iron	mg/L	19	7	0.015	0.054	0.14	0.2	0.068	0.048	0.3
Lead	mg/L	19	11	0.0007	0.025	0.03	0.025	0.016	0.011	0.007
Manganese	mg/L	19	0	0.0408	0.214	0.80	0.964	0.286	0.258	-
Selenium	mg/L	19	15	0.0001	0.1	0.1	0.1	0.058	0.051	0.001
Silver	mg/L	19	12	0.00001	0.005	0.0055	0.01	0.003	0.003	0.0001
Strontium	mg/L	19	0	0.112	0.785	1.02	1.04	0.748	0.247	-
Tin	mg/L	19	19	0.0005	0.015	0.015	0.015	0.009	0.007	-
Vanadium	mg/L	19	11	0.0002	0.015	0.015	0.015	0.009	0.007	-
Zinc	mg/L	19	0	0.16	0.73	1.33	1.38	0.732	0.333	0.03

Note: Based on “Top” water samples only; - indicates no data available.

The concentrations of each COPC in water at the various receptor locations that were considered in the assessment are summarized in Table 2.2-7. Samples collected from each aquatic area (Reference, Dome Creek, Pony Creek, Victoria Creek, Tailings Pond, and Brown-McDade Pit) were evaluated and the reasonable maximum concentration (represented by the 95th percentile when more than 20 samples were available and the maximum when less than 20 samples were available) was used in the risk assessment.

Table 2.2-7 Summary of COPC Concentrations in Water Used in the Assessment

Routine Parameters and Nutrients		Dome Creek 95th Perc.	Pony Creek 95th Perc.	Victoria Creek 95th Perc.	Reference Max	Tailings Pond 95th Perc.	Brown McDade Pit Max
Chloride	mg/L	2.86	2.40	1.2	1.10	3.1	1.5
Sulphate	mg/L	996.5	129.00	95.3	2.60	2191	1290
Ammonia-N	mg/L	7.89	0.03	0.14	0.03	35.1	0.21
Cyanide Compounds							
Cyanate	mg/L	4.6	0.20	0.46	0.25	88	-
Thiocyanate	mg/L	6.2	1.40	2.2	1.7	107	1.13
Total Metals							
Antimony	mg/L	0.10	0.004	0.10	0.1	0.1	0.1
Arsenic	mg/L	0.18	0.24	0.10	0.1	0.20	0.1
Barium	mg/L	0.17	0.10	0.12	0.066	0.05	0.02
Boron	mg/L	0.11	0.00	0.05	0.05	0.31	0.05
Cadmium	mg/L	0.005	0.0061	0.01	0.005	0.005	0.015
Chromium	mg/L	0.008	0.0033	0.005	0.0061	0.005	0.005
Cobalt	mg/L	0.03	0.00	0.01	0.005	0.14	0.005
Copper	mg/L	0.27	0.09	0.02	0.009	19.1	0.05
Iron	mg/L	12.1	8.28	1.84	1.7	4.0	0.2
Lead	mg/L	0.03	0.17	0.03	0.025	0.08	0.025
Manganese	mg/L	5.6	0.77	0.18	0.072	10.2	0.964
Selenium	mg/L	0.10	0.0006	0.10	0.1	0.1	0.1
Silver	mg/L	0.005	0.0016	0.01	0.005	0.06	0.01
Strontium	mg/L	0.80	0.36	0.37	0.269	1.5	1.04
Tin	mg/L	0.80	0.01	0.37	0.015	0.025	0.015
Vanadium	mg/L	0.02	0.0005	0.02	0.015	0.029	0.015
Zinc	mg/L	0.18	0.42	0.02	0.016	0.25	1.38

2.2.2 Sediment Quality

The total metals concentrations in sediment measured at the Mt. Nansen Mine between 1988 and 2006 from Dome Creek, Pony Creek, and Victoria Creek were used in the assessment. Measurements from a reference sampling location "upstream of mine development" were used to determine the background concentrations. The three samples from the reference location were collected in 1988. Sediment data were not available for the Tailings Pond and the Brown-McDade Pit and therefore, sediment concentrations at these locations were estimated as described in Section 2.2.2.1. For the purposes of calculating summary statistics, observations reported as less than MDL were assumed to be at half of the MDL.

2.2.2.1 Dome Creek

Sediment data were collected from different sampling locations in Dome Creek (sampling locations D1, D2, D3, D4, D5, D5_1, "at final discharge of tailings dam") and are summarized in Table 2.2-8.

2.2.2.2 Pony Creek

Sediment data were collected from different sampling locations in Pony Creek (B1, B1_1, P1, P2, P3) and are summarized in Table 2.2-9.

2.2.2.3 Victoria Creek

Sediment data were collected from different sampling locations in Victoria Creek (V1, V2, V3, V4, V5) and are summarized in Table 2.2-10.

2.2.2.4 Reference Locations

Sediment data were collected from a reference location ("upstream of mine development") are summarized in Table 2.2-11.

Table 2.2-8 Summary of Sediment Quality Data for COPC in Dome Creek

Dome Creek Total Metals		N	N<MDL	Min	Mean	95th Percentile	Max	St Dev
Antimony	mg/kg	31	11	0.25	19	70	99.6	26
Arsenic	mg/kg	41	0	11	570	2500	2760	765
Barium	mg/kg	40	0	42	154	412	444	125
Boron	mg/kg	10	9	0.5	7	34.9	63	20
Cadmium	mg/kg	41	8	0.025	6	26.4	48	10
Chromium	mg/kg	40	0	8	23	55	60.4	15
Cobalt	mg/kg	41	0	1.9	11	20	29.9	8
Copper	mg/kg	41	0	5.4	50	157	683	107
Iron	mg/kg	40	0	7380	27296	52390	88500	17047
Lead	mg/kg	41	2	2.5	152	530	1030	241
Manganese	mg/kg	41	0	88	1952	14100	20400	4418
Selenium	mg/kg	31	14	0.1	2	8	8	3
Silver	mg/kg	41	15	0.055	2	7	15.7	3
Strontium	mg/kg	40	0	12	39	77	77	21
Tin	mg/kg	41	9	0.3	5	10	32	6
Vanadium	mg/kg	41	0	15	55	110	140	32
Zinc	mg/kg	41	0	27	601	3030	4680	1038

Table 2.2-9 Summary of Sediment Quality Data for COPC in Pony Creek

Pony Creek Total Metals		N	N<MDL	Min	Mean	95th Percentile	Max	St Dev
Antimony	mg/kg	8	1	0.8	62	234	310	108
Arsenic	mg/kg	8	0	21.5	838	3269	4480	1531
Barium	mg/kg	8	0	85.4	233	577	669	202
Boron	mg/kg	0	0	0	--	--	0	--
Cadmium	mg/kg	8	0	0.3	8	28	31.5	12
Chromium	mg/kg	8	0	10.4	15	23	26.7	5
Cobalt	mg/kg	8	0	3	6	11	11.3	3
Copper	mg/kg	8	0	7.44	203	822	1150	389
Iron	mg/kg	8	0	14200	37638	88360	106000	30498
Lead	mg/kg	8	0	12.7	628	2802	4090	1408
Manganese	mg/kg	8	0	153	1257	2877	3360	1056
Selenium	mg/kg	8	8	0.15	0.4	1.0	1.0	0.4
Silver	mg/kg	8	0	0.2	15	69	98.9	34
Strontium	mg/kg	8	0	22.1	44	84	93	27
Tin	mg/kg	8	1	0.4	0.6	0.9	1.0	0.2
Vanadium	mg/kg	8	0	28.1	44	59	61	13
Zinc	mg/kg	8	0	69.3	521	1677	2070	701

Table 2.2-10 Summary of Sediment Quality Data for COPC in Victoria Creek

Victoria Creek Total Metals		N	N<MDL	Min	Mean	95th Percentile	Max	St Dev
Antimony	mg/kg	42	11	0.25	6	20	21	6
Arsenic	mg/kg	55	0	2.5	29	63.2	97	24
Barium	mg/kg	54	0	54.6	167	375.2	434	109
Boron	mg/kg	12	9	0.5	4.7	23.225	51	15
Cadmium	mg/kg	55	8	0.1	0.5	0.92	2.3	0.4
Chromium	mg/kg	54	0	7.67	22	35.215	68.7	11
Cobalt	mg/kg	55	0	2.5	12	20.3	23.5	8
Copper	mg/kg	55	0	4	29	76.54	127	25
Iron	mg/kg	54	0	9580	25242	40470.5	49620	11195
Lead	mg/kg	55	2	1	34	80.2	387	57
Manganese	mg/kg	55	0	113	567	1372	3560	614
Selenium	mg/kg	42	14	0.1	3	8	8	4
Silver	mg/kg	55	15	0.055	1	2.0	2.0	0.8
Strontium	mg/kg	54	0	13	43	79	89.2	24
Tin	mg/kg	55	9	0.3	5.3	8.0	8.0	3
Vanadium	mg/kg	55	0	22.6	64	100	120	27
Zinc	mg/kg	55	0	26	78	150.52	228	47

Table 2.2-11 Summary of Sediment Quality Data for COPC at Reference Location

Reference							
Total Metals		N	Min	Mean	95th Percentile	Max	St Dev
Antimony	mg/kg	0	--	--	--	--	--
Arsenic	mg/kg	3	87	101	117.7	120	17
Barium	mg/kg	3	125	127	128.9	129	2
Boron	mg/kg	0	--	--	--	--	--
Cadmium	mg/kg	3	0.63	0.7	0.86	0.89	0.2
Chromium	mg/kg	3	12	13	13.9	14	1
Cobalt	mg/kg	3	20	20	20	20	0
Copper	mg/kg	3	11	11	11.9	12	1
Iron	mg/kg	3	13700	14133	14790	14900	666
Lead	mg/kg	3	22.4	25	28.4	28.8	3
Manganese	mg/kg	3	297	331	370.4	376	41
Selenium	mg/kg	0	--	--	--	--	--
Silver	mg/kg	3	2	2	2.0	2.0	0.0
Strontium	mg/kg	3	29	30	30.1	30.1	1
Tin	mg/kg	3	8	8.0	8.0	8.0	0
Vanadium	mg/kg	3	43	44	44.9	45	1
Zinc	mg/kg	3	108	111	115.3	116	4

2.2.2.5 Development of Site-Specific Sediment Distribution Coefficients

As seen from the previous discussion, sediment measurements were not available for the Tailings Pond and the Brown-McDade Pit; therefore, it was necessary to estimate sediment concentrations in these waterbodies. The simplest and most commonly used methodology to predict sediment concentrations is to apply a distribution coefficient to the water concentration to estimate the sediment concentration. It is recognized that the use of a distribution coefficient does not take into account the many different sediment processes (i.e. burial, resuspension etc.); however, it provides a reasonable estimate of the sediment concentration.

In order to develop site-specific water-to-sediment distribution coefficients, water quality data measured in Dome Creek, Pony Creek and Victoria Creek were matched with sediment samples collected in the vicinity of the sediment locations. The following water and sediment sampling locations were paired: D1 and D1; Dome Creek @ Road and D5; Pony D/S and P1; Victoria Creek @ Road and V4; Upper Vic Site and V2. For each site, the average sediment concentrations were divided by the corresponding average water concentrations to obtain an estimate of the water-to-sediment distribution coefficients for all COPC. For each COPC, if three water samples or less were measured with concentrations above the MDL for a sampling location, then the water-to-sediment distribution coefficient for this COPC was not calculated at this particular location.

The estimated distribution coefficients were then summarized and the mean values were used as the site-specific water-to-sediment coefficients as shown on Table 2.2-12. These mean values are based on two to five sampling stations. Distribution coefficients from the literature are provided for perspective. It is generally accepted that site-specific distribution coefficients are better to use in assessments than literature-derived values. The table also demonstrates that the site-specific distribution co-efficients are larger than the literature distribution co-efficients with the exception of cadmium, copper, strontium and tin.

It should be noted that there is some uncertainty in applying distribution coefficients based on sediment measurements in Dome Creek, Pony Creek, and Victoria Creek to the sediments in the Tailings Pond and Brown-McDade Pit and this will be addressed in the Uncertainty Section (Section 6.5).

Table 2.2-12 Site-Specific Water-to-Sediment Distribution Coefficient Factors for the Mt. Nansen Site

COPC	No. of Sampling Stations	Site-Specific Distribution Coefficient (mg/kg (dw)/(mg/L))	Literature Distribution Coefficient[a] (mg/kg (dw)/(mg/L))
Antimony	4	500	45
Arsenic	5	5,300	31
Barium	5	4,200	60
Boron	4	160	3.0
Cadmium	5	2,200	4,300
Chromium	5	13,300	30
Cobalt	5	7,400	5,000
Copper	5	5,300	10,000
Iron	5	46,500	25
Lead	5	8,500	900
Manganese	5	8,000	1,000
Selenium	3	25	2.2
Silver	5	1,100	1,100
Strontium	5	130	1,000
Tin	2	740	13,000
Vanadium	5	19,500	50
Zinc	5	6,200	500

Note: [a] - All literature values obtained from U.S. EPA (1998) with the exception of: boron, and iron (Baes et al. 1984), barium and chromium (Bechtel Jacobs 1998), cobalt and zinc (IAEA 1994, Bechtel Jacobs 1998), manganese, silver, and strontium (IAEA 1994), and tin (U.S. NRC 1992).

The concentrations of each COPC in sediment at the various receptor locations that were considered in the assessment are summarized in Table 2.2-13. Samples collected from each aquatic area (Reference, Dome Creek, Pony Creek, Victoria Creek) were evaluated and the reasonable maximum concentration (represented by the 95^{th} percentile when more than 20 samples were available and the maximum when less than 20 samples were available) was used in the risk assessment. Sediment concentrations in the Tailings Pond and Brown-McDade Pit were estimated using site-specific water-to-sediment distribution coefficients.

Table 2.2-13 Summary of COPC Concentrations in Sediment Used in the Assessment

Total Metals mg/kg dw	**Dome Creek 95th Per.**	**Pony Creek Max**	**Victoria Creek 95th Per.**	**Reference Max**	**Tailings Pond Calc.**	**Brown-McDade Pit Calc.**
Antimony	70	310	20	--	50	50
Arsenic	2500	4480	63.2	120	1063	530
Barium	412	669	375.2	129	227	84
Boron	34.9	0	23.225	--	50	8
Cadmium	26.4	31.5	0.92	0.89	11	34
Chromium	55	26.7	35.215	14	67	67
Cobalt	20	11.3	20.3	20	1058	37
Copper	157	1150	76.54	12	100965	265
Iron	52390	106000	40470.5	14900	186326	9300
Lead	530	4090	80.2	28.8	663	213
Manganese	14100	3360	1372	376	81440	7712
Selenium	8	1.0	8	--	3	3
Silver	7	98.9	2.0	2.0	71	11
Strontium	77	93	79	30.1	194	135
Tin	10	1.0	8.0	8.0	25	15
Vanadium	110	61	100	45	566	293
Zinc	3030	2070	150.52	116	1548	8556

Note: -- - no value
95th Per. – 95th Percentile Calc. – Calculated
dw – dry weight

2.2.3 Fish Concentrations

Fish samples from slimy sculpin and burbot were collected and analyzed for metals concentrations during the field investigation conducted in 2005 and 2006 by EDI (2007). Fish caught in Victoria Creek sampling locations Vic3 (downstream from Dome Creek) and Vic4 (downstream of the road crossing) were selected for use in this assessment. Fish collected from Vic5 (outlet of Victoria Lake) and Rowlinson Creek (reference location) were considered to represent background concentrations outside the influence of the site for the purposes of this assessment.

Slimy sculpin were selected by EDI (2007) as the primary species to monitor COPC concentrations in the vicinity of the site because they are less mobile. Due to their reduced mobility and non-migratory behavior, they are expected to be exposed to site impacts for longer exposure periods and therefore are considered a good indicator species. Slimy sculpin were analyzed on a whole body basis due to the small size of the species and the whole body samples were considered in the assessment. However, only fish flesh (muscle) concentrations for burbot were used in the assessment. The COPC concentrations in these species were pooled and a summary of COPC concentrations in fish tissue (slimy sculpin (whole body) and burbot (muscle)) used in the assessment is given in Table 2.2-14. Dry weight concentrations reported by the laboratory are converted to fresh weight based on the reported sample moisture content. Maximum concentrations from the mine area (less than 20 samples were available) and 95th percentile concentrations from the reference location (more than 20 samples were available) were used in the risk assessment and are shaded in the Table 2.2-14.

Table 2.2-14 Summary of COPC Concentrations in Fish Tissue

COPC	Units	Mine Area						Reference Location					
		N	N <MDL	Min	Mean	95th Per.	Max	N	N <MDL	Min	Mean	95th Per.	Max
Antimony	µg/g (ww)	19	19	0.010	0.013	0.016	0.02	24	24	0.01	0.02	0.02	0.06
Arsenic	µg/g (ww)	19	0	0.20	0.4	0.6	0.7	24	0	0.06	0.15	0.26	0.27
Barium	µg/g (ww)	19	0	0.13	2.5	4.3	5.7	24	0	0.05	2.7	5.5	6.3
Boron	µg/g (ww)	19	19	0.21	0.26	0.32	0.40	24	24	0.2	0.3	0.3	1.2
Cadmium	µg/g (ww)	19	4	0.002	0.04	0.09	0.10	24	10	0.00	0.02	0.07	0.08
Chromium	µg/g (ww)	19	4	0.01	0.06	0.11	0.22	24	12	0.01	0.05	0.19	0.29
Cobalt	µg/g (ww)	19	4	0.01	0.07	0.11	0.15	24	4	0.01	0.06	0.15	0.23
Copper	µg/g (ww)	19	0	0.55	0.92	1.25	1.30	24	0	0.4	1.0	1.6	1.7
Iron	µg/g (ww)	19	0	5	88	188	312	24	0	4.5	70	118	254
Lead	µg/g (ww)	19	6	0.01	0.05	0.12	0.22	24	13	0.01	0.02	0.06	0.10
Manganese	µg/g (ww)	19	0	0.73	14.3	28.0	35.2	24	0	0.5	12.0	24.1	31.7
Selenium	µg/g (ww)	19	0	0.16	0.89	1.84	2.44	24	0	0.1	0.5	1.5	1.7
Silver	µg/g (ww)	19	9	0.001	0.003	0.006	0.008	24	14	0.001	0.002	0.003	0.006
Strontium	µg/g (ww)	19	0	0.38	15.83	28.54	29.03	24	0	0.4	19.7	38.9	50.2
Tin	µg/g (ww)	19	15	0.010	0.020	0.049	0.093	24	21	0.010	0.027	0.084	0.164
Vanadium	µg/g (ww)	19	4	0.05	0.32	0.69	0.74	24	5	0.05	0.27	0.45	0.55
Zinc	µg/g (ww)	19	0	5.7	18.3	25.2	25.3	24	0	5.2	19.2	27.3	28.4

Notes: Analytical results reported as less than method detection limit (MDL) were assumed to be equal to ½ method detection limit in the calculation of minimum, mean, 95th percentile and maximum.
Values presented are for pooled samples of slimy sculpin (whole body) and burbot (muscle).
Shading indicates the concentrations used in the risk assessment.
ww – wet weight

2.2.4 Benthic Invertebrate and Aquatic Vegetation Concentrations

Benthic invertebrate and aquatic vegetation concentrations were not available for the site. Therefore, concentrations in these media were predicted using literature transfer factors based on water. Table 2.2-15 summarizes the transfer factors (TFs) used to predict concentrations of COPC in benthic invertebrates and aquatic vegetation. A sample calculation to demonstrate the use of transfer factors is provided in Appendix C. Table 2.2-16 summarizes the concentrations in benthic invertebrates used in the assessment and Table 2.2-17 summarizes the concentrations in aquatic vegetation used in the assessment.

Table 2.2-15 Summary of Transfer Factors used in Exposure Calculations for Aquatic Ecological Receptors

COPC	Benthic Invertebrates		Aquatic Vegetation	
	L/kg ww	Reference	L/kg ww	Reference
Antimony	10	NRCC 1983	1,500	NRCC 1983
Arsenic	1,700	U.S. EPA 1979, COGEMA 1997	5	CSA1987, Bird and Schwartz 1996
Barium	200	NRCC 1983	500	NRCC 1983
Boron	N/A		N/A	
Cadmium	4,000	U.S. EPA 1979	1,900	Bird and Schwartz 1996
Chromium	20	NRCC 1983	0.12	Bird and Schwartz 1996
Cobalt	1,000	assumed from copper, nickel and selenium	1,200	Bird and Schwartz 1996
Copper	1,000	U.S. EPA 1979	1,000	ORNL 1976
Iron	N/A		N/A	
Lead	100	U.S. EPA 1979	150	Bird and Schwartz 1996
Manganese	7.5×10^{-2}	Bird and Schwartz 1996	170	Bird and Schwartz 1996
Selenium	680	NTIS 1985 and measured data from Northern Ontario, Elliot Lake	63	Santschi and Honeyman 1989
Silver	770	NRCC 1983	200	NRCC 1983
Strontium	450	Bird and Schwartz 1996	260	Bird and Schwartz 1996
Tin	1,000	NRCC 1983	100	NRCC 1983
Vanadium	100	NRCC 1983, assumed same as niobium	2,000	U.S. NRC 1977
Zinc	7,600	COGEMA 2003, 2004	550	NTIS 1988, CSA 1987

Note: N/A - not available
ww – wet weight

Table 2.2-16 Summary of COPC Concentrations in Benthic Invertebrate Used in the Assessment

Total Metals mg/kg ww	Dome Creek Calc.	Pony Creek Calc.	Victoria Creek Calc.	Reference Calc.	Tailings Pond Calc.	Brown-McDade Pit Calc.
Antimony	1	0.04	1	1	1	1
Arsenic	306	410.8	170	170	341.0	170
Barium	34.8	19.54	23.18	13.2	10.8	4
Boron	--	--	--	--	--	--
Cadmium	20	24.2	20	20	20	61.6
Chromium	0.16	0.07	0.1	0.12	0.1	0.1
Cobalt	30.7	1.895	5	5	143	5
Copper	266.4	93.3	18.9	9	19050	50
Iron	--	--	--	--	--	--
Lead	2.5	16.9	2.5	2.5	7.8	2.5
Manganese	0.42	0.058	0.013	0.005	0.76	0.072
Selenium	68	0.4012	68	68	68	68
Silver	3.85	1.20	3.85	3.85	49.9	7.7
Strontium	360.9	163.17	167.31	121.05	670.05	468
Tin	15	0.5	15	15	25	15
Vanadium	2.35	0.799	1.5	1.5	2.9	1.5
Zinc	7124	16624	720	640	9988	55200

Note: -- – no value
ww – wet weight

Table 2.2-17 Summary of COPC Concentrations in Aquatic Vegetation Used in the Assessment

Total Metals mg/kg ww	Dome Creek Calc.	Pony Creek Calc.	Victoria Creek Calc.	Reference Calc.	Tailings Pond Calc.	Brown-McDade Pit Calc.
Antimony	150	6.7	150	150	150	150
Arsenic	0.9	1.21	0.5	0.5	1.0	0.5
Barium	87.1	48.9	57.95	33	27	10
Boron	--	--	--	--	--	--
Cadmium	9.5	11.5	9.5	9.5	9.5	29.3
Chromium	0.00096	0.0004	0.0006	0.0007	0.0006	0.0006
Cobalt	36.84	2.27	6	6	171.6	6
Copper	266.4	93.3	18.9	9	19050	50
Iron	--	--	--	--	--	--
Lead	3.75	25.5	3.75	3.75	11.7	3.75
Manganese	958.97	131.5	29.9	12.24	1730.6	163.9
Selenium	6.3	0.04	6.3	6.3	6.3	6.3
Silver	1	0.31	1	1	12.98	2
Strontium	208.5	94.3	96.7	69.94	387.1	270.4
Tin	1.5	0.05	1.5	1.5	2.5	1.5
Vanadium	47	15.98	30	30	58	30
Zinc	97.9	228.6	9.9	8.8	137.3	759

Note: -- – no value
ww – wet weight

2.3 TERRESTRIAL ENVIRONMENT

The Mt. Nansen Terrestrial and Aquatic Effects Study 2005-2006 (EDI 2007) presents the results from extensive soil, vegetation, and small animal sampling completed around the Mt. Nansen Mine site, as well as from upland (reference) areas. Ungulate (caribou and moose) sample concentrations were also presented in EDI (2007).

The summary tables presented in this section are for the COPC that were identified in the terrestrial environment.

2.3.1 Soil Data

Soil data were provided by EDI (2007). Soil samples were collected from three soil horizons (A, B, and C). The A Horizon was mineral soil above the ash layer; the B Horizon was the ash layer; and the C Horizon was the mineral soil below the ash layer. For the purposes of the assessment, only data from the top (A) soil horizon was considered since terrestrial receptors and humans generally only contact the first 5 cm of soil and aerial deposition also occurs on the surface.

Table 2.3-1 summarizes the concentrations of COPC in soil samples from the reference and mine site areas.

Table 2.3-1 Summary of Soil Quality Data for Background and Mine Site Areas

COPC	Units	N	N <MDL	Min	Mean	95th Percentile	Max
Background							
Arsenic	mg/kg dw	3	0	11	42	80	85
Boron	mg/kg dw	3	2	0.5	0.6	0.9	0.9
Cadmium	mg/kg dw	3	0	0.3	1.3	2.1	2.2
Copper	mg/kg dw	3	0	12	19	28	30
Lead	mg/kg dw	3	0	8.9	16.0	26.3	28.0
Manganese	mg/kg dw	3	0	121	204	334	356
Selenium	mg/kg dw	3	3	0.1	0.1	0.1	0.1
Strontium	mg/kg dw	3	0	8	19	29	30
Tin	mg/kg dw	3	3	2.5	2.5	2.5	2.5
Zinc	mg/kg dw	3	0	31	68	106	111
Mill Site							
Arsenic	mg/kg dw	10	3	5	110.5	397	485
Boron	mg/kg dw	10	7	0.5	1.5	4.75	7
Cadmium	mg/kg dw	10	1	0.25	1.6	3.9	4.6
Copper	mg/kg dw	10	0	19	35.3	50	54
Lead	mg/kg dw	10	5	2.5	20.0	84	129
Manganese	mg/kg dw	10	0	121	1,536	4,103	5,930
Selenium	mg/kg dw	10	1	0.1	0.6	1.5	2
Strontium	mg/kg dw	10	0	22	60.5	98	100
Tin	mg/kg dw	10	10	2.5	2.5	2.5	2.5
Zinc	mg/kg dw	10	0	12	76.5	200	253
Tailings Site							
Arsenic	mg/kg dw	6	3	5	52	169.8	201
Boron	mg/kg dw	6	5	0.5	3.3	12.9	17
Cadmium	mg/kg dw	6	4	0.25	1.3	3.8	4.3
Copper	mg/kg dw	6	0	5	30	90.5	110
Lead	mg/kg dw	6	3	2.5	5.1	9.25	10
Manganese	mg/kg dw	6	0	66	1,986	7,770	9,880
Selenium	mg/kg dw	6	3	0.1	0.3	0.6	0.7
Strontium	mg/kg dw	6	0	12	29	57.25	66
Tin	mg/kg dw	6	5	2.5	3	5.125	6
Zinc	mg/kg dw	6	0	14	53	140	159

Table 2.3-1 Summary of Soil Quality Data for Background and Mine Site Areas (Cont'd)

COPC	Units	N	N <MDL	Min	Mean	95th Percentile	Max
Brown-McDade Pit							
Arsenic	mg/kg dw	6	4	5	7.5	13.3	14
Boron	mg/kg dw	6	4	0.5	1.17	2.75	3
Cadmium	mg/kg dw	6	0	1	3.8	6.1	6.5
Copper	mg/kg dw	6	0	7	23.7	39.8	42
Lead	mg/kg dw	6	6	2.5	2.5	2.5	2.5
Manganese	mg/kg dw	6	0	66	937	2,513	2,840
Selenium	mg/kg dw	6	2	0.1	0.35	0.58	0.6
Strontium	mg/kg dw	6	0	23	78.2	136	150
Tin	mg/kg dw	6	6	2.5	2.5	2.5	2.5
Zinc	mg/kg dw	6	0	18	47.0	92.5	105

Notes: Analytical results reported as less than method detection limit (MDL) were assumed to be equal to ½ method detection limit in the calculation of minimum, mean and maximum.
Represented by concentrations in the soil horizon "A" – mineral soil above the ash layer.

As seen from Table 2.3-1, in general, the soil concentrations in mine areas are higher than the reference location. For the purpose of ecological risk assessment, receptors were assumed to be present in different areas at the site. These receptor locations were defined based on home range of the species and the specific areas of interest at the site (i.e., mill, tailings pond, Brown-McDade Pit). A detailed discussion of the receptors selected for the assessment, their home ranges and diets and the areas where the species were assumed to be present in the study area is provided in Section 3.1. A brief discussion of the species home ranges is provided below for the purpose of identifying the basis used to characterize soil and vegetation levels across the study area.

For small local mammals such as hares and porcupine and terrestrial birds such as grouse and gray jay, the site was divided up into four smaller locations since these animals have a small home range. These locations have been defined as follows: Background, Mill Site, Tailings Site (around the Tailings Pond), and Brown-McDade Pit Site (around the Brown-McDade Pit). The background area includes upland soil and vegetation concentrations and samples collected from reference locations and Rowlinson Creek. Figure 2.3-1 shows the locations of these areas.

Slightly larger areas are defined for mammals such as bear, bison, and marten which have a larger home range. These are defined as: Background (same as the background used for small local mammals) and the Mine Site (area around the Mt. Nansen Site).

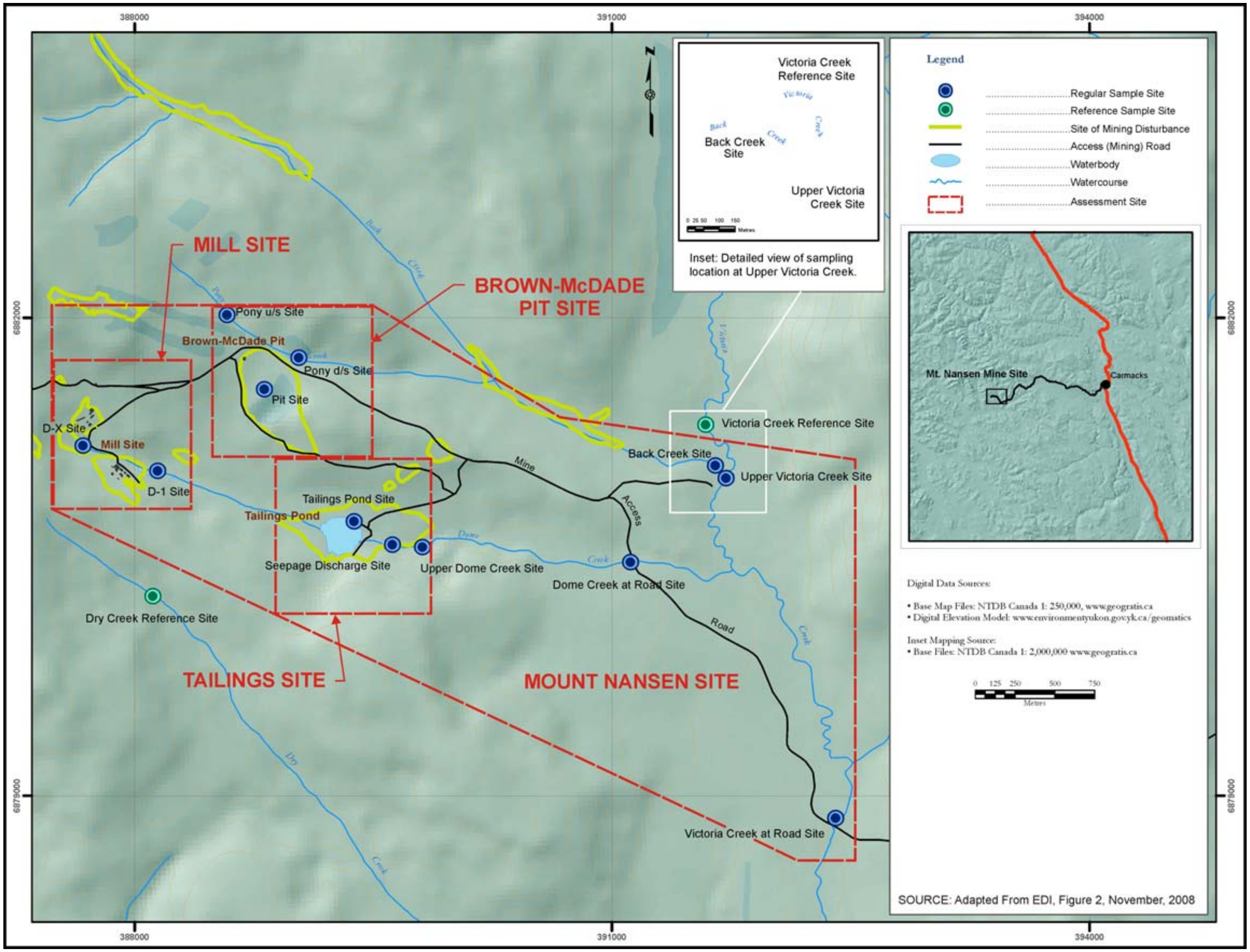
For mammals with a very large home range such as caribou, moose and wolf, it was assumed that they would be present across the mine site for a portion of the year.
The concentrations of each COPC in soils at the various receptor locations that were considered in the assessment are summarized in Table 2.3-2. Samples collected from each of the four defined terrestrial areas (Background, Mill Site, Tailings Site, and Brown-McDade Pit) were evaluated and the reasonable maximum concentration (represented by the 95th percentile when more than 20 samples were available and the maximum when less than 20 samples were available) was used in the risk assessment.

COPC concentrations in soil for the Mine Site were represented as the maximum concentration of the Mill Site, Tailings Site, and Brown-McDade Pit.

Table 2.3-2 Summary of COPC Concentrations in Soil Used in the Assessment

COPC	Units	Mill Site Max	Tailings Site Max	Brown-McDade Site Max	Background Max	Mine Site Max (Areas)
Arsenic	mg/kg dw	485	201	14	85.2	201
Boron	mg/kg dw	7	17	3	0.9	17
Cadmium	mg/kg dw	4.6	4.3	6.5	2.22	6.5
Copper	mg/kg dw	54	110	42	30	110
Lead	mg/kg dw	129	10	2.5	28	129
Manganese	mg/kg dw	5,930	9,880	2,840	356	9,880
Selenium	mg/kg dw	2	0.7	0.6	0.1	2
Strontium	mg/kg dw	100	66	150	30	150
Tin	mg/kg dw	2.5	6	2.5	2.5	6
Zinc	mg/kg dw	253	159	105	111	253

Figure 2.3-1 Ecological Receptor Locations Considered in the Assessment



2.3.2 Terrestrial Vegetation Data

Extensive vegetation sampling was completed in 2005 and 2006 from around the Mt. Nansen Mine site and COPC concentrations in various types of vegetation are available (EDI 2007). Vegetation types sampled include: trembling aspen, blueberry, cranberry, foxtail barley, lichen, sphagnum moss, bolete mushroom, rose hip, spruce, Labrador tea, willow, and wheatgrass.

Mill Site (transects G, H, I, J, K, L and samples Dome-6, Dome-7), Tailings Site (transects A, B, C, D, E, F and samples FG, Dome-1, Dome-2, Dome-3, Dome-4, Dome-5), and Brown-McDade Pit (transects M, N, O, P, Q, R and samples EM3, V1, V2, V3, V4, Pony1, Pony2, Pony3, Dust1, Dust2, Dust3) were assessed separately. Measurements from a reference sampling location (CP-1, CP-2, CP-3, CP-4, CP-5, CP-6, CP-7, CP-8, CP-9) were used to determine the background concentrations.

Tables 2.3-3 to 2.3-8 summarize COPC concentrations for each vegetation type in both the background and mine areas. Forage (Table 2.3-3), browse (Table 2.3-4), berries (Table 2.3-5), lichen (Table 2.3-6), fungi (Table 2.3-7), and evergreens (Table 2.3-8) are consumed by wildlife in the area. In the ecological risk assessment, wheatgrass, foxtail barley, and Labrador tea were grouped as forage and cranberry (foliage), willow and trembling aspen as browse and their concentrations are summarized for each receptor locations as defined in Section 2.3.1. Berries were characterized by blueberry, cranberry, and crowberry. Fungi were characterized by bolete mushroom and evergreens were represented by spruce. Dry weight concentrations reported by the laboratory are converted to fresh weight based on the reported sample moisture content, when available. In the absence of reported sample moisture content, an average moisture content for the vegetation type was used and in the absence of moisture content data for the vegetation type, an assumed moisture content of 70% was used.

Maximum concentrations were used in the risk assessment when less than 20 samples were available and 95th percentile concentrations were used when more than 20 samples were available. Concentrations used in the risk assessment are shaded in the Tables 2.3-3 to 2.3-8.

Table 2.3-3 Summary of COPC Concentrations in Forage Vegetation from the Mt. Nansen Site

COPC	Units	N	N <MDL	Min	Mean	95th Percentile	Max
Background							
Arsenic	mg/kg ww	13	7	0.02	0.04	0.12	0.15
Boron	mg/kg ww	13	0	1.1	5.5	9.3	10.5
Cadmium	mg/kg ww	13	6	0.004	0.02	0.07	0.09
Copper	mg/kg ww	13	0	1.2	1.6	1.9	2.0
Lead	mg/kg ww	13	8	0.02	0.68	3.8	5.9
Manganese	mg/kg ww	13	0	10	439	937	964
Selenium	mg/kg ww	13	13	0.04	0.04	0.05	0.05
Strontium	mg/kg ww	13	0	2.6	3.6	5.3	5.8
Tin	mg/kg ww	13	12	0.02	0.03	0.05	0.08
Zinc	mg/kg ww	13	0	6.5	11.4	14.1	15.3
Mill Site							
Arsenic	mg/kg ww	24	2	0.02	0.6	2	5
Boron	mg/kg ww	24	0	2.0	9.0	18	22
Cadmium	mg/kg ww	24	7	0.0	0.1	0.2	0.6
Copper	mg/kg ww	24	0	1.0	1.7	2.1	2.2
Lead	mg/kg ww	24	5	0.02	0.4	2.0	3.0
Manganese	mg/kg ww	24	0	29	349	767	938
Selenium	mg/kg ww	24	24	0.040	0.045	0.047	0.051
Strontium	mg/kg ww	24	0	2.0	3.9	6	9
Tin	mg/kg ww	24	23	0.02	0.04	0.03	0.33
Zinc	mg/kg ww	24	0	9	19	42	91
Tailings Site							
Arsenic	mg/kg ww	14	6	0.02	2.5	12.1	24.4
Boron	mg/kg ww	14	0	3.4	6.7	10.5	15.9
Cadmium	mg/kg ww	14	4	0.0	0.1	0.4	0.8
Copper	mg/kg ww	14	0	1.2	3.5	11.5	26.2
Lead	mg/kg ww	14	5	0.02	2.3	11.4	24.2
Manganese	mg/kg ww	14	0	25	476	916	1226
Selenium	mg/kg ww	14	14	0.039	0.048	0.052	0.052
Strontium	mg/kg ww	14	0	1.6	4.3	8.8	9.9
Tin	mg/kg ww	14	14	0.019	0.024	0.026	0.026
Zinc	mg/kg ww	14	0	7	20	70	99

Table 2.3-3 Summary of COPC Concentrations in Forage Vegetation from the Mt. Nansen Site (Cont'd)

COPC	Units	N	N <MDL	Min	Mean	95th Percentile	Max
Brown-McDade Pit							
Arsenic	mg/kg ww	21	1	0.02	0.94	5.8	7.4
Boron	mg/kg ww	21	0	1.9	7.4	14.0	15.8
Cadmium	mg/kg ww	21	3	0.005	0.09	0.31	0.41
Copper	mg/kg ww	21	0	1.2	2.0	4.1	5.3
Lead	mg/kg ww	21	4	0.02	0.64	2.42	6.09
Manganese	mg/kg ww	21	0	18	300	772	810
Selenium	mg/kg ww	21	21	0.04	0.05	0.05	0.05
Strontium	mg/kg ww	21	0	2.0	4.8	6.5	10.6
Tin	mg/kg ww	21	21	0.021	0.023	0.025	0.025
Zinc	mg/kg ww	21	0	8.6	35.5	117	125

Notes: Analytical results reported as less than method detection limit (MDL) were assumed to be equal to ½ method detection limit in the calculation of minimum, mean and maximum.
Forage: wheatgrass, foxtail barley, and Labrador tea
Moisture content reported by laboratory or assumed to be equal to the average moisture content of other forage samples.
Shading indicates the concentrations used in the risk assessment.
ww – wet weight

Table 2.3-4 Summary of COPC Concentrations in Browse Vegetation from the Mt. Nansen Site

COPC	Units	N	N <MDL	Min	Mean	95th Percentile	Max
Background							
Arsenic	mg/kg ww	11	5	0.02	0.04	0.08	0.12
Boron	mg/kg ww	11	0	2.1	3.3	4.6	5.0
Cadmium	mg/kg ww	11	0	0.82	3.3	8.7	11.4
Copper	mg/kg ww	11	0	1.0	1.5	1.8	1.9
Lead	mg/kg ww	11	2	0.02	0.13	0.49	0.89
Manganese	mg/kg ww	11	0	78	232	569	768
Selenium	mg/kg ww	11	11	0.038	0.041	0.046	0.049
Strontium	mg/kg ww	11	0	22	39	60	60
Tin	mg/kg ww	11	10	0.019	0.023	0.033	0.042
Zinc	mg/kg ww	11	0	34	69	168	272
Mill Site							
Arsenic	mg/kg ww	22	1	0.02	4.2	24	55
Boron	mg/kg ww	22	0	1.5	9.9	34	85
Cadmium	mg/kg ww	22	0	0.4	3.2	11.1	20.7
Copper	mg/kg ww	22	0	0.8	1.7	3.4	4.0
Lead	mg/kg ww	22	1	0.02	2.3	14.9	25.0
Manganese	mg/kg ww	22	0	31	165	316	609
Selenium	mg/kg ww	22	22	0.036	0.038	0.038	0.039
Strontium	mg/kg ww	22	0	5.1	19.7	33	51
Tin	mg/kg ww	22	19	0.019	0.025	0.071	0.075
Zinc	mg/kg ww	22	0	39	142	389	556

Table 2.3-4 Summary of COPC Concentrations in Browse Vegetation from the Mt. Nansen Site (Cont'd)

COPC	Units	N	N <MDL	Min	Mean	95th Percentile	Max
Tailings Site							
Arsenic	mg/kg ww	13	2	0.02	0.7	2.6	3.5
Boron	mg/kg ww	13	0	3.0	11.8	25.0	33.3
Cadmium	mg/kg ww	13	0	0.3	2.4	7.5	10.0
Copper	mg/kg ww	13	0	1.2	2.0	3.3	4.7
Lead	mg/kg ww	13	7	0.02	0.7	2.6	2.7
Manganese	mg/kg ww	13	0	70	260	509	557
Selenium	mg/kg ww	13	12	0.04	0.05	0.06	0.08
Strontium	mg/kg ww	13	0	9.5	22.5	42.1	42.6
Tin	mg/kg ww	13	13	0.021	0.021	0.021	0.021
Zinc	mg/kg ww	13	0	51	141	261	322
Brown-McDade Pit							
Arsenic	mg/kg ww	19	3	0.02	0.45	1.5	2.0
Boron	mg/kg ww	19	0	1.6	6.3	12.7	13.4
Cadmium	mg/kg ww	19	0	0.72	5.1	12.4	15.0
Copper	mg/kg ww	19	0	0.93	1.8	2.9	4.0
Lead	mg/kg ww	19	4	0.02	0.32	0.83	1.77
Manganese	mg/kg ww	19	0	40	198	346	495
Selenium	mg/kg ww	19	19	0.038	0.041	0.041	0.042
Strontium	mg/kg ww	19	0	10	28	52	71
Tin	mg/kg ww	19	18	0.02	0.03	0.03	0.13
Zinc	mg/kg ww	19	0	33	171	473	518

Notes: Analytical results reported as less than method detection limit (MDL) were assumed to be equal to ½ method detection limit in the calculation of minimum, mean and maximum.
Browse: cranberry (foliage), willow and trembling aspen
Moisture content reported by laboratory or assumed to be equal to the average moisture content of other browse samples.
Shading indicates the concentrations used in the risk assessment.
ww – wet weight

Table 2.3-5 Summary of COPC Concentrations in Berries from the Mt. Nansen Site

COPC	Units	N	N <MDL	Min	Mean	95th Percentile	Max
Background							
Arsenic	mg/kg ww	12	11	0.01	0.01	0.02	0.03
Boron	mg/kg ww	12	0	0.7	1.5	2.4	2.4
Cadmium	mg/kg ww	12	2	0.001	0.05	0.21	0.30
Copper	mg/kg ww	12	0	0.44	0.64	0.83	0.87
Lead	mg/kg ww	12	12	0.007	0.008	0.008	0.008
Manganese	mg/kg ww	12	0	4.1	56	165	275
Selenium	mg/kg ww	12	12	0.01	0.02	0.02	0.02
Strontium	mg/kg ww	12	0	0.22	0.65	1.7	3.0
Tin	mg/kg ww	12	12	0.007	0.008	0.008	0.008
Zinc	mg/kg ww	12	0	0.69	2.3	4.6	6.6

Table 2.3-5 Summary of COPC Concentrations in Berries from the Mt. Nansen Site (Cont'd)

COPC	Units	N	N <MDL	Min	Mean	95th Percentile	Max
Mill Site							
Arsenic	mg/kg ww	18	7	0.01	0.03	0.10	0.13
Boron	mg/kg ww	18	0	0.5	2.5	6.0	6.7
Cadmium	mg/kg ww	18	4	0.00	0.05	0.15	0.24
Copper	mg/kg ww	18	0	0.4	0.6	0.8	0.9
Lead	mg/kg ww	18	16	0.005	0.010	0.019	0.033
Manganese	mg/kg ww	18	0	5	85	265	356
Selenium	mg/kg ww	18	18	0.010	0.016	0.024	0.025
Strontium	mg/kg ww	18	0	0.1	1.1	3.7	4.8
Tin	mg/kg ww	18	18	0.005	0.008	0.012	0.012
Zinc	mg/kg ww	18	0	1	3	8	10
Tailings Site							
Arsenic	mg/kg ww	24	19	0.01	0.02	0.04	0.08
Boron	mg/kg ww	24	0	0.72	2.2	3.8	9.3
Cadmium	mg/kg ww	24	10	0.001	0.02	0.07	0.19
Copper	mg/kg ww	24	0	0.46	0.64	0.80	0.97
Lead	mg/kg ww	24	22	0.006	0.009	0.016	0.016
Manganese	mg/kg ww	24	0	11	56	205	244
Selenium	mg/kg ww	24	24	0.01	0.02	0.02	0.03
Strontium	mg/kg ww	24	0	0.08	0.94	3.8	6.0
Tin	mg/kg ww	24	23	0.006	0.009	0.015	0.032
Zinc	mg/kg ww	24	0	0.71	2.5	6.6	11.2
Brown-McDade Pit							
Arsenic	mg/kg ww	31	25	0.005	0.02	0.06	0.18
Boron	mg/kg ww	31	0	0.94	2.7	6.8	9.6
Cadmium	mg/kg ww	31	10	0.001	0.06	0.30	0.46
Copper	mg/kg ww	31	0	0.41	0.67	1.0	1.2
Lead	mg/kg ww	31	30	0.005	0.01	0.02	0.02
Manganese	mg/kg ww	31	0	1.6	56	112	207
Selenium	mg/kg ww	31	31	0.01	0.02	0.03	0.03
Strontium	mg/kg ww	31	0	0.11	3.6	15.2	16.8
Tin	mg/kg ww	31	30	0.005	0.017	0.016	0.255
Zinc	mg/kg ww	31	0	0.53	4.2	13.2	24.9

Notes: Analytical results reported as less than method detection limit (MDL) were assumed to be equal to ½ method detection limit in the calculation of minimum, mean and maximum.
Berries: blueberry, cranberry, and crowberry
Moisture content reported by laboratory or assumed to be equal to the average moisture content of other berry samples.
Shading indicates the concentrations used in the risk assessment.
ww – wet weight

Table 2.3-6 Summary of COPC Concentrations in Lichen from the Mt. Nansen Site

COPC	Units	N	N <MDL	Min	Mean	95th Percentile	Max
Mine Site							
Arsenic	mg/kg ww	114	0	0.1	3.1	10	20
Boron	mg/kg ww	114	69	0.4	1.6	6	8
Cadmium	mg/kg ww	114	0	0.01	0.2	0.5	0.6
Copper	mg/kg ww	114	0	0.4	1.3	2.5	5.8
Lead	mg/kg ww	114	0	0.11	2.7	8.3	21.5
Manganese	mg/kg ww	114	0	17	101	198	231
Selenium	mg/kg ww	114	113	0.03	0.05	0.08	0.18
Strontium	mg/kg ww	114	0	0.7	2.6	5	8
Tin	mg/kg ww	113	53	0.02	0.11	0.28	1.96
Zinc	mg/kg ww	114	0	5	17	30	40

Notes: Analytical results reported as less than method detection limit (MDL) were assumed to be equal to ½ method detection limit in the calculation of minimum, mean and maximum.
Moisture content reported by laboratory or assumed to be equal to the average moisture content of other lichen samples.
Shading indicates the concentrations used in the risk assessment.
ww – wet weight

Table 2.3-7 Summary of COPC Concentrations in Fungi from the Mt. Nansen Site

COPC	Units	N	N <MDL	Min	Mean	95th Percentile	Max
Background							
Arsenic	mg/kg ww	No fungi samples available from the reference location					
Boron	mg/kg ww						
Cadmium	mg/kg ww						
Copper	mg/kg ww						
Lead	mg/kg ww						
Manganese	mg/kg ww						
Selenium	mg/kg ww						
Strontium	mg/kg ww						
Tin	mg/kg ww						
Zinc	mg/kg ww						
Mill Site							
Arsenic	mg/kg ww	1	0	1.1	1.1	1.1	1.1
Boron	mg/kg ww	1	0	0.6	0.6	0.6	0.6
Cadmium	mg/kg ww	1	0	0.1	0.1	0.1	0.1
Copper	mg/kg ww	1	0	3.4	3.4	3.4	3.4
Lead	mg/kg ww	1	0	0.7	0.7	0.7	0.7
Manganese	mg/kg ww	1	0	11	11	11	11
Selenium	mg/kg ww	1	1	0.03	0.03	0.03	0.03
Strontium	mg/kg ww	1	0	0.3	0.3	0.3	0.3
Tin	mg/kg ww	1	1	0.015	0.015	0.015	0.015
Zinc	mg/kg ww	1	0	31	31	31	31

Table 2.3-7 Summary of COPC Concentrations in Fungi from the Mt. Nansen Site (Cont'd)

COPC	Units	N	N <MDL	Min	Mean	95th Percentile	Max
Tailings Site							
Arsenic	mg/kg ww	No fungi samples available from the Tailings Site					
Boron	mg/kg ww						
Cadmium	mg/kg ww						
Copper	mg/kg ww						
Lead	mg/kg ww						
Manganese	mg/kg ww						
Selenium	mg/kg ww						
Strontium	mg/kg ww						
Tin	mg/kg ww						
Zinc	mg/kg ww						
Brown-McDade Pit							
Arsenic	mg/kg ww	No fungi samples available from the Brown-McDade Pit					
Boron	mg/kg ww						
Cadmium	mg/kg ww						
Copper	mg/kg ww						
Lead	mg/kg ww						
Manganese	mg/kg ww						
Selenium	mg/kg ww						
Strontium	mg/kg ww						
Tin	mg/kg ww						
Zinc	mg/kg ww						

Notes: Analytical results reported as less than method detection limit (MDL) were assumed to be equal to ½ method detection limit in the calculation of minimum, mean and maximum.
Fungi: bolete mushroom
Moisture content assumed to be 70%
Shading indicates the concentrations used in the risk assessment.
ww – wet weight

Table 2.3-8 Summary of COPC Concentrations in Evergreen from the Mt. Nansen Site

COPC	Units	N	N <MDL	Min	Mean	95th Percentile	Max
Background							
Arsenic	mg/kg ww	No evergreen samples available from the reference location					
Boron	mg/kg ww						
Cadmium	mg/kg ww						
Copper	mg/kg ww						
Lead	mg/kg ww						
Manganese	mg/kg ww						
Selenium	mg/kg ww						
Strontium	mg/kg ww						
Tin	mg/kg ww						
Zinc	mg/kg ww						

Table 2.3-8 Summary of COPC Concentrations in Evergreen from the Mt. Nansen Site (Cont'd)

COPC	Units	N	N <MDL	Min	Mean	95th Percentile	Max
Mill Site							
Arsenic	mg/kg ww	1	0	0.09	0.09	0.09	0.09
Boron	mg/kg ww	1	1	0.3	0.3	0.3	0.3
Cadmium	mg/kg ww	1	1	0.003	0.003	0.003	0.003
Copper	mg/kg ww	1	0	0.1	0.1	0.1	0.1
Lead	mg/kg ww	1	0	0.1	0.1	0.1	0.1
Manganese	mg/kg ww	1	0	1	1	1	1
Selenium	mg/kg ww	1	1	0.03	0.03	0.03	0.03
Strontium	mg/kg ww	1	0	0.6	0.6	0.6	0.6
Tin	mg/kg ww	1	1	0.02	0.02	0.02	0.02
Zinc	mg/kg ww	1	0	1.6	1.6	1.6	1.6
Tailings Site							
Arsenic	mg/kg ww	1	1	0.015	0.015	0.015	0.015
Boron	mg/kg ww	1	1	0.3	0.3	0.3	0.3
Cadmium	mg/kg ww	1	1	0.0	0.0	0.0	0.0
Copper	mg/kg ww	1	0	0.0	0.0	0.0	0.0
Lead	mg/kg ww	1	1	0.02	0.02	0.02	0.02
Manganese	mg/kg ww	1	0	3	3	3	3
Selenium	mg/kg ww	1	1	0.030	0.030	0.030	0.030
Strontium	mg/kg ww	1	0	0.2	0.2	0.2	0.2
Tin	mg/kg ww	1	1	0.015	0.015	0.015	0.015
Zinc	mg/kg ww	1	0	0.4	0.4	0.4	0.4
Brown-McDade Pit							
Arsenic	mg/kg ww	3	0	0.15	0.60	1.05	1.11
Boron	mg/kg ww	3	3	0.300	0.300	0.300	0.300
Cadmium	mg/kg ww	3	1	0.003	0.021	0.032	0.033
Copper	mg/kg ww	3	0	0.06	0.20	0.29	0.30
Lead	mg/kg ww	3	0	0.12	0.65	1.1	1.2
Manganese	mg/kg ww	3	0	1.8	3.5	4.4	4.4
Selenium	mg/kg ww	3	3	0.03	0.03	0.03	0.03
Strontium	mg/kg ww	3	0	0.34	0.74	1.11	1.16
Tin	mg/kg ww	3	3	0.015	0.015	0.015	0.015
Zinc	mg/kg ww	3	0	1.9	2.6	3.1	3.2

Notes: Analytical results reported as less than method detection limit (MDL) were assumed to be equal to ½ method detection limit in the calculation of minimum, mean and maximum.
Evergreen: spruce
Moisture content assumed to be 70%
Shading indicates the concentrations used in the risk assessment.
ww – wet weight

2.3.3 Small Animal Data

As described in EDI (2007), a trapping program was completed for small animals within 500 m of the three main areas of concern on site (i.e., the Mill Site, Tailings Pond, and Brown-McDade Pit). Small animals were also trapped at the reference location of Rowlinson Creek, approximately 20 km from the Mt Nansen Mine Site. Small animals generally have a small home range and therefore make good indicators for contamination accumulation.

Measured concentrations in small animals were used in the ecological risk assessment for the assessment of food chain effects. Gray jay and squirrel captured from the mine site and gray jay captured from the reference location were analyzed for COPC concentrations in liver and kidney; both liver and kidney concentrations were considered in the risk assessment. Hare and grouse were analyzed for COPC concentrations in liver, kidney, and muscle tissue; muscle tissue concentrations only were considered in the risk assessment. The whole body of shrews from the mine site and reference location were analyzed for COPC concentrations due to their small size; the whole body concentrations were considered in the risk assessment.

Table 2.3-9 summarizes the concentrations in small animals from the mine site and the reference (Rowlinson Creek) site. Dry weight concentrations were reported by the laboratory and are converted to fresh weight based on the reported sample moisture content. Maximum concentrations were used in the risk assessment when less than 20 samples were available and 95th percentile concentrations were used when more than 20 samples were available. Concentrations used in the risk assessment are shaded in the Table 2.3-9.

Table 2.3-9 Summary of COPC Concentrations in Small Animals from the Mt. Nansen Site

COPC	Units	Mine Area						Reference Location					
		N	N <MDL	Min	Mean	95th Per.	Max	N	N <MDL	Min	Mean	95th Per.	Max
Gray Jay													
Arsenic	µg/g (ww)	3	1	0.04	0.24	0.23	0.24	3	3	0.014	0.022	0.034	0.036
Boron	µg/g (ww)	3	3	0.30	0.77	0.75	0.77	3	3	0.28	0.43	0.68	0.73
Cadmium	µg/g (ww)	3	0	0.89	3.51	3.45	3.51	3	0	0.49	1.30	1.77	1.79
Copper	µg/g (ww)	3	0	3.83	4.59	4.57	4.59	3	0	4.3	4.6	4.9	4.9
Lead	µg/g (ww)	3	1	0.04	0.09	0.08	0.09	3	3	0.01	0.02	0.03	0.04
Manganese	µg/g (ww)	3	0	2.52	3.17	3.16	3.17	3	0	1.30	1.84	2.54	2.65
Selenium	µg/g (ww)	3	0	0.29	0.59	0.57	0.59	3	0	0.39	0.44	0.52	0.53
Strontium	µg/g (ww)	3	0	0.047	0.097	0.097	0.097	3	0	0.04	0.05	0.06	0.06
Tin	µg/g (ww)	3	3	0.015	0.038	0.037	0.038	3	3	0.014	0.022	0.034	0.036
Zinc	µg/g (ww)	3	0	22.8	27.0	26.6	27.0	3	0	20.7	23.4	25.6	25.8

Table 2.3-9 Summary of COPC Concentrations in Small Animals from the Mt. Nansen Site (Cont'd)

COPC	Units	Mine Area						Reference Location					
		N	N <MDL	Min	Mean	95th Per.	Max	N	N <MDL	Min	Mean	95th Per.	Max
Grouse													
Arsenic	µg/g (ww)	6	0	0.01	0.09	0.27	0.33	3	0	0.01	0.08	0.19	0.21
Boron	µg/g (ww)	6	6	0.25	0.27	0.29	0.30	3	3	0.26	0.27	0.28	0.29
Cadmium	µg/g (ww)	6	0	0.003	0.009	0.027	0.033	3	0	0.003	0.004	0.005	0.005
Copper	µg/g (ww)	6	0	1.12	1.29	1.50	1.54	3	0	1.20	1.27	1.31	1.32
Lead	µg/g (ww)	6	0	0.01	0.20	0.77	0.98	3	0	0.01	0.10	0.16	0.16
Manganese	µg/g (ww)	6	0	0.29	0.49	0.80	0.82	3	0	0.3	1.1	2.3	2.4
Selenium	µg/g (ww)	6	0	0.03	0.04	0.06	0.06	3	3	0.026	0.027	0.028	0.029
Strontium	µg/g (ww)	6	0	0.04	0.08	0.17	0.21	3	0	0.066	0.075	0.083	0.084
Tin	µg/g (ww)	6	0	0.01	0.03	0.07	0.08	3	3	0.013	0.014	0.014	0.014
Zinc	µg/g (ww)	6	0	14.8	18.0	21.4	21.7	3	0	14.7	18.8	24.1	24.9
Hare													
Arsenic	µg/g (ww)	3	1	0.01	0.06	0.10	0.10	3	3	0.012	0.013	0.014	0.014
Boron	µg/g (ww)	3	3	0.24	0.25	0.26	0.26	3	3	0.24	0.26	0.28	0.28
Cadmium	µg/g (ww)	3	0	0.02	0.06	0.14	0.15	3	1	0.003	0.03	0.05	0.06
Copper	µg/g (ww)	3	0	1.94	2.32	2.73	2.79	3	0	2.0	2.3	2.5	2.5
Lead	µg/g (ww)	3	3	0.012	0.013	0.013	0.013	3	1	0.01	0.05	0.09	0.10
Manganese	µg/g (ww)	3	0	0.20	0.28	0.36	0.37	3	0	0.27	0.34	0.41	0.42
Selenium	µg/g (ww)	3	1	0.02	0.05	0.07	0.07	3	3	0.024	0.026	0.028	0.028
Strontium	µg/g (ww)	3	0	0.062	0.070	0.080	0.082	3	0	0.09	0.11	0.14	0.14
Tin	µg/g (ww)	3	2	0.012	0.025	0.046	0.050	3	2	0.012	0.027	0.051	0.056
Zinc	µg/g (ww)	3	0	19.9	25.6	31.3	32.1	3	0	26.3	27.4	29.0	29.3
Shrew													
Arsenic	µg/g (ww)	7	0	0.03	0.14	0.49	0.68	1	1	0.013	0.013	0.013	0.013
Boron	µg/g (ww)	7	6	0.3	0.4	0.8	1.0	1	1	0.25	0.25	0.25	0.25
Cadmium	µg/g (ww)	7	0	0.1	0.3	0.6	0.6	1	0	0.04	0.04	0.04	0.04
Copper	µg/g (ww)	7	0	2.9	3.5	4.4	4.7	1	0	3.71	3.71	3.71	3.71
Lead	µg/g (ww)	7	2	0.01	0.06	0.15	0.18	1	0	0.05	0.05	0.05	0.05
Manganese	µg/g (ww)	7	0	1.5	6.3	12.4	14.5	1	0	2.79	2.79	2.79	2.79
Selenium	µg/g (ww)	7	0	0.3	0.4	0.7	0.7	1	0	0.25	0.25	0.25	0.25
Strontium	µg/g (ww)	7	0	1.9	3.6	7.4	8.9	1	0	3.86	3.86	3.86	3.86
Tin	µg/g (ww)	7	7	0.013	0.015	0.017	0.018	1	0	0.025	0.025	0.025	0.025
Zinc	µg/g (ww)	7	0	23.8	28.8	34.4	36.0	1	0	26.7	26.7	26.7	26.7

Table 2.3-9 Summary of COPC Concentrations in Small Animals from the Mt. Nansen Site (Cont'd)

COPC	Units	Mine Area						Reference Location					
		N	N <MDL	Min	Mean	95th Per.	Max	N	N <MDL	Min	Mean	95th Per.	Max
Squirrel													
Arsenic	µg/g (ww)	2	0	1.6	2.1	2.5	2.6	No squirrel samples available from the reference location					
Boron	µg/g (ww)	2	2	0.30	0.41	0.51	0.52						
Cadmium	µg/g (ww)	2	0	3.7	7.7	11.3	11.7						
Copper	µg/g (ww)	2	0	3.2	4.4	5.5	5.6						
Lead	µg/g (ww)	2	0	0.30	0.61	0.89	0.92						
Manganese	µg/g (ww)	2	0	0.9	1.6	2.2	2.3						
Selenium	µg/g (ww)	2	0	0.48	0.78	1.04	1.07						
Strontium	µg/g (ww)	2	0	0.052	0.061	0.069	0.069						
Tin	µg/g (ww)	2	2	0.015	0.021	0.026	0.026						
Zinc	µg/g (ww)	2	0	21.0	24.6	27.9	28.2						

Notes: Analytical results reported as less than method detection limit (MDL) were assumed to be equal to ½ method detection limit in the calculation of minimum, mean and maximum.
Shading indicates the concentrations used in the risk assessment.
ww – wet weight

2.3.4 Large Mammal Data

EDI (2007) summarized eight caribou and two moose samples provided by the community and the Northern Contaminants Program. Of these samples, two each of caribou and moose were muscle samples, and these were used in the risk assessment to represent impacts from the mine and are summarized in Table 2.3-10. EDI (2007) also provided background concentrations for select COPCs to characterize Yukon background concentrations, and these are also summarized in Table 2.3-10, as available. Dry weight concentrations were reported by the laboratory and are converted to fresh weight based on the reported sample moisture content. The average moisture content from the site moose samples (78%) and caribou samples (73.8%) were used to convert the Yukon background concentrations from dry weight to wet weight.

Table 2.3-11 summarizes the kidney and liver concentrations reported for caribou moose samples from EDI (2007). These concentrations in organs were used as part of a sensitivity analysis for the ingestion of organs by human receptors, presented in Section 6.5. Dry weight concentrations were reported by the laboratory and are converted to fresh weight based on the reported sample moisture content.

Maximum concentrations were used in the risk assessment when less than 20 samples were available and 95th percentile concentrations were used when more than 20 samples were available. Concentrations used in the risk assessment are shaded in the Tables 2.3-10 and 2.3-11.

Table 2.3-10 Summary of COPC Concentrations in Large Mammals from the Mt. Nansen Site

COPC	Units	Mine Area						Reference Location					
		N	N <MDL	Min	Mean	95th Per.	Max	N	-	-	Mean	-	-
Caribou - Muscle													
Arsenic	µg/g (ww)	2	0	0.001	0.002	0.003	0.003	50			0.02		
Boron	µg/g (ww)	No data											
Cadmium	µg/g (ww)	2	0	0.006	0.008	0.010	0.010	50			0.022		
Copper	µg/g (ww)	2	0	0.9	0.9	1.0	1.0	50			1.276		
Lead	µg/g (ww)	2	0	0.0005	0.0005	0.0005	0.0005	50			1.11		
Manganese	µg/g (ww)	2	0	0.10	0.11	0.11	0.12	50			0.176		
Selenium	µg/g (ww)	2	0	0.011	0.014	0.017	0.018	50			0.205		
Strontium	µg/g (ww)	2	0	0.008	0.011	0.013	0.014	50			No data		
Tin	µg/g (ww)	No data											
Zinc	µg/g (ww)	2	0	6.64	6.87	7.08	7.10	50			46.0		
Moose - Muscle													
Arsenic	µg/g (ww)	2	0	0.0021	0.0022	0.0023	0.0023	36			0.066		
Boron	µg/g (ww)	No data											
Cadmium	µg/g (ww)	2	0	0.006	0.009	0.011	0.012	36			0.026		
Copper	µg/g (ww)	2	0	4.0	6.0	7.8	8.0	36			2.7		
Lead	µg/g (ww)	2	0	0.006	0.009	0.011	0.012	36			0.014		
Manganese	µg/g (ww)	2	0	0.020	0.027	0.034	0.034	36			0.29		
Selenium	µg/g (ww)	2	0	0.012	0.017	0.022	0.023	36			0.41		
Strontium	µg/g (ww)	2	0	0.0052	0.0055	0.0058	0.0059	36			No data		
Tin	µg/g (ww)		No data										
Zinc	µg/g (ww)	2	0	9.4	10.7	11.8	11.9	36			43.0		

Notes: Analytical results reported as less than method detection limit (MDL) were assumed to be equal to ½ method detection limit in the calculation of minimum, mean and maximum.
Shading indicates the concentrations used in the risk assessment.
ww – wet weight

Table 2.3-11 Summary of COPC Concentrations in Large Mammal Organs from the Mt. Nansen Site

COPC	Units	Liver						Kidney		
		N	N <MDL	Min	Mean	95th Per.	Max	N	N <MDL	Value
Caribou										
Arsenic	µg/g (ww)	6	1	0.0003	0.001	0.002	0.003	1	0	0.003
Boron	µg/g (ww)	No data								
Cadmium	µg/g (ww)	6	0	0.289	0.714	1.468	1.593	1	0	1.922
Copper	µg/g (ww)	6	0	1.5	8.0	16.9	18.0	1	0	1.5
Lead	µg/g (ww)	6	0	0.0037	0.0067	0.0106	0.0110	1	0	0.0165
Manganese	µg/g (ww)	6	0	0.34	0.97	1.23	1.23	1	0	0.49
Selenium	µg/g (ww)	6	0	0.023	0.064	0.118	0.121	1	0	0.153
Strontium	µg/g (ww)	6	0	0.008	0.026	0.044	0.047	1	0	0.008
Tin	µg/g (ww)	No data								
Zinc	µg/g (ww)	6	0	5.97	7.67	10.55	10.92	1	0	7.36
Moose										
Arsenic	µg/g (ww)	2	0	0.0018	0.0027	0.0035	0.0036	1	0	0.0016
Boron	µg/g (ww)	No data								
Cadmium	µg/g (ww)	2	0	1.43	1.59	1.73	1.75	1	0	4.9
Copper	µg/g (ww)	2	0	11.1	30.8	48.5	50.4	1	0	0.69
Lead	µg/g (ww)	2	0	0.0003	0.0010	0.0017	0.0018	1	0	0.0012
Manganese	µg/g (ww)	2	0	0.62	0.69	0.76	0.77	1	0	0.38
Selenium	µg/g (ww)	2	0	0.07	0.16	0.24	0.25	1	0	0.16
Strontium	µg/g (ww)	2	0	0.0139	0.0147	0.0154	0.0155	1	0	0.03
Tin	µg/g (ww)	No data								
Zinc	µg/g (ww)	2	0	6.0	6.1	6.2	6.2	1	0	5.4

Notes: Analytical results reported as less than method detection limit (MDL) were assumed to be equal to ½ method detection limit in the calculation of minimum, mean and maximum.
Shading indicates the concentrations used in the risk assessment.
ww – wet weight

3.0 RECEPTOR CHARACTERIZATION

This chapter discusses the rationale behind the selection of ecological and human receptors for the purposes of the assessment from risks of exposure to chemicals of potential concern (COPC) at the Mt. Nansen Mine.

3.1 ECOLOGICAL RECEPTORS

The receptor characterization phase involves selection of ecological receptors for inclusion in the risk assessment and identification of their pathways of exposure to the COPC. As it is not practical to assess risks to all ecological species, it is common practice to select representative species based on level of potential exposure, importance as a food source for other species and/or humans, importance for cultural reasons, or because they are endangered or rare species.

Therefore, ecological receptors are generally chosen to capture various levels of exposure via the different types of diets that they consume. They are also selected if they are considered important: (1) in the functioning of the ecosystem; (2) in the production of food for subsistence; or (3) due to their cultural or medicinal significance.

3.1.1 Aquatic Receptors

Figure 3.1-1 provides a schematic representation of the selected ecological receptors for the aquatic environment. The aquatic species chosen represent a typical food chain that would be found in aquatic systems and are expected to be found in Dome Creek, Pony Creek, and Victoria Creek.

Primary Producers - Primary producers occupy the lowest level in the food chain. These organisms are generally plants that use the sun and inorganic molecules to produce food.

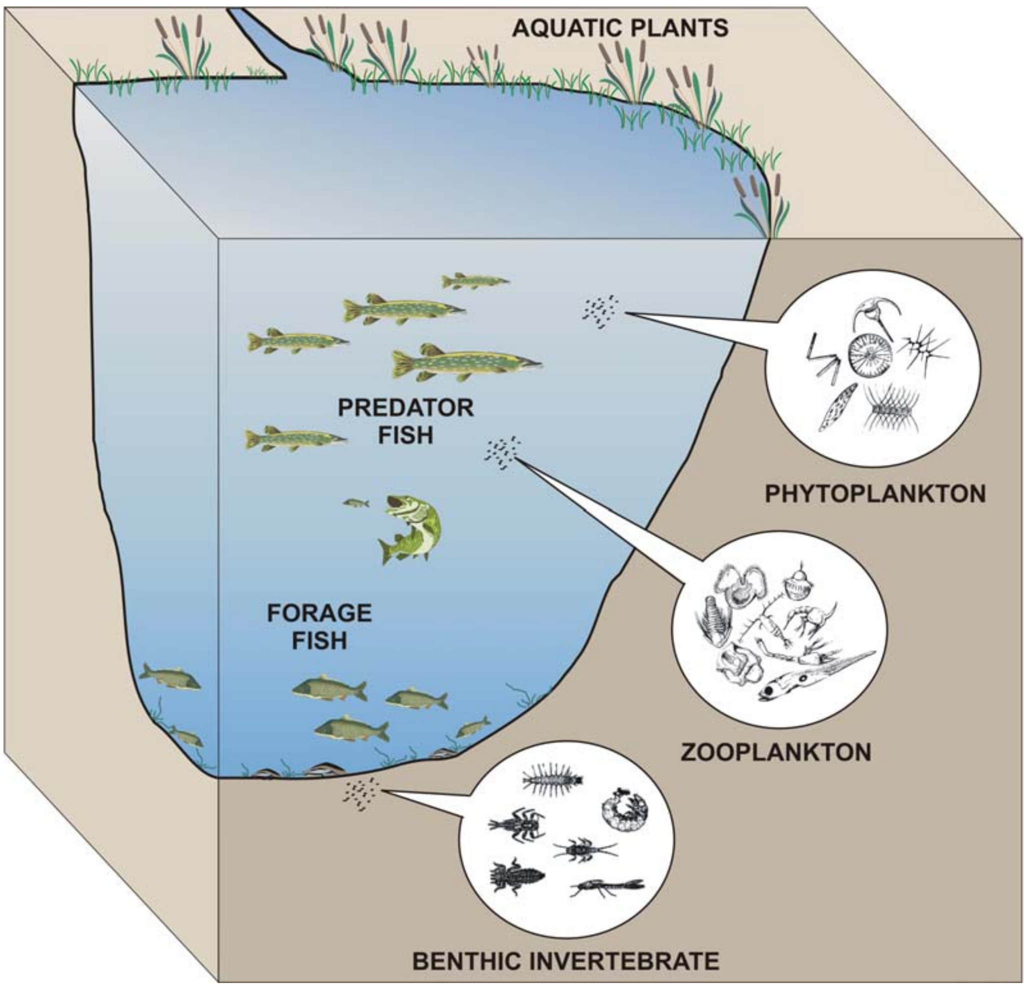
Aquatic plants in most ecosystems usually constitute the majority of the primary producer biomass. Aquatic plants are often consumed by moose, porcupine and other animals, thereby forming a link between aquatic and terrestrial ecosystems. Besides being an important food resource, aquatic plants also provide habitat to aquatic organisms.

Phytoplankton are also part of the first level in the aquatic food chain. Members of the division *Chlorophyta* have been studied extensively and are relatively common in most northern aquatic ecosystems. Even though the overall contribution of *Chlorophyta* to northern aquatic ecosystems is relatively small, they are a primary food resource for grazing zooplankton.

Primary Consumers - Primary consumers occupy the second level in the food chain. These organisms generally eat plant material such as phytoplankton.

Zooplankton such as *Cladocerans* are found in most northern aquatic ecosystems. Although *Cladocerans* may be seasonally quite abundant, their overall contribution to northern aquatic ecosystems is relatively small.

Figure 3.1-1 Aquatic Receptors Included in the Assessment



Benthic invertebrates both live and feed within sediments and therefore may be exposed to COPCs through ingestion of sediment-bound COPCs and also through exposure to interstitial waters within the sediment. Benthic invertebrates provide a link between aquatic and terrestrial ecosystems. For example, *Chironomidae* (midge) larvae are usually the most abundant benthic invertebrate taxa present in aquatic ecosystems in the northern climate. Many species feed on decaying organic matter and thereby form an important link between the decomposer and primary consumer levels. Furthermore, midge larvae are a main food source for small/juvenile fish and larger omnivorous fish. The adults are capable of flight and are frequently consumed by birds and bats. This life stage provides an important link between aquatic and terrestrial ecosystems in the region.

Secondary Consumers - Ecological receptors at the secondary consumer level include forage fish that feed primarily on benthic invertebrates and smaller individuals, and are an important food source for larger predatory fishes. Examples of forage fish are Arctic grayling, round whitefish and slimy sculpin, which are prevalent in the study area streams. Fish have not been found in Dome Creek or Pony Creek, so they are not included in the assessment for these areas.

Tertiary Consumers - Tertiary consumers are found at the top end of the aquatic food chain and consist of larger predatory fish species that consumer other fish species. An example of a predator fish is the Chinook salmon, northern pike, and burbot, which are found in some of the study area rivers. Predatory fish are also an important component of the human food chain. Both forage and predatory fish are an important component of the diet of omnivores (e.g., bear) and carnivores (e.g., eagle). Fish have not been found in Dome Creek or Pony Creek, so they are not included in the assessment for these areas.

3.1.2 Terrestrial Receptors

The terrestrial receptors chosen for the assessment of potential adverse effects from the Mt. Nansen Mine were obtained from information provided by the Little Salmon Carmacks First Nation (LSCFN) people who use the site as well other site-specific details provided in the Mt. Nansen Terrestrial and Aquatic Effects Study (EDI 2007). The terrestrial species selected for the risk assessment are presented in Table 3.1-1. The risk assessment cannot evaluate all the ecological species found on the Yukon Plateau; rather, the risk assessment evaluates species that cover a wide range of dietary habits that can act as surrogates for other species since they encompass the dietary habits of the other species.

Table 3.1-1 Terrestrial Receptors Chosen for the Mt. Nansen Mine Assessment

Herbivores	Omnivores	Carnivores
Wood Bison	Black Bear	Wolf
Woodland Caribou	Ducks (mallard, merganser, scaup)	
Grouse	Gray Jay	
Snowshoe Hare	Marten	
Moose		
Porcupine		

Black Bear **–**While berries, herbs and roots are their primary food source, they also consume fish and are thus potentially exposed via the aquatic pathways as well as terrestrial pathways.

Wood Bison – Between 1988 and 1992, wood bison were reintroduced to the Yukon in the Nisling River Valley (Environment Yukon 2008). Since that time, the herd has grown in size and expanded their range. Wood bison have been seen in area of the Mt. Nansen mine. They are considered a threatened species but are hunted by LSCFN. Their diet consists of terrestrial vegetation (forage).

Caribou – Caribou consume predominantly lichen, which are mostly impacted by COPC deposition from the air. Woodland caribou were chosen since they are in the area and represent a portion of the diet of the LSCFN.

Ducks – Waterfowl can be highly exposed ecological receptors, since their diet is almost entirely obtained from the aquatic environment. The waterfowl diet includes aquatic vegetation, fish, and aquatic (benthic) invertebrates. Three species were selected to take into account differences in the diets of warerfowl and are mallard (consumes primarily aquatic plants), merganser (consumes mainly fish) and scaup (consumes mostly benthic invertebrates).

Grouse – Grouse (and ptarmigan) are terrestrial birds common in the northern environment. The diets of both species are primarily terrestrial, comprising primarily berries and browse. Grouse were selected to represent both species.

Snowshoe Hare – The snowshoe hare is chosen as it may be trapped in the area and used as a food source. Browse and forage comprise most of the diet of hare.

Gray Jay – Gray jays are omnivores and are found in the study area. They do not migrate and therefore are exposed to a range of COPC from the site. Gray jays consume berries, fungi, and small animals such as shrew.

Marten – Marten are a predatory species and thus are exposed via food chain effects. They are omnivores and consume a varied diet including berries, squirrels, grouse, and hare.

Moose – Moose consume aquatic macrophytes and browse and thus are potentially an exposed species. There is very limited aquatic macrophyte growth in Dome Creek and Pony Creek, thus the likelihood of moose being exposed to COPC downstream of the Mt. Nansen Mine is reduced. Nonetheless, moose may be exposed to COPC via terrestrial pathways and given that moose are an important source of food to people in the study area, they were included in the assessment.

Porcupine – Porcupine live among trees but can be found living along rivers in thickets. They obtain their food from both aquatic (aquatic vegetation) and terrestrial (browse, evergreens) environments. The porcupine is included in this assessment because it has been identified as being of great importance to the LSCFN. Also, porcupine migrate less than some of the other ecological species identified for the site, and therefore have the potential for increased exposure from the site.

Wolf - The wolf is a predatory species that consumes a number of other species including caribou, hare and moose. Food chain effects are assessed in this study through the inclusion of the wolf.

In addition to the food sources noted above, all of the terrestrial species mentioned above were assumed to consume soil or sediment, depending on where they obtained their food from, for example, a hare which has a predominantly terrestrial diet is assumed to consume soil and waterfowl which are predominantly in the aquatic environment are considered to consume sediment. Appendix D provides detailed ecological receptor characteristics. Figure 3.1-2 provides a schematic of the receptors selected for this assessment. The following section discusses the pathways that have been considered in this assessment. The pathways are illustrated in Figures 3.1-3a through 3.1-3d for the receptors.

Table 3.1-2 identifies areas where the various terrestrial receptors were considered to be present at the site. These areas are shown on Figure 3.1-4. The areas were chosen based on the COPC levels present in the soils and vegetation and consideration of the home range of the species. With exception of the large mammals, which were considered to be exposed to site-wide average values, all other terrestrial receptors were placed at background locations as well as at affected locations (or areas). Table 3.1-3 provides a more detailed summary of the exact locations of the water, soil and vegetation used for the various terrestrial receptors.

For small local mammals and terrestrial birds, four areas of concern at the Anvil Range Mine were identified as shown in Figure 3.1-4: Background (upland mineralized areas for soils and vegetation, Rowlinson Creek for animals), Mill Site, Tailings Site, and the Brown-McDade Pit.

Larger areas were considered for the medium ranging mammals (see Figure 3.1-4): Background (upland mineralized areas for soils and vegetation, Rowlinson Creek for animals) and the Mt. Nansen Mine (including the Mill Site, Tailings Site, and the Brown-McDade Pit).

Waterfowl were assessed at Background (Victoria Creek Reference location and Dry Creek), Mill Site (Dome Creek), the Tailings Pond, the Brown-McDade Pit, Pony Creek, and Victoria Creek.

As mentioned in Section 3.1-1, fish have not been observed in Dome Creek and Pony Creek and fish are assumed to be absent from the Tailings Pond and Brown-McDade Pit; therefore, fish concentrations measured in Victoria Creek were considered for the pathways assessment at the four areas of concern.

Large broad ranging mammals were assumed to be at the site for only a portion of the year as their home range is much larger than the size of the Mt. Nansen Mine (area of impact was considered to be approximately 10 km^2).

Figure 3.1-2 Terrestrial Receptors Considered in the Assessment

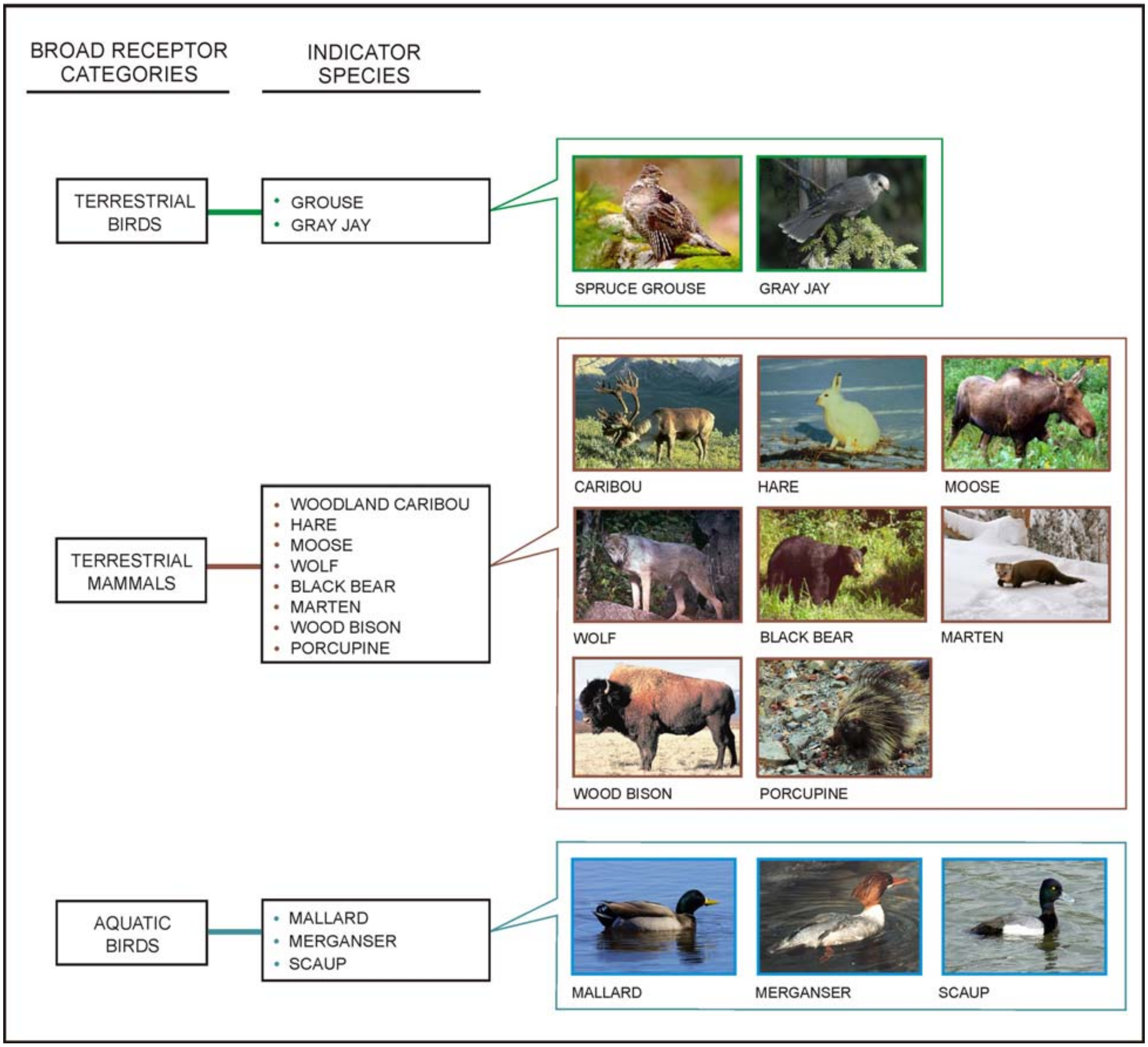


Figure 3.1-3a Potential Pathways of Exposure for Caribou, Grouse, Hare, and Bison

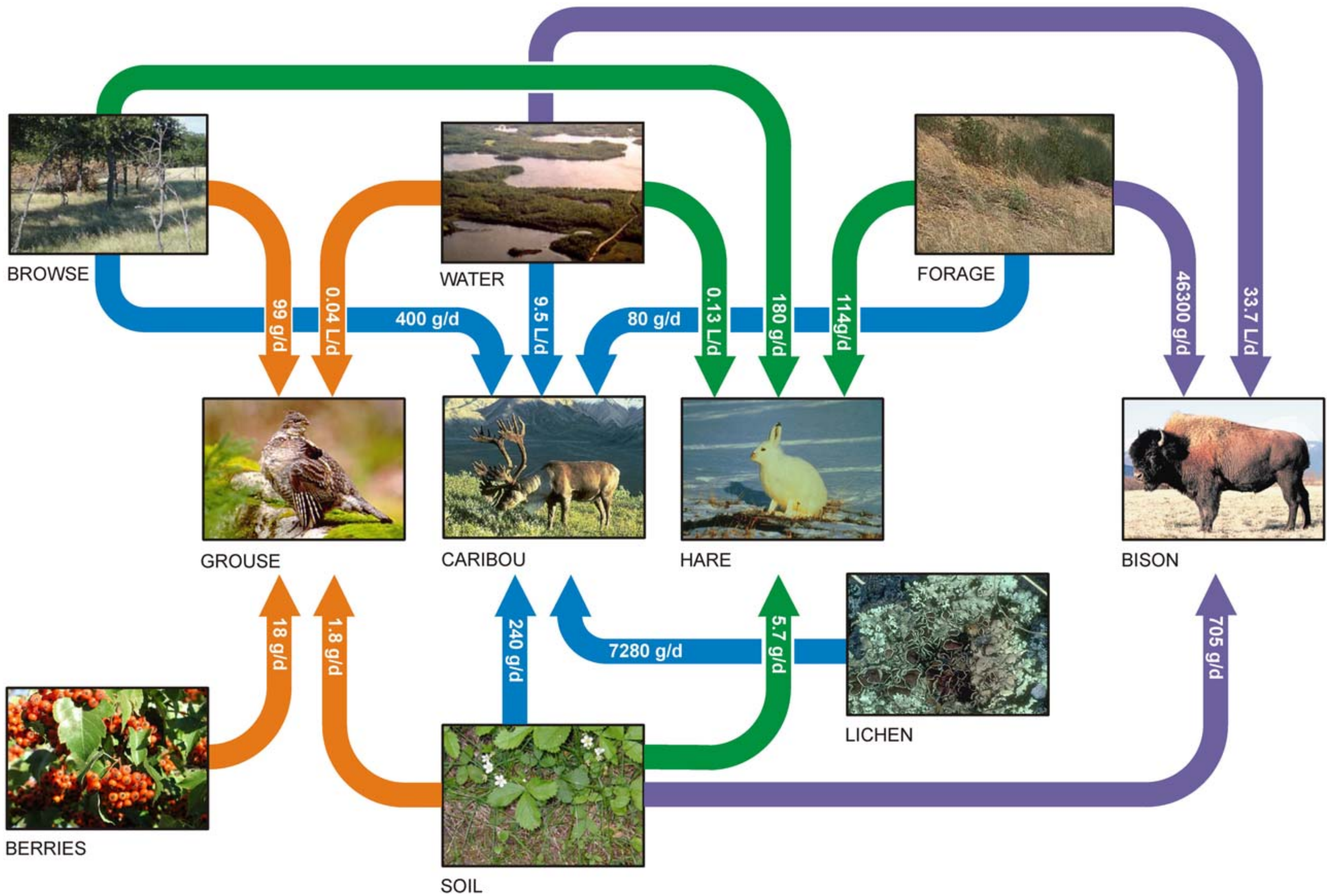


Figure 3.1-3b Potential Pathways of Exposure for Black Bear, Gray Jay, Marten, and Wolf

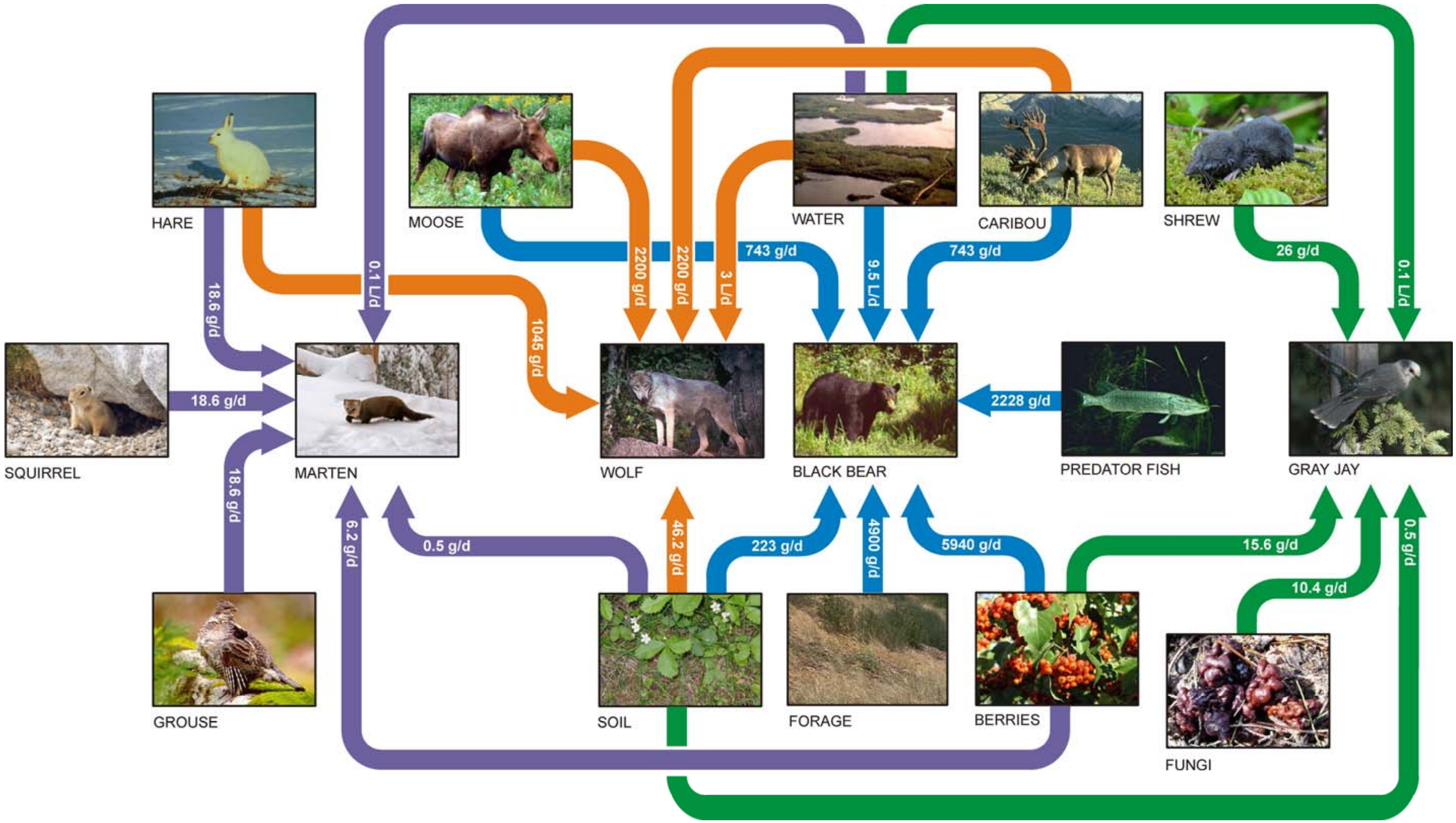


Figure 3.1-3c Potential Pathways of Exposure for Moose and Porcupine

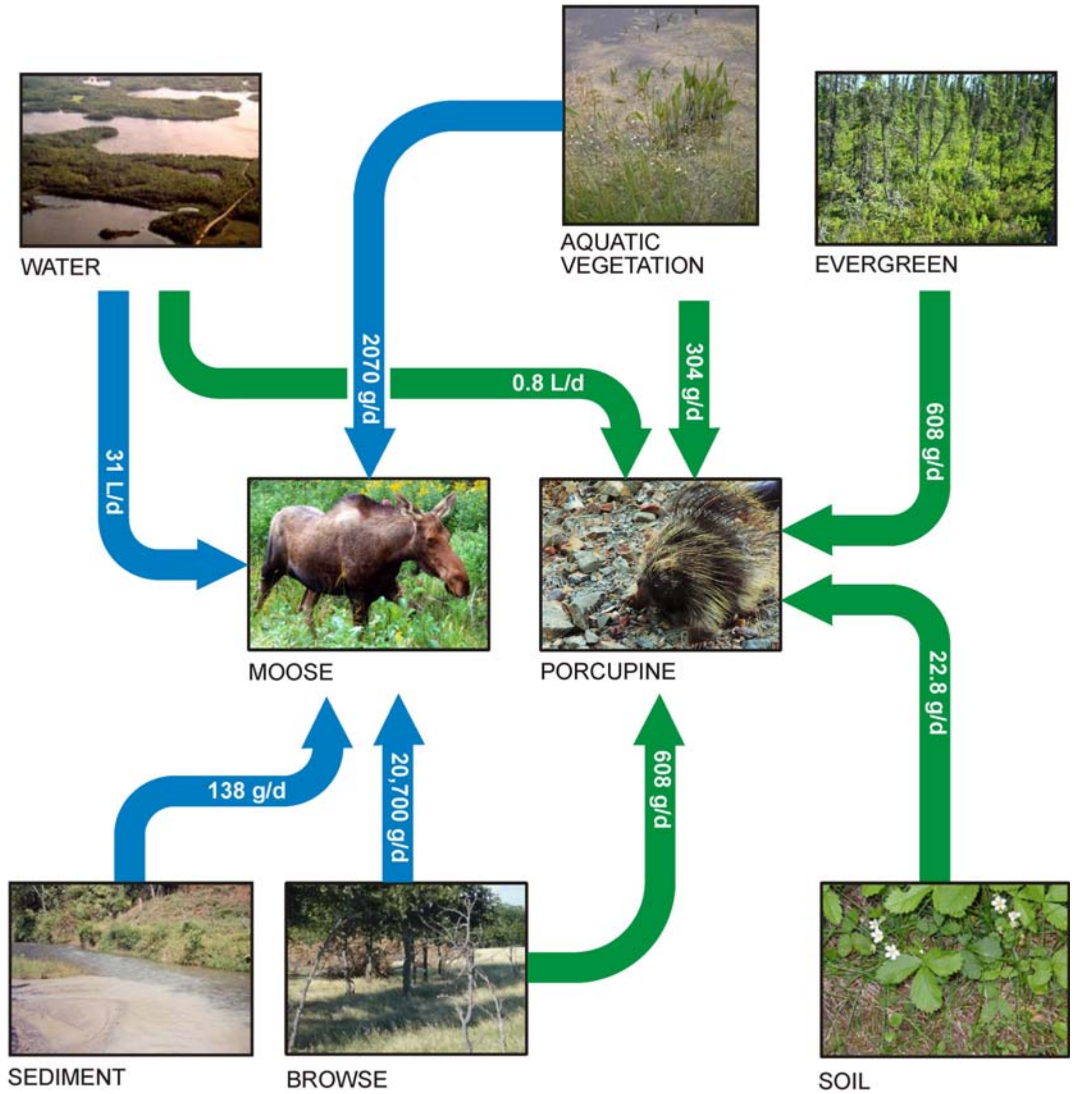


Figure 3.1-3d Potential Pathways of Exposure for Mallard, Merganser and Scaup

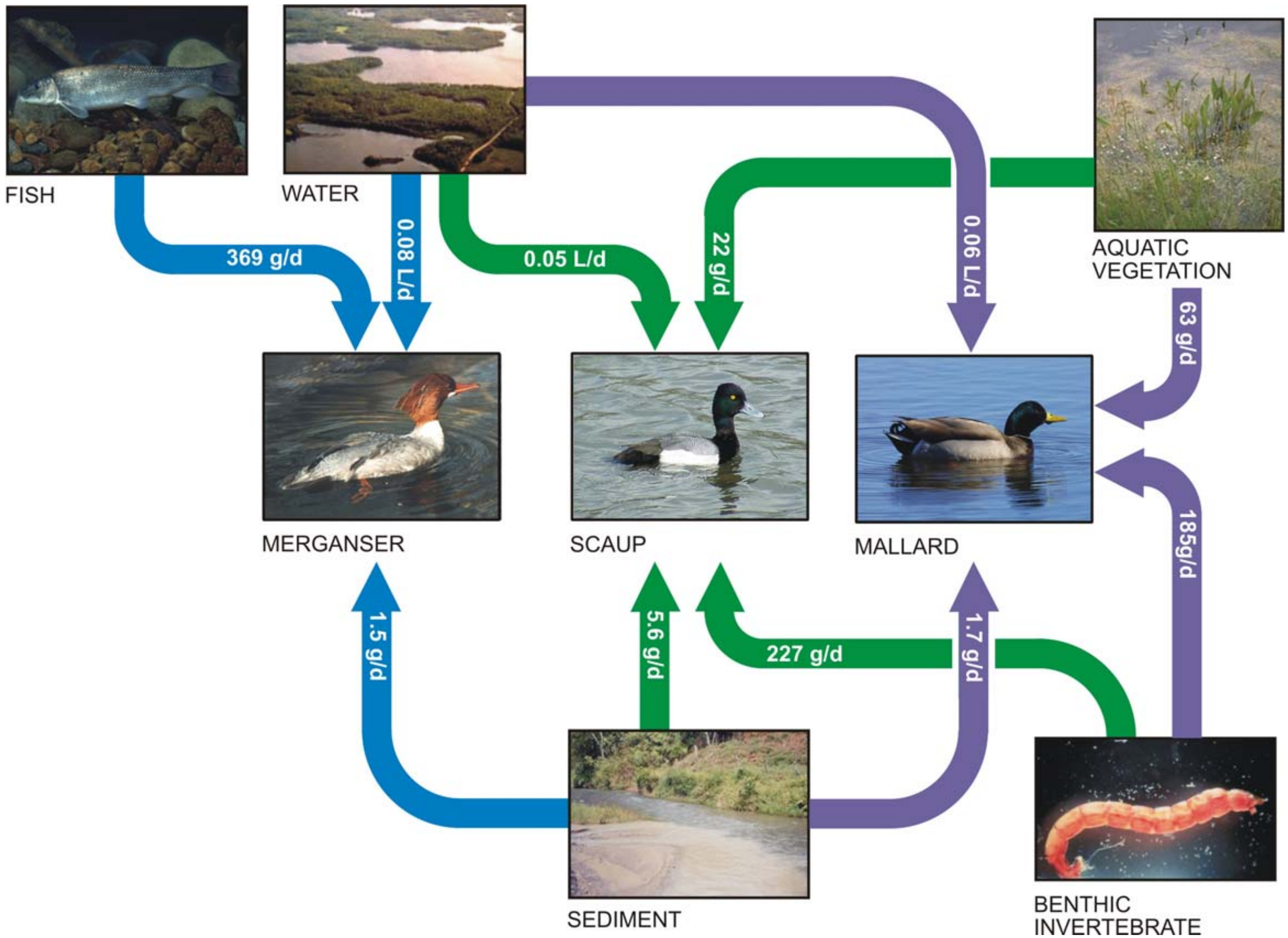


Figure 3.1-4 Locations Considered in Terrestrial Ecological Assessment

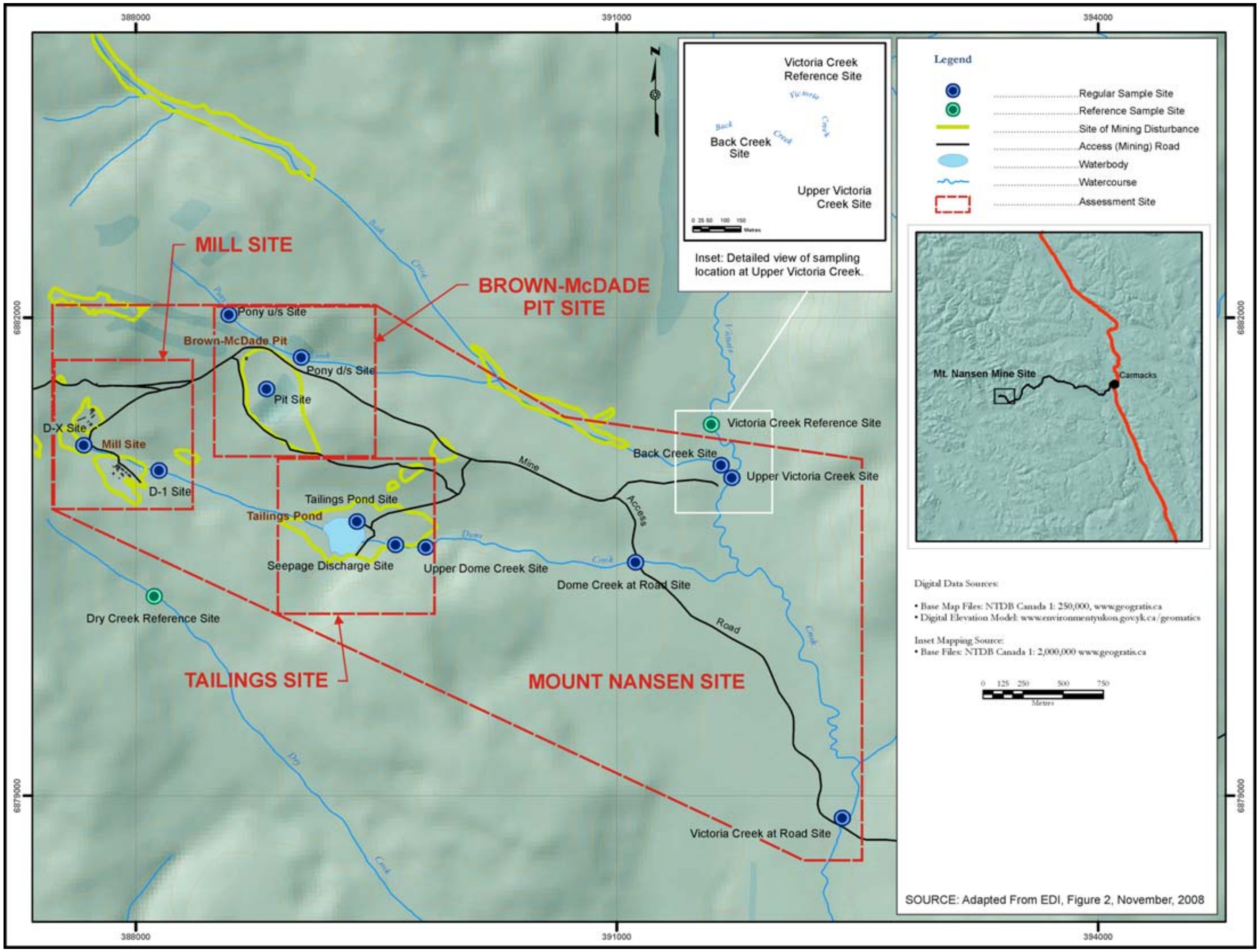


Table 3.1-2 Exposure Characteristics Assumed for Terrestrial Ecological Receptors at Mt. Nansen Mine

Receptor	Pathways of Exposure	Area of Concern for Ecological Assessment	Fraction of time at site	Home Range
Bear	Water, soil, herbaceous vegetation, berries, fish, moose, caribou	Background Mine Site	1.0	20 km^2 (2.6 to 155 km^2) [a]
Bison	Water, soil, forage	Background Mine Site	1.0	Assumed resident in the area year-round
Woodland Caribou	Water, soil, summer forage, browse, lichen	Mine Site (not including background)	0.1	250 km^2 [c]
Grouse	Water, soil, browse, berries	Background Mill Site Tailings Site Brown-McDade Pit	1.0	0.2 km^2 (no migration - resident year round; 0.04 to 0.40 km^2) [e]
Hare	Water, soil, browse, herbaceous vegetation	Background Mill Site Tailings Site Brown-McDade Pit	1.0	0.08 km^2 (6 to 10 ha) [d]
Gray Jay	Water, berries, fungi, shrew	Background Mill Site Tailings Site Brown-McDade Pit	1.0	0.6 km^2 [i]
Mallard	Water, sediment, benthic invertebrates, aquatic vegetation	Background Mill Site Tailings Site Brown-McDade Pit Pony Creek Victoria Creek	0.5	5.8 km^2 [b] (home range in spring - possibly in area from Mar /Apr/May to Sept/Oct/Nov)
Marten	Water, soil, berries, grouse, squirrel, hare	Background Mine Site	1.0	2 to 8 km^2 [f]
Merganser	Water, sediment, fish	Background Mill Site Tailings Site Brown-McDade Pit Pony Creek Victoria Creek	0.5	Possibly in area from April to Sept/Oct
Moose	Water, sediment, browse, aquatic vegetation	Mine Site (not including background)	0.25	60 km^2 [g] (15 to to 100 km^2)
Porcupine	Water, soil, browse, spruce, aquatic vegetation	Background Mill Site Tailings Site Brown-McDade Pit	1.0	0.15 km^2 (varies from 8 ha to 21 ha depending on gender) [f]

Table 3.1-2 Exposure Characteristics Assumed for Terrestrial Ecological Receptors at Mt. Nansen Mine (Cont'd)

Receptor	Pathways of Exposure	Area of Concern for Ecological Assessment	Fraction of time at site	Home Range
Scaup	Water, sediment, benthic invertebrates, aquatic vegetation	Background Mill Site Tailings Site Brown-McDade Pit Pony Creek Victoria Creek	0.5	0.89 km^2 [b] (possibly in area from Apr/May to Sept/Oct)
Wolf	Water, soil, moose, caribou, hare	Mine Site (not including background)	0.10	1000 km^2 (100 to 2500 km^2) [h]

Notes:

a Home range for a female bear can range between 2.6 km^2 to 40 km^2; the home range for a male bear can range from 21 km^2 to 155 km^2 (American Bear Association 2003).

b U.S. EPA (1993).

c Rock (1992).

d Hinterland Who's Who (Canadian Wildlife Service 2005).

e Home range for a female grouse is from 0.16 km^2 to 0.40 km^2; home range for a male grouse is from 0.04 km^2 to 0.20 km^2 (North Carolina State University 1995).

f Animal Diversity Web: Marten (Ellis 1999), Porcupine (Weber and Meyers 2004),

g In northern Saskatchewan, it is reported that moose may range over 25 to 100 km^2 (Cameco 2004). Home range studies based on radio-collared individuals were reported to average 59 km^2 for the Copper River Delta in south-central Alaska (MacCracken et al. 1997). In more southerly regions such as Idaho, the home range for female moose has been observed to range from 15.5 to 25.9 km^2, and for male from 31 to 51.8 km^2 (Pierce and Peck 1984).

h In Alaska, the home range may include some 200 to 600 square miles (520-1560 km^2) of habitat (Woodland 2005). Home range is 100 to 2500 km^2 (Resources Inventory Committee 1998).

i Ulev (2006).

Table 3.1-3 Summary of Locations Evaluated in Terrestrial Ecological Assessment

Receptor	Area of Concern	Pathways of Exposure
Bear	Background	water from Victoria Creek and Dry Creek reference sites and fish from Rowlinson Creek soil, forage and berries from upland control area; moose and caribou from Yukon background
	Mine Site	water and fish from Victoria Creek soil, forage, berries, moose and caribou from Mt. Nansen Mine Site
Bison	Background	water from Victoria Creek and Dry Creek reference sites soil and forage from upland control area
	Mine Site	water from Victoria Creek soil and forage from Mt. Nansen Mine Site
Woodland Caribou	Site-Wide	water from Victoria Creek soil, lichen, forage and browse from site-wide average

Table 3.1-3 Summary of Locations Evaluated in Terrestrial Ecological Assessment (Cont'd)

Receptor	Area of Concern	Pathways of Exposure
Grouse	Background	water from Victoria Creek and Dry Creek reference sites soil, berries and browse from upland control area
	Mill Site	water from Dome Creek soil, berries and browse from Mill Site
	Tailings Site	water from the Tailings Pond soil, berries and browse from Tailings Site
	Brown-McDade Pit	water from the Pit soil, berries and browse from Brown-McDade Pit
Hare	Background	water from Victoria Creek and Dry Creek reference sites soil, forage and browse from upland control area
	Mill Site	water from Dome Creek soil, forage and browse from Mill Site
	Tailings Site	water from the Tailings Pond soil, forage and browse from Tailings Site
	Brown-McDade Pit	water from the Pit soil, forage and browse from Brown-McDade Pit
Gray Jay	Background	water from Victoria Creek and Dry Creek reference sites soil, berries and fungi from upland control area shrew from Rowlinson Creek
	Mill Site	water from Dome Creek soil, berries, fungi and shrew from Mill Site
	Tailings Site	water from the Tailings Pond soil, berries, fungi and shrew from Tailings Site
	Brown-McDade Pit	water from the Pit soil, berries, fungi and shrew from Brown-McDade Pit
Mallard	Background	water, aquatic vegetation, benthic invertebrates from Victoria Creek and Dry Creek reference sites sediment from upstream of mine development
	Mill Site	water, sediment, aquatic vegetation, and benthic invertebrates from Dome Creek
	Tailings Site	water, sediment, aquatic vegetation, and benthic invertebrates from the Tailings Pond
	Brown-McDade Pit	water, sediment, aquatic vegetation, and benthic invertebrates from the Pit
	Pony Creek	water, sediment, aquatic vegetation, and benthic invertebrates from Pony Creek
	Victoria Creek	water, sediment, aquatic vegetation, and benthic invertebrates from Victoria Creek
Marten	Background	water from Victoria Creek and Dry Creek reference soil, berries, squirrel, grouse and hare from upland control area
	Mine Site	water from Victoria Creek soil, berries, squirrel, grouse and hare from Mt. Nansen Mine Site

Table 3.1-3 Summary of Locations Evaluated in Terrestrial Ecological Assessment (Cont'd)

Receptor	Area of Concern	Pathways of Exposure
Merganser	Background	water and fish from Victoria Creek and Dry Creek reference sites sediment from upstream of mine development
	Mill Site	water and sediment from Dome Creek fish from Victoria Creek
	Tailings Site	water and sediment from the Tailings Pond fish from Victoria Creek
	Brown-McDade Pit	water and sediment from the Pit fish from Victoria Creek
	Pony Creek	water and sediment from Pony Creek fish from Victoria Creek
	Victoria Creek	Water, sediment, and fish from Victoria Creek
Moose	Site-Wide	water, sediment and aquatic vegetation Victoria Creek browse from site-wide average
Porcupine	Background	water from Victoria Creek and Dry Creek reference sites soil and browse from upland control area
	Mill Site	water from Dome Creek soil, browse, and spruce from Mill Site
	Tailings Site	water from the Tailings Pond soil, browse, and spruce from Tailings Site
	Brown-McDade Pit	water from the Pit soil, browse, and spruce from Brown-McDade Pit
Scaup	Background	water, aquatic vegetation, benthic invertebrates from Victoria Creek and Dry Creek reference sites sediment from upstream of mine development
	Mill Site	water, sediment, aquatic vegetation, and benthic invertebrates from Dome Creek
	Tailings Site	water, sediment, aquatic vegetation, and benthic invertebrates from the Tailings Pond
	Brown-McDade Pit	water, sediment, aquatic vegetation, and benthic invertebrates from the Pit
	Pony Creek	water, sediment, aquatic vegetation, and benthic invertebrates from Pony Creek
	Victoria Creek	water, sediment, aquatic vegetation, and benthic invertebrates from Victoria Creek
Wolf	Site-Wide	water from Victoria Creek soil from site-wide average; moose, caribou and hare from the site

3.2 HUMAN RECEPTORS

The LSCFN has strong ties to the Mt. Nansen Mine area with accounts of significant use dating back prior to mining or mining exploration. The harvesting of plants and animals from the area is an important part of the lifestyle for many in the LSCFN (EDI 2007). A survey was completed by EDI (2007) in conjunction with LSCFN volunteers to identify the types of plants, animals, and fish that are consumed and used from the area by LSCFN. Based on the results of the survey, this assessment considers the potential for adverse effects to hypothetical individuals who camp at the site while hunting and gathering. It was assumed that a hypothetical camper would spend a similar amount of time on-site to trappers and other occasional users of the site.

It was assumed that a family would camp on the site and carry out their hunting and gathering activities; therefore, an adult, child, and toddler were considered in the assessment. The assessment was carried out for campers on Victoria Creek. The time that the campers spend in the vicinity of the site was assumed be approximately 1.5 months of the year. Based on the EDI (2007) survey, it was assumed that fishing only occurred on Victoria Creek.

The results of the survey completed by EDI (2007) provided the basis for the dietary characteristics of the hypothetical human receptors, and dietary data from a regional survey of First Nations people in the Yukon were used to augment the dietary characteristics for campers who would be present at the Mt. Nansen Mine. Other exposure data, such as drinking water consumption and body weight, were obtained from a survey of the general Canadian population and are acceptable for use in the current assessment.

Section 3.2.2 provides a detailed discussion on the receptor locations and dietary characteristics of the hypothetical campers considered in the assessment.

3.2.1 Pathways Considered

The human exposure analysis focused on the pathways as shown on Figure 3.2-1. They include:

- consumption of drinking water containing COPC from Victoria Creek by humans;
- consumption of measured COPC concentrations in caribou flesh by humans;
- consumption of measured COPC concentrations in moose flesh by humans;
- uptake by porcupine of COPC from water, soil and vegetation from the highest exposure area and consumption of porcupine flesh by the human receptors;
- consumption of measured COPC concentrations in snowshoe hare flesh by the human receptors;
- consumption of measured COPC concentrations in grouse flesh by humans;
- consumption of measured COPC concentrations in squirrels by humans;

- consumption of measured COPC concentrations in fish flesh (Victoria Creek) by humans;
- consumption of measured COPC concentrations in site-wide berries/medicinal plants by humans; and,
- inadvertent ingestion of soil site-wide containing COPC and dermal contact with soil by humans.

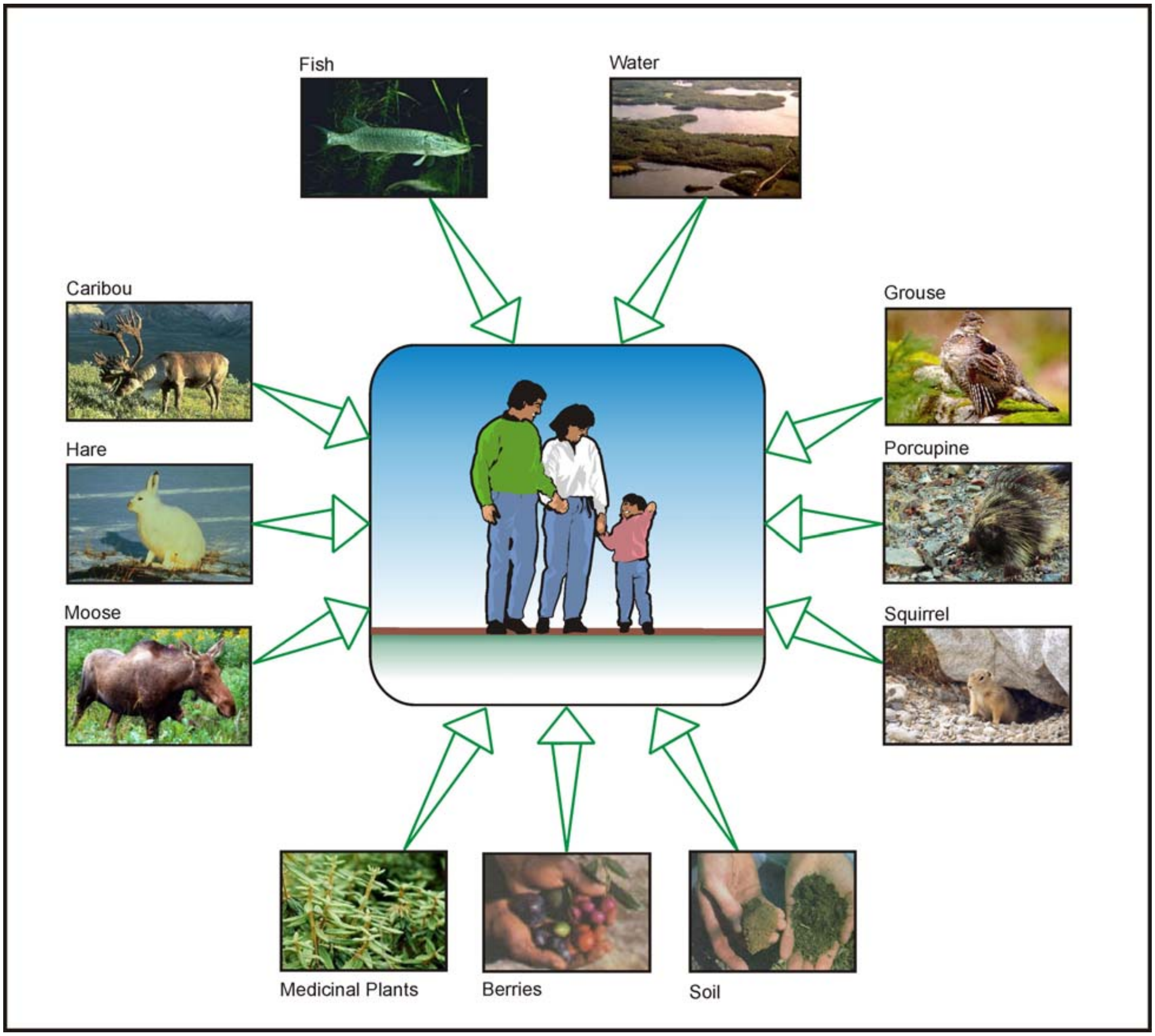
There are no pathways for contamination to intersect groundwater that could potentially be used for drinking water; therefore, the groundwater pathway was not evaluated.

As indicated by Health Canada (2004) in their PQRA Manual, the fugitive dust pathway (airborne respirable dust) is *"generally insignificant relative to direct ingestion of soil and water and to dermal absorption"*; therefore, this pathway was not considered in the assessment.

3.2.2 Location of Human Receptors and Time Spent On-Site

Based on the EDI (2007) survey, LSCFN harvest plants from within 10 to 15 km of the site; however, they avoid the mine site due to contamination issues. Fishing is the least important activity for LSCFN in the area of the mine site, but nevertheless, valuable fishing does occur at Victoria Lake (arctic grayling, round whitefish, northern pike) and to a lesser extent at Victoria Creek (arctic grayling). Gathering and hunting/trapping activities also occur in the vicinity of the site. It is assumed that trapping activities around the site can occur for up to approximately 50 days; therefore, for purposes of this assessment it was assumed that individuals could potentially be present at the site around Victoria Creek for 1.5 months of the year. It was assumed that individuals would fish in Victoria Creek. The background location was also considered in the assessment.

Figure 3.2-1 Potential Pathways of Exposure for Human Receptors



The assessment assumes that all of these activities (hunting, trapping, gathering, fishing) occur at the same time; however, hunting and trapping generally occur in the fall and winter time and possibly spring whereas gathering, fishing and inadvertent ingestion of soil occur during the summer months. For the purposes of this assessment, it was assumed that some meat and fish would be taken from the mine site and consumed by individuals. It was assumed that this would be done over a six-month period whereas drinking water and soil exposure would only occur over the 1.5 month at the site.

Table 3.2-1 provides a summary of the receptors considered in the assessment, the location of the various dietary components based on the information from the EDI (2007). Water and fish are obtained from Victoria Creek as it is reported that fishing does not occur on the site. It was assumed that small mammals are trapped in the areas of highest contamination and that berries and medicinal plants are gathered in a larger area around the camp. As with the terrestrial assessment, it was assumed that larger terrestrial mammals such as moose and caribou have a larger home range and would be hunted across the entire site.

Table 3.2-1 Location of the Various Dietary Components for the Human Receptors

Receptor	Camper 1	Camper 2
Drinking Water	Reference Locations on Victoria Creek and Dry Creek (Background)	Victoria Creek
Fish	Rowlinson Creek (Background)	Victoria Creek
Large Mammals	Yukon Background	Mine Site
Small Mammals	Rowlinson Creek (Background)	Highest exposed areas at Mine Site
Berries/Medicinal Plants	Upland Areas (Background)	Mine Site
Soil	Upland Areas (Background)	Mine Site
Time on Site (months per year)	1.5	1.5

3.2.3 Assumed Dietary Characteristics

The dietary characteristics for the assessment were based on the EDI (2007) survey and supplemented by a study of Yukon First Nations communities in 1998. It is acknowledged that this information was not collected for the purposes of this assessment; however, it is the best information available at present for conducting this assessment. Assumptions regarding the intakes of the adult and child receptors are outlined below.

3.2.3.1 Food Consumption

Traditional and market food intake rates for the LSCFN group were derived from Receveur *et al.* (1998). The use of region-specific dietary intake rates was deemed more appropriate than the use of other data sources and methods to estimate traditional and market food intakes, and is associated with less uncertainty.

Receveur *et al.* (1998) collected dietary intake data using methods including food frequency questionnaires and 24-hour recall surveys administered by trained interviewers during the late winter and fall of 1995. Ten communities in the Yukon participated in the study, including Dawson City, Mayo, Carmacks, Ross River, Watson Lake, Lower Post, Beaver Creek, Burwash Landing, Carcross and Atlin. Only adults in the communities were sampled, and included both men and women divided into age categories including ages 20-40, ages 41-60 and 61+ years.

Traditional food intake rates were available for both consumers only (people who only eat traditional foods) and consumers and non-consumers (people who eat a mixture of store bought food and traditional food). Rates for consumers and non-consumers provide an average estimate for the community, while rates for consumers only provide an upper bound on the average estimate for the community. Intake rates for both groups were derived for this assessment.

To derive average traditional food intake rates for an adult at the Mt. Nansen Mine, rates provided by Receveur *et al.* (1998) were first averaged for both sexes over the three adult age groups for which data were available. Traditional food items were subsequently grouped into categories including meat and poultry, fish, and berries in order to calculate intake rates for these based on a summation of the group items. The food groupings chosen were those typically used in Canadian total diet studies (Richardson 1997, Health Canada 2005).

Traditional food items in the meat and poultry group contained some items for which concentrations of COPC could not be estimated in the risk assessment, such as moose bone marrow and heart. The amount consumed of each of these items was counted nonetheless so as not to under-estimate intake of traditional foods. However, it was assumed that the COPC content of these items was the same as that in the flesh of the animal under consideration; this would provide an underestimate of the COPC intake as organs generally contain higher concentrations of COPC. A sensitivity analysis was performed to determine the effect of organ consumption and is presented in Section 6.5.

The intakes for a toddler and child were estimated assuming that the ratio of toddler to adult (0.52 meat and eggs; 0.50 fish and shellfish; 0.96 fruits and juices) and child to adult (0.74 meat and eggs; 0.81 fish and shellfish; 1.09 fruits and juices) of a particular category of food for the general population (Richardson 1997) could be applied to the information for the LSCFN region.

Table 3.2-2 provides the average traditional food intake rates (people who eat traditional food and a mixture of store bought food) derived from Receveur *et al.* (1998) for a LSCFN adult and child.

Total meat and fish intake rates were derived for risk assessment purposes, as well as fractions of the intake rate attributable to different traditional foods. This rate is presented in Table 3.2-2 and the fractions are presented in Table 3.2-3.

Table 3.2-2 Intake of Traditional Foods for Yukon First Nations

Food Category	Mean Intake Rate (g/d)		
	Toddler	Child	Adult
Meat and poultry	90	128	173
Fish and shellfish	10.8	17.5	21.6
Berries/Fruit	1.57	1.78	1.63
Total meat and fish	101	145	195

Source: Receveur *et al*. 1998

Table 3.2-3 Composition of Different Fractions of Meat and Fish Intake for Yukon First Nations

Traditional Food Item	Dietary Fraction
Fraction that is caribou	0.06
Fraction that is moose	0.75
Fraction that is hare	0.03
Fraction that is squirrel	0.02
Fraction that is poultry (grouse)	0.01
Fraction that is porcupine	0.02
Fraction that is fish	0.11

Source: Receveur *et al*. 1998.

Table 3.2-4 provides the traditional food intake rates for consumers only derived from Receveur *et al*. (1998) for a Yukon First Nations adult, child, and toddler.

Again, a total meat and fish intake rate was also derived for risk assessment purposes, as well as fractions of the intake rate attributable to different traditional foods. This rate is presented in Table 3.2-4 and the fractions are presented in Table 3.2-5.

Table 3.2-4 Intake of Traditional Foods for Yukon First Nations (Consumers of Traditional Food Only)

Food Category	Mean Intake Rate (g/d)		
	Toddler	Child	Adult
Meat and poultry	1971	2804	3790
Fish and shellfish	1043	1690	2086
Berries/Fruit	541	738	677
Total meat and fish	3014	4494	5876

Source: Receveur *et al*. 1998

Table 3.2-5 Composition of Different Fractions of Meat and Fish Intake for Yukon First Nations (Consumers of Traditional Food Only)

Traditional Food Item	Dietary Fraction
Fraction that is caribou	0.05
Fraction that is moose	0.36
Fraction that is hare	0.04
Fraction that is squirrel	0.02
Fraction that is poultry	0.05
Fraction that is porcupine	0.11
Fraction that is fish	0.36

Source: Receveur *et al*. 1998

Intake rates for commercial market foods were also available in Receveur *et al*. (1998). Similar to the methods used for the intakes of traditional foods, adults of different age groups were interviewed regarding their consumption of market food using 24-hour dietary recall surveys conducted by trained interviewers during the late winter and fall of 1995. Intake rates for individual market food items for consuming and non-consuming adults of different age groups and sexes were subsequently calculated by Receveur *et al*. (1998).

To derive average market food intake rates for an adult at the Mt. Nansen Mine, rates by Receveur *et al.* (1998) for the Yukon First Nations were first averaged for both sexes over the three adult age groups for which data were available. Market food items were then grouped into their respective food categories, which included milk and dairy products, meat and poultry, fish and shellfish, soups, bakery goods and cereals, vegetables, fruits and fruit juices, fats and oils, sugar and candies, beverages and miscellaneous items based on a summation of individual items in the group. The food groupings chosen were those typically used in Canadian total diet studies (Richardson 1997, Health Canada 2005). Market foods intake rates were only available for consumers and non-consumers combined (zeros in).

Again, the intake for a child was estimated assuming that the ratio of child to adult of a particular category of food for the general population (Richardson 1997) could be applied to the information for the Yukon First Nations region. A similar ratio was used to determine toddler intakes.

Table 3.2-6 provides the market food intake rates derived from Receveur *et al.* (1998) for a Yukon First Nations adult, child, and toddler.

Table 3.2-6 Intake of Market Foods Based on the Yukon First Nations

Food Category	Mean Intake Rate of Market Foods (g/d)		
	Toddler	Child	Adult
Milk and dairy products	36	52	70
Meat and poultry	93	132	178
Fish and shellfish	1.7	2.8	3.5
Soups	73	104	141
Bakery goods and cereals	96	137	185
Vegetables	100	143	193
Fruit and fruit juices	60	68	63
Fats and oils	10	14	19
Sugar and candies	18	25	34
Beverages	717	1021	1379
Miscellaneous	40	56	76

Source: Receveur *et al.* 1998

As a significant amount of the beverage intake is coffee and tea, the beverage intake for the toddler and child is likely overstated.

In this assessment, the dietary intakes for people who eat a mixture of traditional foods and store bought foods were used as this seems indicative of the community around the Mt. Nansen Mine.

3.2.3.2 Medicinal Tea Intake

First Nations People generally use Labrador tea and other teas made from natural plants for medicinal purposes. The Yukon dietary survey (Receveur *et al.* 1998), for the area only, indicated that in the winter 12% of the population consumes Labrador Tea 1.2 days/week and in the summer 23% of the population consumes Labrador Tea 1.4 days/week. This equates to an average Labrador Tea consumption of 1.3 days per week. The survey does not provide the amount of Labrador tea or other medicinal teas that are consumed.

In an attempt to determine the amount of medicinal tea consumed by members of the community, a web search was undertaken. The web search indicated that "*Labrador Tea contains small amounts of the toxin andromedotoxin which can cause headaches, cramps, paralysis and intestinal problems if too much is consumed. As a general rule, this tea should be consumed in moderation. One cup is often considered the safe amount.*" - *http://www.laurentiancenter.com/plantkey/plants/labradortea.html*

Therefore, it was assumed in this assessment that an adult (70kg body weight) would consume 250 mL (1 cup) of medicinal teas for 1.3 days a week. This equates to a consumption rate of 0.17 cups/day. It is assumed that all of the Labrador tea consumed over a year is gathered from the site area.

3.2.3.3 Water Intake

The water intakes for an adult and child were obtained from the "*Compendium of Canadian Human Exposure Factors for Risk Assessment*" (Richardson, 1997). The average water intakes for an adult, child (5 to 11 years of age) and toddler (0.5 to 4 years of age) are estimated to be 1.5 L/d, 0.8 L/d and 0.6 L/d respectively.

3.2.3.4 Soil Intake

Soil intake rates were obtained from Health Canada (2003) and were based on the information obtained from CCME (1996) and the Massachusetts Department of Environmental Protection (MADEP 2002). The mean daily soil intake provided for an adult was 20 mg/d, and, for a child was 20 mg/d. The mean soil intake for a toddler is reported to be 80 mg/d.

3.2.3.5 Body Weight

The body weight (bw) of a toddler, child and adult are also necessary in order to calculate a daily intake (mg/(kg (bw) d)). In this assessment, the body weights used for the toddler, child and adult receptors were 16.5 kg, 32.9 kg and 70.7 kg, respectively (Richardson 1997).

3.2.3.6 Summary of Receptor Characteristics

The amount of traditional foods and berries that were assumed to be consumed by the adult, child, and toddler receptors present at the Mt. Nansen Mine are summarized in Table 3.2-7.

Table 3.2-7 Adult, Child, and Toddler Characteristics for Pathways Modelling

	Receptor		
	Adult	**Child**	**Toddler**
Water (L/d)	1.5	0.8	0.6
Soil Intake (mg dw/d)	20	20	80
Local Meat (g ww/d)			
Caribou	11.8	8.7	6.1
Moose	146	108	75.9
Other small mammals	14.2	10.5	7.4
Local Poultry (g ww/d)			
Ground birds	1	0.74	0.52
Local Fish (g ww/d)	21.6	17.5	10.8
Total local meat, fish and poultry (g ww/d)	195	145	101
Other (g ww/d)			
Berries	1.6	1.8	1.6
Exposure Duration (yr) – carcinogenic effects only	63	7	5
Averaging Time (yr) – carcinogenic effects only	75	75	75
Adherence Factor of soil to skin (kg cm^{-2} $event^{-1}$)[a]	1.88×10^{-8}	2.03×10^{-8}	2.29×10^{-8}
Skin Surface Area exposed to soil (cm^2)[b]	9110	5140	3010

Note: Adult Weight = 70.7 kg; Child Weight = 32.9 kg; Toddler = 16.5 kg

a - Kissel *et al*. 1996, 1998

b - Richardson 1997

4.0 EXPOSURE ASSESSMENT

The exposure assessment phase of an ecological and human health risk assessment entails the quantification of exposure for the selected receptors. As previously noted, the pathways of exposure considered in this assessment are related to the COPC (mostly metals) present in various media (water, soils, vegetation (aquatic and terrestrial), sediments, etc.) on the mine site. The approach and assumptions applied in this assessment are described in this chapter.

The data provided in this chapter include the estimates of the potential intakes of the COPC by ecological species exposed to COPC in the aquatic and terrestrial environments as well as intakes for human receptors who use the site. The implications of the measured exposure levels of the COPC are discussed in Chapter 6.

4.1 PATHWAYS ANALYSIS

Exposure of the receptors described in Chapter 3 to the COPC was calculated using a pathways modelling approach. Pathways modelling combines the receptor characteristics (described in Chapter 3) with environmental media concentrations of COPC (Chapter 2) to estimate exposure of each receptor.

When measured environmental media concentrations of COPC are not available, they can be estimated using transfer factors and certain assumptions. Transfer factors are empirical values that provide a measure of the partitioning behaviour of a COPC between two environmental media. Transfer factors are available from literature sources or from site-specific measurements to describe partitioning between many different media, including water-to-sediment, food-to-animal flesh and other media. Literature derived transfer factors were used in the aquatic environment for water-to-aquatic vegetation and –benthic invertebreates as no measured data were available for aquatic vegetation and benthic invertebrates. Site-specific distribution coefficients were developed for water-to-sediment to estimate sediment concentrations in the Tailings Pond and Brown-McDade Pit. Therefore, for the aquatic pathways, representative maximum concentrations of COPC measured in water, fish and sediments (as available) were used in the pathways analysis and literature transfer factors and site-specific distribution coefficients were used to develop concentrations of COPC in aquatic plants, benthic invertebrates and sediments, respectively. For determing potential effects of COPC in the aquatic environment on aquatic receptors such as aquatic plants and fish, no pathways analysis is needed since potential effects are evaluated by a comparison of the water concentrations to toxicity reference values that are specific for a given aquatic receptor.

In the terrestrial environment, an extensive database of measured concentrations was available for soil and various types of vegetation and animals at both background/reference and mine locations. Therefore, transfer factors were not necessary for the terrestrial environment.

4.2 METAL BIOAVAILABILITY

Bioavailability of a chemical can be defined as the fraction of an administered dose that reaches the central (blood) compartment, whether through the gastrointestinal tract, skin or lungs (NEPI 2000). This type of bioavailability is known as "absolute bioavailability".

In risk assessments, oral exposures are generally described in terms of an external dose or intake, as opposed to an absorbed dose or uptake. Intake occurs as an agent enters the body of a human or animal without passing an absorption barrier (e.g., through ingestion or inhalation), while uptake occurs as an agent passes across the absorption barrier (IPCS 2000). Not all materials (e.g., metals, nutrients) that enter the body as intake are absorbed into the body as uptake. Many are passed through the body and expelled without effect.

When calculating the intake via the oral route of exposure, it is customary to take into account the food, water and soil pathways. As there was insufficient information to derive site-specific bioavailability/bioaccessibility factors, it was assumed that all the COPC were 100% available from all sources. This is a highly conservative assumption as the reality is that the bioaccessibility of COPC from soil/sediment is generally less than 100%.

4.3 TERRESTRIAL ECOLOGICAL INTAKES

Intakes of COPC by terrestrial animals were predicted based on the dietary characteristics of the respective animals. In essence, the total intake of the COPC for the selected receptors is equal to the sum of COPC intake from all the appropriate pathways including the ingestion of water, sediment, soil, aquatic vegetation, benthic invertebrates, fish, terrestrial vegetation and other animals. The general equation used to calculate each of the intake routes is as follows:

$$I_n = C_n \times IR_n \times f_{loc}/1000 \tag{4-1}$$

Where:

I_n	=	Intake of COPC via pathway "n" where "n" can represent all exposure routes such as water, soil, vegetation (mg/d)
C_n	=	COPC concentration in "n" media (mg/kg)
IR_n	=	intake rate of "n" by the receptor (g/d, see Figures 3.1-3a-d or Appendix D)
f_{loc}	=	fraction of time at site (see Table 3.1-2)
1000	=	unit conversion (g/kg)

The intake rates by the individual pathways can be summed to provide a total intake for the receptor. Appendix C provides a sample calculation for developing these intakes. Appendix E provides the breakdown by the various pathway.

The predicted intakes of the COPC by the various terrestrial receptors are provided on Table 4.3-1 for the terrestrial environment and Table 4.3-2 for the aquatic environment. As seen in the tables, depending on the terrestrial receptor, different locations across the site were examined. These locations depended on the home range of the animal, for example, for caribou, which has a large home range, the whole site is considered, for a hare with a much smaller home, three different areas spanning the mill, tailings pond, and Brown McDade Pit are evaluated. These areas were selected based on data availability and home range. Background (reference locations on Victoria Creek and Dry Creek; Rowlinson Creek) is also considered in the assessment. Aquatic birds (Table 4.3-2) were also assessed located on Pony Creek and Victoria Creek.

Table 4.3-1 Predicted Intakes by Terrestrial Ecological Receptors in the Terrestrial Environment

mg/kg-d	Black Bear		Bison		Caribou	Grouse				Hare			
	BG	Mine	BG	Mine	Mine	BG	Mill	Tailings	Pit	BG	Mill	Tailings	Pit
Arsenic	0.16	1.39	0.11	2.27	0.96	0.42	7.05	1.64	0.55	0.38	5.30	3.27	0.80
Boron	0.30	0.61	0.75	1.30	0.28	1.18	7.34	7.37	3.09	1.51	5.81	5.68	2.88
Cadmium	0.01	0.04	0.01	0.07	0.06	2.39	2.34	2.10	3.17	1.48	1.47	1.37	1.98
Copper	0.15	0.81	0.18	1.98	0.23	0.56	1.15	15.79	1.06	0.54	0.86	4.96	1.02
Lead	0.18	0.76	0.45	1.86	0.47	0.31	3.60	0.65	0.40	0.71	2.61	2.36	0.44
Manganese	29	54	69	98	20	172	106	169	119	179	128	213	138
Selenium	0.02	0.03	0.01	0.01	0.01	0.09	0.09	0.10	0.09	0.02	0.03	0.03	0.02
Strontium	0.66	1.19	0.46	0.89	0.49	12.97	8.04	10.38	16.71	8.38	5.26	6.70	10.38
Tin	0.01	0.01	0.01	0.01	0.02	0.03	0.04	0.05	0.05	0.02	0.02	0.03	0.03
Zinc	1.3	3.7	1.2	8.6	2.4	57.2	82.3	68.0	109.6	36.7	54.4	50.1	76.7

mg/kg-d	Gray Jay				Marten		Moose	Porcupine				Wolf
	BG	Mill	Tailings	Pit	BG	Mine	Mine	BG	Mill	Tailings	Pit	Mine
Arsenic	0.63	3.93	1.88	0.54	0.06	0.34	0.86	0.23	2.65	0.72	0.25	0.13
Boron	0.65	2.01	1.47	1.98	0.03	0.08	1.17	0.31	2.08	2.11	0.84	0.01
Cadmium	0.10	0.35	0.31	0.38	0.01	0.25	0.55	0.99	0.98	0.91	1.82	0.00
Copper	1.79	2.86	5.93	2.77	0.10	0.28	0.25	0.46	8.46	581.19	1.88	0.06
Lead	0.22	1.10	0.25	0.19	0.02	0.11	0.55	0.23	1.32	0.55	0.30	0.04
Manganese	65	129	125	52	2	8	20	48	63	110	42	3
Selenium	0.11	0.32	0.31	0.31	0.01	0.04	0.03	0.20	0.21	0.21	0.21	0.00
Strontium	2.35	5.24	4.88	7.96	0.07	0.24	2.82	5.88	8.68	14.64	13.04	0.05
Tin	0.03	0.03	0.06	0.03	0.00	0.01	0.01	0.06	0.06	0.09	0.06	0.00
Zinc	12.2	21.9	20.6	21.8	1.2	1.9	17.9	17.1	27.3	24.2	55.1	0.5

Note: Terrestrial ecological receptors in the terrestrial environment are assessed for terrestrial COPC.
BG - Background

Table 4.3-2 Predicted Intakes by Terrestrial Ecological Receptors in the Aquatic Environment

mg/kg-d	Mallard						Merganser						Scaup					
	BG	**Mill**	**Tailings**	**Pit**	**Pony**	**Victoria**	**BG**	**Mill**	**Tailings**	**Pit**	**Pony**	**Victoria**	**BG**	**Mill**	**Tailings**	**Pit**	**Pony**	**Victoria**
Antimony	4.4	4.5	4.5	4.5	0.4	4.4	0.00	0.04	0.03	0.03	0.16	0.02	2.2	2.5	2.4	2.4	1.2	2.3
Arsenic	14.7	28.2	30.1	15.0	38.8	14.6	0.1	1.4	0.6	0.4	2.4	0.1	23.9	50.9	50.8	25.3	72.2	23.8
Barium	2.2	5.8	1.9	0.7	3.6	4.0	0.8	0.9	0.8	0.8	1.1	0.9	2.7	7.5	2.6	1.0	5.7	5.3
Boron	0.001	0.1	0.05	0.01	0.0001	0.04	0.04	0.09	0.08	0.06	0.05	0.08	0.002	0.22	0.18	0.03	0.0001	0.18
Cadmium	2.0	2.0	2.0	6.1	2.4	2.0	0.009	0.03	0.02	0.03	0.03	0.01	2.9	3.0	2.9	9.1	3.6	2.9
Chromium	0.02	0.06	0.06	0.06	0.03	0.04	0.03	0.06	0.06	0.06	0.04	0.05	0.06	0.21	0.24	0.24	0.10	0.13
Cobalt	0.6	3.7	18.0	0.6	0.2	0.6	0.03	0.03	0.6	0.04	0.03	0.03	0.8	4.8	25.8	0.9	0.3	0.8
Copper	1.0	30.7	2262.8	5.9	11.6	2.2	0.2	0.2	52.2	0.3	0.8	0.2	1.4	41.1	3248.2	8.5	18.1	3.1
Iron	11.8	41.6	146.8	7.3	83.7	31.9	22.4	66.2	134.3	43.9	93.4	59.8	50.9	179.3	636.4	31.8	362.2	138.3
Lead	0.3	0.7	1.5	0.5	5.4	0.4	0.02	0.3	0.4	0.1	2.1	0.1	0.5	2.2	3.5	1.1	16.7	0.7
Manganese	0.7	39.0	114.5	10.8	6.5	2.0	3.2	11.8	46.2	8.4	6.1	5.1	1.5	61.8	302.7	28.7	13.3	5.1
Selenium	6.0	6.0	6.0	6.0	0.04	6.0	0.2	0.3	0.3	0.3	0.3	0.3	9.5	9.5	9.5	9.5	0.1	9.5
Silver	0.4	0.4	4.7	0.7	0.2	0.4	0.001	0.005	0.04	0.01	0.05	0.002	0.6	0.6	7.3	1.1	0.5	0.6
Strontium	12.4	37.0	68.8	48.0	16.8	17.2	4.9	3.7	3.8	3.7	3.7	3.7	17.8	53.1	98.9	69.0	24.2	24.8
Vanadium	1.0	1.6	2.4	1.2	0.6	1.08	0.08	0.15	0.38	0.24	0.12	0.14	0.8	1.4	3.1	1.6	0.5	1.0
Zinc	55.2	615.4	860.7	4756.5	1432.1	62.1	3.5	4.7	4.0	7.6	4.2	3.3	89.1	997.6	1389.4	7678.7	2310.8	100.3

Note: Terrestrial ecological receptors in the aquatic environment are assessed for aquatic COPC.

Chloride, sulphate, ammonia, cyanate, and thiocyanate do not transfer through the food chain and are not included in the terrestrial ecological assessment.

BG- Background; Tailings – Tailings Pond; Pit – Brown McDade Pit; Pony – Pony Creek; Victoria – Victoria Creek

4.4 HUMAN RECEPTOR INTAKES

Intakes of COPC by humans located at the site were predicted based on the dietary characteristics provided in Section 3.2 and the locations in the study area from which the various components of the diet were assumed to be obtained (see Table 3.2-1). Appendix F provides the sample calculation for human intakes. The equations and assumptions used to calculate the intakes are provided in this section.

Ingestion of Water

$$I_{water} = \frac{C_{water} \times R_{water} \times F_{site}}{BW} \tag{4-1}$$

where:

I_{water}	=	exposure to contaminant through the water pathway [mg/(kg d)];
C_{water}	=	measured water concentration [mg/L];
R_{water}	=	water ingestion rate [L/d] {shown in Table 3.2-7};
F_{site}	=	fraction of time at site [-]{shown in Table 3.2-7};
BW	=	body weight [kg] {shown in Table 3.2-7}.

Incidental Ingestion of Soil

$$I_{soil} = \frac{C_{soil} \times R_{soil} \times F_{site}}{BW} \times \frac{1}{1000} \tag{4-2}$$

where:

I_{soil}	=	exposure to contaminant through the soil pathway [mg/(kg d)];
C_{soil}	=	soil concentration [mg/kg (dw)];
R_{soil}	=	soil ingestion rate [mg (dw)/d] {shown in Table 3.2-7};
F_{site}	=	fraction of time at site [-]{shown in Table 3.2-7};
BW	=	body weight [kg] {shown in Table 3.2-7};

Ingestion of Food

$$I_{food\ x} = \frac{C_x \times R_{ing} \times F_x \times F_{site}}{BW} \times \frac{1}{1000} \qquad (4\text{-}3)$$

where:

$I_{food\ x}$	=	exposure to contaminant through the food pathway [mg/(kg d)], where x is fish, berry, hare, duck moose, caribou, as applicable;
C_x	=	concentration of contaminant [mg/kg (ww)] for each x;
R_{ing}	=	food ingestion rate [g (ww)/d] {shown in Table 3.2-7};
F_x	=	fraction of diet that is x, where x is fish, berry, grouse, hare, porcupine, moose, caribou, squirrel, as applicable [-] {shown in Table 3.2-7};
F_{site}	=	fraction of food from site [-] {0.50 for fish, grouse, hare, porcupine, moose, caribou, squirrel and 0.125 for berry};
BW	=	body weight [kg];
1/1000	=	unit conversion factor [kg/g].

Dermal Exposure to Soil

The approach used for estimating the dermal exposure to COPC in soil was based on the equations given in U.S. EPA (2001).

$$I_{dermal} = \frac{C_{soil} \times SA \times SL \times RAF \times EF \times F_{site}}{BW} \qquad (4\text{-}4)$$

where:

I_{dermal}	=	exposure to constituent in soil through the dermal pathway [mg/(kg d)];
C_{soil}	=	soil concentration [mg/kg (dw)];
SA	=	skin surface area – total [cm^2] {shown in Table 3.2-7};
SL	=	loading to exposed skin [kg (dw)/(cm^2 event)] {shown in Table 3.2-7};
RAF	=	dermal absorption factor [-] – obtained from Health Canada
EF	=	exposure frequency [events/d] {assumed to be 1/d}
F_{site}	=	fraction of time at site [-]{shown in Table 3.2-7};
BW	=	body weight [kg] {shown in Table 3.2-7}.

Camper 1 was assumed to receive background exposures, while Camper 2 was considered to receive exposure from the Mt. Nansen site. Adults, children and toddlers were considered for both camper scenarios. As seen from Tables 4.4-1 and 4.4-2, intakes of COPC for toddlers are higher than for older children or adults. This is because of the higher intakes to body weight ratio as well as the fact that toddlers are more exposed to the soil pathway. It has been assumed that these individuals spend 1.5 months of the year on site and consume meat and fish obtained from the site every other day for the rest of the year. Measured concentrations of fish, caribou, hare, squirrel, grouse, and moose flesh were used in the calculations.

Tables 4.4-3 and 4.4-4 provide the percentage breakdown by pathway. As seen from these tables, consumption of fish from background and the site represents the largest exposure pathway for manganese, selenium (Camper 2 only) strontium and tin (Camper 2 only). For cadmium (Camper 1 only), copper, lead (Camper 1 only), selenium (Camper 1 only) and zinc, consumption of moose considered to be background exposure represents a significant exposure pathway. For arsenic, boron, selenium, and tin, water associated with background is the significant exposure pathway for Camper 1, with Labrador tea from background locations also a significant pathway for boron for the Camper 1 adult. Water is a significant pathway for arsenic, boron, lead, selenium, and tin for the Camper 2. The ingestion of soil for the Camper 2 is significant for arsenic and lead. The Camper 2 adult also has a large part of exposure for boron and tin from the ingestion of Labrador tea. Ingestion of squirrel is a significant portion of exposure of cadmium and the ingestion of moose and porcupine is a large part of exposure for copper for Camper 2.

Table 4.4-1 Predicted Intakes for Human Receptors – Camper 1 – Background

Toddler	**Ingestion**											**Total Intake**	
mg/(kg d)	**Water**	**Fish**	**Hare**	**Porcupine**	**Moose**	**Caribou**	**Squirrel**	**Grouse**	**Berries**	**Lab Tea**	**Soil**	**Ingestion**	**Dermal**
Arsenic	4.55×10^{-4}	8.63×10^{-5}	1.35×10^{-6}	3.94×10^{-8}	4.56×10^{-5}	1.21×10^{-5}		3.32×10^{-6}	3.62×10^{-7}	0.0	5.16×10^{-5}	6.55×10^{-4}	1.42×10^{-6}
Boron	2.27×10^{-4}	1.06×10^{-4}	2.69×10^{-5}	1.33×10^{-8}	0.0	0.0		4.51×10^{-6}	2.90×10^{-5}	0.0	5.45×10^{-7}	3.94×10^{-4}	4.70×10^{-8}
Cadmium	2.27×10^{-5}	2.31×10^{-5}	5.50×10^{-6}	3.29×10^{-8}	5.06×10^{-5}	4.85×10^{-6}		8.29×10^{-8}	3.55×10^{-6}	0.0	1.35×10^{-6}	1.12×10^{-4}	1.62×10^{-7}
Copper	4.09×10^{-5}	5.17×10^{-4}	2.42×10^{-4}	2.70×10^{-7}	2.94×10^{-3}	5.05×10^{-4}		2.07×10^{-5}	1.03×10^{-5}	0.0	1.82×10^{-5}	4.29×10^{-3}	1.57×10^{-6}
Lead	1.14×10^{-4}	1.80×10^{-5}	9.30×10^{-6}	2.13×10^{-6}	2.57×10^{-3}	2.62×10^{-6}		2.49×10^{-6}	1.00×10^{-7}	0.0	1.70×10^{-5}	2.73×10^{-3}	8.77×10^{-8}
Manganese	3.27×10^{-4}	7.86×10^{-3}	4.04×10^{-5}	1.54×10^{-6}	4.05×10^{-4}	5.34×10^{-5}		3.85×10^{-5}	3.26×10^{-3}	0.0	2.16×10^{-4}	1.22×10^{-2}	1.86×10^{-5}
Selenium	4.55×10^{-4}	4.78×10^{-4}	2.69×10^{-6}	1.95×10^{-7}	4.71×10^{-4}	7.52×10^{-5}		4.51×10^{-7}	2.00×10^{-7}	0.0	6.06×10^{-8}	1.48×10^{-3}	1.04×10^{-10}
Strontium	1.22×10^{-3}	1.27×10^{-2}	1.37×10^{-5}	1.89×10^{-6}	0.0	0.0		1.33×10^{-6}	3.55×10^{-5}	0.0	1.82×10^{-5}	1.40×10^{-2}	1.57×10^{-6}
Tin	6.82×10^{-5}	2.75×10^{-5}	5.38×10^{-6}	1.31×10^{-7}	0.0	0.0		2.25×10^{-7}	1.00×10^{-7}	0.0	1.52×10^{-6}	1.03×10^{-4}	1.31×10^{-7}
Zinc	7.27×10^{-5}	8.92×10^{-3}	2.83×10^{-3}	1.10×10^{-4}	1.06×10^{-1}	7.96×10^{-3}		3.93×10^{-4}	7.81×10^{-5}	0.0	6.73×10^{-5}	1.26×10^{-1}	1.16×10^{-6}
Child	**Ingestion**											**Total Intake**	
mg/(kg d)	**Water**	**Fish**	**Hare**	**Porcupine**	**Moose**	**Caribou**	**Squirrel**	**Grouse**	**Berries**	**Lab Tea**	**Soil**	**Ingestion**	**Dermal**
Arsenic	3.04×10^{-4}	7.01×10^{-5}	9.60×10^{-7}	2.81×10^{-8}	3.25×10^{-5}	8.66×10^{-6}		2.37×10^{-6}	2.06×10^{-7}	0.0	6.47×10^{-6}	4.25×10^{-4}	1.08×10^{-6}
Boron	1.52×10^{-4}	8.58×10^{-5}	1.92×10^{-5}	9.53×10^{-9}	0.0	0.0		3.22×10^{-6}	1.65×10^{-5}	0.0	6.84×10^{-8}	2.77×10^{-4}	3.57×10^{-8}
Cadmium	1.52×10^{-5}	1.88×10^{-5}	3.93×10^{-6}	2.35×10^{-8}	3.61×10^{-5}	3.46×10^{-6}		5.92×10^{-8}	2.02×10^{-6}	0.0	1.69×10^{-7}	7.98×10^{-5}	1.23×10^{-7}
Copper	2.74×10^{-5}	4.20×10^{-4}	1.73×10^{-4}	1.93×10^{-7}	2.10×10^{-3}	3.60×10^{-4}		1.48×10^{-5}	5.85×10^{-6}	0.0	2.28×10^{-6}	3.10×10^{-3}	1.19×10^{-6}
Lead	7.60×10^{-5}	1.46×10^{-5}	6.63×10^{-6}	1.52×10^{-6}	1.83×10^{-3}	1.87×10^{-6}		1.77×10^{-6}	5.70×10^{-8}	0.0	2.13×10^{-6}	1.94×10^{-3}	6.66×10^{-8}
Manganese	2.19×10^{-4}	6.39×10^{-3}	2.88×10^{-5}	1.10×10^{-6}	2.89×10^{-4}	3.81×10^{-5}		2.75×10^{-5}	1.86×10^{-3}	0.0	2.71×10^{-5}	8.88×10^{-3}	1.41×10^{-5}
Selenium	3.04×10^{-4}	3.88×10^{-4}	1.92×10^{-6}	1.39×10^{-7}	3.36×10^{-4}	5.37×10^{-5}		3.22×10^{-7}	1.14×10^{-7}	0.0	7.60×10^{-9}	1.08×10^{-3}	7.93×10^{-11}
Strontium	8.18×10^{-4}	1.03×10^{-2}	9.79×10^{-6}	1.35×10^{-6}	0.0	0.0		9.46×10^{-7}	2.02×10^{-5}	0.0	2.28×10^{-6}	1.12×10^{-2}	1.19×10^{-6}
Tin	4.56×10^{-5}	2.24×10^{-5}	3.84×10^{-6}	9.32×10^{-8}	0.0	0.0		1.61×10^{-7}	5.70×10^{-8}	0.0	1.90×10^{-7}	7.23×10^{-5}	9.91×10^{-8}
Zinc	4.86×10^{-5}	7.25×10^{-3}	2.02×10^{-3}	7.83×10^{-5}	7.55×10^{-2}	5.68×10^{-3}		2.80×10^{-4}	4.45×10^{-5}	0.0	8.43×10^{-6}	9.09×10^{-2}	8.80×10^{-7}
Adult	**Ingestion**											**Total Intake**	
mg/(kg d)	**Water**	**Fish**	**Hare**	**Porcupine**	**Moose**	**Caribou**	**Squirrel**	**Grouse**	**Berries**	**Lab Tea**	**Soil**	**Ingestion**	**Dermal**
Arsenic	2.65×10^{-4}	4.03×10^{-5}	6.04×10^{-7}	1.77×10^{-8}	2.04×10^{-5}	5.44×10^{-6}		1.49×10^{-6}	8.81×10^{-8}	1.20×10^{-6}	3.01×10^{-6}	3.38×10^{-4}	8.26×10^{-7}
Boron	1.33×10^{-4}	4.93×10^{-5}	1.21×10^{-5}	5.99×10^{-9}	0.0	0.0		2.02×10^{-6}	7.05×10^{-6}	2.49×10^{-4}	3.18×10^{-8}	4.52×10^{-4}	2.73×10^{-8}
Cadmium	1.33×10^{-5}	1.08×10^{-5}	2.47×10^{-6}	1.48×10^{-8}	2.27×10^{-5}	2.18×10^{-6}		3.72×10^{-8}	8.63×10^{-7}	3.01×10^{-7}	7.85×10^{-8}	5.27×10^{-5}	9.41×10^{-8}
Copper	2.39×10^{-5}	2.41×10^{-4}	1.09×10^{-4}	1.21×10^{-7}	1.32×10^{-3}	2.26×10^{-4}		9.30×10^{-6}	2.50×10^{-6}	4.57×10^{-5}	1.06×10^{-6}	1.98×10^{-3}	9.08×10^{-7}
Lead	6.63×10^{-5}	8.39×10^{-6}	4.17×10^{-6}	9.55×10^{-7}	1.15×10^{-3}	1.18×10^{-6}		1.12×10^{-6}	2.44×10^{-8}	1.50×10^{-6}	9.90×10^{-7}	1.24×10^{-3}	5.09×10^{-8}
Manganese	1.91×10^{-4}	3.67×10^{-3}	1.81×10^{-5}	6.92×10^{-7}	1.82×10^{-4}	2.39×10^{-5}		1.73×10^{-5}	7.93×10^{-4}	7.39×10^{-4}	1.26×10^{-5}	5.65×10^{-3}	1.08×10^{-5}
Selenium	2.65×10^{-4}	2.23×10^{-4}	1.21×10^{-6}	8.76×10^{-8}	2.11×10^{-4}	3.37×10^{-5}		2.02×10^{-7}	4.87×10^{-8}	1.50×10^{-6}	3.54×10^{-9}	7.36×10^{-4}	6.06×10^{-11}
Strontium	7.13×10^{-4}	5.93×10^{-3}	6.15×10^{-6}	8.49×10^{-7}	0.0	0.0		5.95×10^{-7}	8.63×10^{-6}	1.41×10^{-4}	1.06×10^{-6}	6.80×10^{-3}	9.08×10^{-7}
Tin	3.98×10^{-5}	1.28×10^{-5}	2.42×10^{-6}	5.86×10^{-8}	0.0	0.0		1.01×10^{-7}	2.44×10^{-8}	1.20×10^{-6}	8.84×10^{-8}	5.65×10^{-5}	7.57×10^{-8}
Zinc	4.24×10^{-5}	4.16×10^{-3}	1.27×10^{-3}	4.92×10^{-5}	4.75×10^{-2}	3.57×10^{-3}		1.76×10^{-4}	1.90×10^{-5}	7.03×10^{-5}	3.93×10^{-6}	5.68×10^{-2}	6.72×10^{-7}

Note: There are no predicted intakes from squirrel since there were no available measured concentrations of squirrel from background locations. The ingestion of Labrador tea is not considered for the toddler and child. Boron, strontium, and tin concentrations in moose and caribou for the Yukon background were not available; therefore, there are no predicted intakes from moose and caribou for these COPC.

Table 4.4-2 Predicted Intakes for Human Receptors – Camper 2 – Mine Site

Toddler	**Ingestion**											**Total Intake**	
mg/(kg d)	**Water**	**Fish**	**Hare**	**Porcupine**	**Moose**	**Caribou**	**Squirrel**	**Grouse**	**Berries**	**Lab Tea**	**Soil**	**Ingestion**	**Dermal**
Arsenic	4.55x10^{-4}	2.42x10^{-4}	9.57x10^{-6}	9.36x10^{-7}	5.40x10^{-6}	5.54x10^{-7}	1.65x10^{-4}	5.25x10^{-6}	1.56x10^{-6}	0.0	2.94x10^{-4}	1.18x10^{-3}	8.10x10^{-6}
Boron	2.27x10^{-4}	1.31x10^{-4}	2.54x10^{-5}	9.52x10^{-8}	0.0	0.0	3.37x10^{-5}	4.77x10^{-6}	8.04x10^{-5}	0.0	1.03x10^{-5}	5.13x10^{-4}	8.88x10^{-7}
Cadmium	2.27x10^{-5}	3.37x10^{-5}	1.42x10^{-5}	6.30x10^{-8}	3.61x10^{-6}	1.82x10^{-6}	7.55x10^{-4}	5.20x10^{-7}	3.60x10^{-6}	0.0	3.94x10^{-6}	8.39x10^{-4}	4.75x10^{-7}
Copper	8.59x10^{-5}	4.24x10^{-4}	2.69x10^{-4}	5.23x10^{-4}	7.66x10^{-4}	1.86x10^{-4}	3.61x10^{-4}	2.43x10^{-5}	1.18x10^{-5}	0.0	6.67x10^{-5}	2.72x10^{-3}	5.74x10^{-6}
Lead	1.14x10^{-4}	7.07x10^{-5}	1.27x10^{-6}	2.02x10^{-5}	1.93x10^{-6}	1.01x10^{-7}	5.90x10^{-5}	1.55x10^{-5}	3.91x10^{-7}	0.0	7.82x10^{-5}	3.61x10^{-4}	4.04x10^{-7}
Manganese	7.99x10^{-4}	1.15x10^{-2}	3.55x10^{-5}	8.83x10^{-6}	7.88x10^{-5}	2.14x10^{-5}	1.46x10^{-4}	1.29x10^{-5}	4.22x10^{-3}	0.0	5.99x10^{-3}	2.28x10^{-2}	5.16x10^{-4}
Selenium	4.55x10^{-4}	7.98x10^{-4}	7.17x10^{-6}	2.14x10^{-7}	5.30x10^{-5}	3.26x10^{-6}	6.91x10^{-5}	9.55x10^{-7}	3.69x10^{-7}	0.0	1.21x10^{-6}	1.39x10^{-3}	2.09x10^{-9}
Strontium	1.69x10^{-3}	9.49x10^{-3}	7.86x10^{-6}	4.80x10^{-6}	1.35x10^{-5}	2.52x10^{-6}	4.47x10^{-6}	3.25x10^{-6}	1.81x10^{-4}	0.0	9.09x10^{-5}	1.15x10^{-2}	7.83x10^{-6}
Tin	6.82x10^{-5}	3.03x10^{-5}	4.78x10^{-6}	2.37x10^{-7}	0.0	0.0	1.68x10^{-6}	1.20x10^{-6}	1.94x10^{-7}	0.0	3.64x10^{-6}	1.10x10^{-4}	3.13x10^{-7}
Zinc	8.18x10^{-5}	8.28x10^{-3}	3.09x10^{-3}	4.79x10^{-4}	2.74x10^{-2}	1.32x10^{-3}	1.82x10^{-3}	3.42x10^{-4}	1.56x10^{-4}	0.0	1.53x10^{-4}	4.31x10^{-2}	2.64x10^{-6}
Child	**Ingestion**											**Total Intake**	
mg/(kg d)	**Water**	**Fish**	**Hare**	**Porcupine**	**Moose**	**Caribou**	**Squirrel**	**Grouse**	**Berries**	**Lab Tea**	**Soil**	**Ingestion**	**Dermal**
Arsenic	3.04x10^{-4}	1.97x10^{-4}	6.83x10^{-6}	6.68x10^{-7}	3.85x10^{-6}	3.95x10^{-7}	1.18x10^{-4}	3.75x10^{-6}	8.90x10^{-7}	0.0	3.69x10^{-5}	6.72x10^{-4}	6.15x10^{-6}
Boron	1.52x10^{-4}	1.06x10^{-4}	1.81x10^{-5}	6.80x10^{-8}	0.0	0.0	2.40x10^{-5}	3.41x10^{-6}	4.58x10^{-5}	0.0	1.29x10^{-6}	3.51x10^{-4}	6.74x10^{-7}
Cadmium	1.52x10^{-5}	2.74x10^{-5}	1.01x10^{-5}	4.49x10^{-8}	2.58x10^{-6}	1.30x10^{-6}	5.39x10^{-4}	3.71x10^{-7}	2.05x10^{-6}	0.0	4.94x10^{-7}	5.98x10^{-4}	3.61x10^{-7}
Copper	5.74x10^{-5}	3.45x10^{-4}	1.92x10^{-4}	3.73x10^{-4}	5.47x10^{-4}	1.33x10^{-4}	2.58x10^{-4}	1.74x10^{-5}	6.72x10^{-6}	0.0	8.36x10^{-6}	1.94x10^{-3}	4.36x10^{-6}
Lead	7.60x10^{-5}	5.74x10^{-5}	9.05x10^{-7}	1.44x10^{-5}	1.37x10^{-6}	7.19x10^{-8}	4.21x10^{-5}	1.11x10^{-5}	2.22x10^{-7}	0.0	9.80x10^{-6}	2.13x10^{-4}	3.07x10^{-7}
Manganese	5.34x10^{-4}	9.35x10^{-3}	2.53x10^{-5}	6.30x10^{-6}	5.62x10^{-5}	1.52x10^{-5}	1.04x10^{-4}	9.20x10^{-6}	2.40x10^{-3}	0.0	7.51x10^{-4}	1.33x10^{-2}	3.92x10^{-4}
Selenium	3.04x10^{-4}	6.48x10^{-4}	5.12x10^{-6}	1.53x10^{-7}	3.78x10^{-5}	2.33x10^{-6}	4.93x10^{-5}	6.82x10^{-7}	2.10x10^{-7}	0.0	1.52x10^{-7}	1.05x10^{-3}	1.59x10^{-9}
Strontium	1.13x10^{-3}	7.71x10^{-3}	5.61x10^{-6}	3.43x10^{-6}	9.63x10^{-6}	1.80x10^{-6}	3.19x10^{-6}	2.32x10^{-6}	1.03x10^{-4}	0.0	1.14x10^{-5}	8.98x10^{-3}	5.95x10^{-6}
Tin	4.56x10^{-5}	2.46x10^{-5}	3.41x10^{-6}	1.69x10^{-7}	0.0	0.0	1.20x10^{-6}	8.57x10^{-7}	1.11x10^{-7}	0.0	4.56x10^{-7}	7.64x10^{-5}	2.38x10^{-7}
Zinc	5.47x10^{-5}	6.73x10^{-3}	2.21x10^{-3}	3.42x10^{-4}	1.95x10^{-2}	9.39x10^{-4}	1.30x10^{-3}	2.44x10^{-4}	8.90x10^{-5}	0.0	1.92x10^{-5}	3.14x10^{-2}	2.01x10^{-6}
Adult	**Ingestion**											**Total Intake**	
mg/(kg d)	**Water**	**Fish**	**Hare**	**Porcupine**	**Moose**	**Caribou**	**Squirrel**	**Grouse**	**Berries**	**Lab Tea**	**Soil**	**Ingestion**	**Dermal**
Arsenic	2.65x10^{-4}	1.13x10^{-4}	4.29x10^{-6}	4.20x10^{-7}	2.42x10^{-6}	2.49x10^{-7}	7.41x10^{-5}	2.36x10^{-6}	3.80x10^{-7}	2.04x10^{-5}	1.71x10^{-5}	5.00x10^{-4}	4.70x10^{-6}
Boron	1.33x10^{-4}	6.10x10^{-5}	1.14x10^{-5}	4.27x10^{-8}	0.0	0.0	1.51x10^{-5}	2.14x10^{-6}	1.95x10^{-5}	7.21x10^{-5}	6.01x10^{-7}	3.15x10^{-4}	5.15x10^{-7}
Cadmium	1.33x10^{-5}	1.57x10^{-5}	6.37x10^{-6}	2.83x10^{-8}	1.62x10^{-6}	8.16x10^{-7}	3.39x10^{-4}	2.34x10^{-7}	8.76x10^{-7}	3.01x10^{-7}	2.30x10^{-7}	3.78x10^{-4}	2.76x10^{-7}
Copper	5.01x10^{-5}	1.98x10^{-4}	1.21x10^{-4}	2.35x10^{-4}	3.44x10^{-4}	8.37x10^{-5}	1.62x10^{-4}	1.09x10^{-5}	2.87x10^{-6}	6.73x10^{-5}	3.89x10^{-6}	1.28x10^{-3}	3.33x10^{-6}
Lead	6.63x10^{-5}	3.30x10^{-5}	5.69x10^{-7}	9.06x10^{-6}	8.65x10^{-7}	4.52x10^{-8}	2.65x10^{-5}	6.96x10^{-6}	9.50x10^{-8}	3.61x10^{-6}	4.56x10^{-6}	1.52x10^{-4}	2.34x10^{-7}
Manganese	4.66x10^{-4}	5.37x10^{-3}	1.59x10^{-5}	3.96x10^{-6}	3.54x10^{-5}	9.59x10^{-6}	6.54x10^{-5}	5.79x10^{-6}	1.03x10^{-3}	3.32x10^{-4}	3.49x10^{-4}	7.68x10^{-3}	2.99x10^{-4}
Selenium	2.65x10^{-4}	3.72x10^{-4}	3.22x10^{-6}	9.61x10^{-8}	2.38x10^{-5}	1.47x10^{-6}	3.10x10^{-5}	4.29x10^{-7}	8.98x10^{-8}	1.50x10^{-6}	7.07x10^{-8}	6.99x10^{-4}	1.21x10^{-9}
Strontium	9.86x10^{-4}	4.43x10^{-3}	3.53x10^{-6}	2.16x10^{-6}	6.05x10^{-6}	1.13x10^{-6}	2.00x10^{-6}	1.46x10^{-6}	4.39x10^{-5}	1.17x10^{-4}	5.30x10^{-6}	5.60x10^{-3}	4.54x10^{-6}
Tin	3.98x10^{-5}	1.41x10^{-5}	2.15x10^{-6}	1.06x10^{-7}	0.0	0.0	7.56x10^{-7}	5.39x10^{-7}	4.73x10^{-8}	8.24x10^{-4}	2.12x10^{-7}	8.81x10^{-4}	1.82x10^{-7}
Zinc	4.77x10^{-5}	3.87x10^{-3}	1.39x10^{-3}	2.15x10^{-4}	1.23x10^{-2}	5.90x10^{-4}	8.15x10^{-4}	1.54x10^{-4}	3.80x10^{-5}	5.23x10^{-5}	8.95x10^{-6}	1.95x10^{-2}	1.53x10^{-6}

Note: The ingestion of Labrador tea is not considered for the toddler and child. Boron and tin concentrations in moose and caribou were not available; therefore, there are no predicted intakes from moose and caribou for these COPC.

Table 4.4-3 Predicted Intakes Breakdown by Pathway for Human Receptors – Camper 1

Toddler	**Ingestion**											**Total Intake**	
	Water	**Fish**	**Hare**	**Porcupine**	**Moose**	**Caribou**	**Squirrel**	**Grouse**	**Berries**	**Lab Tea**	**Soil**	**Ingestion**	**Dermal**
Arsenic	69%	13%	0%	0%	7%	2%	-	1%	0%	-	8%	100%	0%
Boron	58%	27%	7%	0%	-	0%	-	1%	7%	-	0%	100%	0%
Cadmium	20%	21%	5%	0%	45%	4%	-	0%	3%	-	1%	100%	0%
Copper	1%	12%	6%	0%	68%	12%	-	0%	0%	-	0%	100%	0%
Lead	4%	1%	0%	0%	94%	0%	-	0%	0%	-	1%	100%	0%
Manganese	3%	64%	0%	0%	3%	0%	-	0%	27%	-	2%	100%	0%
Selenium	31%	32%	0%	0%	32%	5%	-	0%	0%	-	0%	100%	0%
Strontium	9%	91%	0%	0%	-	0%	-	0%	0%	-	0%	100%	0%
Tin	66%	27%	5%	0%	-	0%	-	0%	0%	-	1%	100%	0%
Zinc	0%	7%	2%	0%	84%	6%	-	0%	0%	-	0%	100%	0%
Child	**Ingestion**											**Total Intake**	
	Water	**Fish**	**Hare**	**Porcupine**	**Moose**	**Caribou**	**Squirrel**	**Grouse**	**Berries**	**Lab Tea**	**Soil**	**Ingestion**	**Dermal**
Arsenic	71%	16%	0%	0%	8%	2%	-	1%	0%	-	2%	100%	0%
Boron	55%	31%	7%	0%	-	0%	-	1%	6%	-	0%	100%	0%
Cadmium	19%	24%	5%	0%	45%	4%	-	0%	3%	-	0%	100%	0%
Copper	1%	14%	6%	0%	68%	12%	-	0%	0%	-	0%	100%	0%
Lead	4%	1%	0%	0%	95%	0%	-	0%	0%	-	0%	100%	0%
Manganese	2%	72%	0%	0%	3%	0%	-	0%	21%	-	0%	100%	0%
Selenium	28%	36%	0%	0%	31%	5%	-	0%	0%	-	0%	100%	0%
Strontium	7%	92%	0%	0%	-	0%	-	0%	0%	-	0%	100%	0%
Tin	63%	31%	5%	0%	-	0%	-	0%	0%	-	0%	100%	0%
Zinc	0%	8%	2%	0%	83%	6%	-	0%	0%	-	0%	100%	0%
Adult	**Ingestion**											**Total Intake**	
	Water	**Fish**	**Hare**	**Porcupine**	**Moose**	**Caribou**	**Squirrel**	**Grouse**	**Berries**	**Lab Tea**	**Soil**	**Ingestion**	**Dermal**
Arsenic	78%	12%	0%	0%	6%	2%	-	0%	0%	0%	1%	100%	0%
Boron	29%	11%	3%	0%	-	0%	-	0%	2%	55%	0%	100%	0%
Cadmium	25%	20%	5%	0%	43%	4%	-	0%	2%	1%	0%	100%	0%
Copper	1%	12%	5%	0%	67%	11%	-	0%	0%	2%	0%	100%	0%
Lead	5%	1%	0%	0%	93%	0%	-	0%	0%	0%	0%	100%	0%
Manganese	3%	65%	0%	0%	3%	0%	-	0%	14%	13%	0%	100%	0%
Selenium	36%	30%	0%	0%	29%	5%	-	0%	0%	0%	0%	100%	0%
Strontium	10%	87%	0%	0%	-	0%	-	0%	0%	2%	0%	100%	0%
Tin	70%	23%	4%	0%	-	0%	-	0%	0%	2%	0%	100%	0%
Zinc	0%	7%	2%	0%	84%	6%	-	0%	0%	0%	0%	100%	0%

Note: There are no predicted intakes from squirrel since there were no available measured concentrations of squirrel from background locations. The ingestion of Labrador tea is not considered for the toddler and child. Boron, strontium, and tin concentrations in moose and caribou for the Yukon background were not available; therefore, there are no predicted intakes from moose and caribou for these COPC.

Table 4.4-4 Predicted Intakes Breakdown by Pathway for Human Receptors – Camper 2

Toddler	**Ingestion**											**Total Intake**	
	Water	**Fish**	**Hare**	**Porcupine**	**Moose**	**Caribou**	**Squirrel**	**Grouse**	**Berries**	**Lab Tea**	**Soil**	**Ingestion**	**Dermal**
Arsenic	38%	20%	1%	0%	0%	0%	14%	0%	0%	-	25%	99%	1%
Boron	44%	25%	5%	0%	0%	0%	7%	1%	16%	-	2%	100%	0%
Cadmium	3%	4%	2%	0%	0%	0%	90%	0%	0%	-	0%	100%	0%
Copper	3%	16%	10%	19%	28%	7%	13%	1%	0%	-	2%	100%	0%
Lead	31%	20%	0%	6%	1%	0%	16%	4%	0%	-	22%	100%	0%
Manganese	3%	49%	0%	0%	0%	0%	1%	0%	18%	-	26%	98%	2%
Selenium	33%	57%	1%	0%	4%	0%	5%	0%	0%	-	0%	100%	0%
Strontium	15%	83%	0%	0%	0%	0%	0%	0%	2%	-	1%	100%	0%
Tin	62%	27%	4%	0%	0%	0%	2%	1%	0%	-	3%	100%	0%
Zinc	0%	19%	7%	1%	64%	3%	4%	1%	0%	-	0%	100%	0%
Child	**Ingestion**											**Total Intake**	
	Water	**Fish**	**Hare**	**Porcupine**	**Moose**	**Caribou**	**Squirrel**	**Grouse**	**Berries**	**Lab Tea**	**Soil**	**Ingestion**	**Dermal**
Arsenic	45%	29%	1%	0%	1%	0%	17%	1%	0%	-	5%	99%	1%
Boron	43%	30%	5%	0%	0%	0%	7%	1%	13%	-	0%	100%	0%
Cadmium	3%	5%	2%	0%	0%	0%	90%	0%	0%	-	0%	100%	0%
Copper	3%	18%	10%	19%	28%	7%	13%	1%	0%	-	0%	100%	0%
Lead	36%	27%	0%	7%	1%	0%	20%	5%	0%	-	5%	100%	0%
Manganese	4%	69%	0%	0%	0%	0%	1%	0%	18%	-	6%	97%	3%
Selenium	29%	62%	0%	0%	4%	0%	5%	0%	0%	-	0%	100%	0%
Strontium	13%	86%	0%	0%	0%	0%	0%	0%	1%	-	0%	100%	0%
Tin	59%	32%	4%	0%	0%	0%	2%	1%	0%	-	1%	100%	0%
Zinc	0%	21%	7%	1%	62%	3%	4%	1%	0%	-	0%	100%	0%
Adult	**Ingestion**											**Total Intake**	
	Water	**Fish**	**Hare**	**Porcupine**	**Moose**	**Caribou**	**Squirrel**	**Grouse**	**Berries**	**Lab Tea**	**Soil**	**Ingestion**	**Dermal**
Arsenic	53%	22%	1%	0%	0%	0%	15%	0%	0%	4%	3%	99%	1%
Boron	42%	19%	4%	0%	0%	0%	5%	1%	6%	23%	0%	100%	0%
Cadmium	4%	4%	2%	0%	0%	0%	89%	0%	0%	0%	0%	100%	0%
Copper	4%	15%	9%	18%	27%	7%	13%	1%	0%	5%	0%	100%	0%
Lead	44%	22%	0%	6%	1%	0%	17%	5%	0%	2%	3%	100%	0%
Manganese	6%	67%	0%	0%	0%	0%	1%	0%	13%	4%	4%	96%	4%
Selenium	38%	53%	0%	0%	3%	0%	4%	0%	0%	0%	0%	100%	0%
Strontium	18%	79%	0%	0%	0%	0%	0%	0%	1%	2%	0%	100%	0%
Tin	5%	2%	0%	0%	0%	0%	0%	0%	0%	93%	0%	100%	0%
Zinc	0%	20%	7%	1%	63%	3%	4%	1%	0%	0%	0%	100%	0%

Note: The ingestion of Labrador tea is not considered for the toddler and child. Boron and tin concentrations in moose and caribou were not available; therefore, there are no predicted intakes from moose and caribou for these COPC.

5.0 HAZARD ASSESSMENT

The hazard assessment phase of an ecological and/or human health risk assessment involves identification of chemical concentrations or intakes which have been shown to have adverse effects on the receptors (ecological species or humans) of concern. The exposure concentrations or intakes are generally determined from controlled laboratory tests or from epidemiology studies and are used to establish toxicity reference values which are protective of the receptors.

5.1 AQUATIC TOXICITY EVALUATIONS

Within the Ecological Risk Assessment (ERA), ecological receptor assessment endpoints represent potential effects at population or community levels. At these levels of biological organization, ecological receptor populations and community characteristics can be defined over fairly extended temporal and spatial scales making the potential for the direct measurement of effects challenging (Environment Canada 1997).

Due to the difficulty in measuring direct effects on assessment endpoints, "*measurement endpoints*" are adopted to provide a framework for the evaluation of predicted effects. A measurement endpoint is defined as "…*a quantitative summary of the results of a toxicity test, a biological study, or other activity intended to reveal the effects of a substance*" (Suter 1993). In lieu of direct assessment endpoint effects measures, the adoption of measurement endpoints provides a consistent basis for the evaluation of potential effects due to exposure of assessment endpoints.

Measurement endpoints are commonly selected at the individual level of biological organization, and are typically based on exposure responses that represent key population and community characteristics such as reproduction and abundance (Environment Canada 1997). Such measurement endpoints are commonly based on literature-derived toxicity dose-response relationships, examined through laboratory experimentation (*i.e.*, the response of a particular organism to a certain level of exposure). When derived from toxicity studies, such measurement endpoints are often referred to as toxicity benchmarks or toxicity reference values.

These toxicity reference values are used in risk assessments to judge whether the predicted (estimated) exposures (or doses or intakes) may potentially have an adverse effect on ecological species. Site-specific information was incorporated into the selection process where available. A discussion of selected literature and the associated toxicity reference values consulted in this assessment is provided in the following sections.

In this assessment, EC_{20} (effects concentration) values which have the potential to affect 20% of the population were used to determine whether COPC are likely to cause adverse effects in aquatic receptors in Dome Creek, Pony Creek, and Victoria Creek. An EC_{25} value is suggested by Environment Canada for use in risk assessments (Environment Canada 1997). An EC_{20} concentration was chosen as a TRV because effects or changes in populations in this range are generally not distinguishable from natural variation. In addition, a 20% reduction in rapidly growing populations (e.g. phytoplankton or zooplankton) might be quickly offset by reproduction once the chemical stress is removed or may be offset by growth and immigration from non-affected nearby locations.

Where possible, effects concentration (EC) data were collected over lethal concentration (LC; mortality) data. Different models exist for translating chemical exposure (or dose) to toxic responses. For EC_{50} toxicity values, in the absence of detailed dose-response functions, a linear approximation is commonly applied assuming zero effect at zero exposure. This linearization is pessimistic since the predicted effect will be greater than that observed using the commonly encountered sigmoidal dose-response function for low dose exposures. For acute toxicity values (LC_{50} values derived from 96 hour tests) a factor of 10 was applied in the derivation of appropriate toxicity reference values (EC_{20} values) for this assessment (Environment Canada/Health Canada 2003). For LC_{50} data derived from chronic tests a factor of 4 was applied to determine the EC_{20} benchmark. This is an empirical factor based on the results of other toxicity tests.

It was not the intent in this assessment to extensively search the primary literature to obtain TRVs; rather, this assessment relied on TRVs that have been collated and peer reviewed by various agencies for use in risk assessments. The U.S. DOE database (Suter *et al*. 1996) on aquatic TRVs was the primary source of toxicity information. This database contains TRVs for the protection of aquatic life from chemicals in water. EC_{20} values provided in this database were selected as appropriate TRVs. The advantage in using these TRVs is that they were developed for use in risk assessments and have been peer reviewed. This database provides documentation on the sources and derivations of the values and discusses the relative conservatisms in the TRVs. The selection of the species was based species that are present at the site, but also encompassed species found in the general area.

If data were not available from the DOE database then the U.S. EPA database AQUIRE (2003) was examined for infilling purposes. The data summarized in this database are from a variety of sources, including peer reviewed literature. Toxicity information provided in the CCME Water Quality Guidelines (1999) was also used in the development of TRVs for this assessment. It is acknowledged that these databases may not have the most recent data; however, the TRVs selected are, in our opinion, appropriate.

Decision rules for the selection of test species were developed around the available data. For aquatic plants, the lowest of the toxicity values for *Lemna* sp. or *Myriophyllum* sp. test species was chosen. These two species are considered to be the most sensitive aquatic plant species for which toxicity data are available. For benthic invertebrates, the lowest available toxicity values for any invertebrate test species were used. For the fish species, data were chosen for the species based on feeding habits (i.e., predatory or forage). The lowest toxicity value of these species was chosen to represent the respective predatory or forage fish.

In summary, TRVs provided in Table 5.1-1 were obtained from the U.S. DOE (Suter *et al*. 1996) and U.S. EPA AQUIRE (2003) databases, as well as the CCME (1999). This table outlines the references from which the TRVs were obtained, the test species and the rationale for selecting the appropriate values. It should be noted that the aquatic TRVs presented for benthic invertebrates are all based on water exposure only; sediment exposure is discussed and assessed separately using toxicity data based on sediment toxicity studies.

Table 5.1-1 Summary of Toxicity Reference Values for Aquatic Species

Aquatic Receptor	Un-ionized Ammonia (mg/L)				
	Test Species	**LC/EC_{50}**	**Toxicity Reference Value**	**Reference**	**Comments**
Aquatic Plants	--	--	--	--	no data available
Phytoplankton	*Chlorella* sp.	2	1.0	EC/HC PSL2 (2003)	assumed data was for EC_{50} for growth; derived EC_{25} by linear extrapolation
Benthic Invertebrates	*Cladoceran* sp.	1.2	0.12	EC/HC PSL2 (2003)	acute LC_{50}; lowest value for invertebrate species; derived TRV using a factor of 10 based on an empirical relationship between an acute LC_{50} and an EC_{20}
Zooplankton	*Daphnia* sp.	1.6	0.16	EC/HC PSL2 (2003)	acute LC_{50} reported as geometric mean of 12 studies; derived TRV using a factor of 10 based on an empirical relationship between an acute LC_{50} and an EC_{20}
Predator Fish	Rainbow Trout	--	0.09	EC/HC PSL2 (2003)	EC_{20} study provided in PSL2 – reduction in growth or reproductive success
Forage Fish	Fathead Minnow	--	0.173	EC/HC PSL2 (2003)	EC_{20} study provided in PSL2 – reduction in growth or reproductive success

Aquatic Receptor	Antimony (mg/L)				
	Test Species	**LC/EC_{50}**	**Toxicity Reference Value**	**Reference**	**Comments**
Aquatic Plants	--	--	--	--	no data available
Phytoplankton	*Selenastrum capricornutum*	0.61	0.15	Kimball (n.d.)	from Suter and Tsao (1996); 4-d EC_{50}; derived an EC_{25} by linear extrapolation
Benthic Invertebrates	*Gammarus pseudolimnaeus*	26	2.6	Brooke *et al*., 1986	4-day LC_{50} derived TRV using a factor of 10 based on an empirical relationship between an acute LC_{50} and EC_{50}
Zooplankton	*Daphnia magna*	5.4	1.35	Kimball (n.d.)	from Suter and Tsao (1996); 28-d LC_{50}; derived TRV using a factor of 4 based on an empirical relationship between a chronic LC_{50} and an EC_{20}.
Predatory Fish	Rainbow trout	16	4	Doe *et al*, 1987	30-day LC_{50}; derived TRV using a factor of 4 based on an empirical relationship between a chronic LC_{50} and an EC_{20}.
Forage Fish	*Pimephales promelas*	--	2.31	Kimball (n.d.)	from Suter and Tsao (1996); lowest chronic test EC_{20} – early life stage tests

Table 5.1-1 Summary of Toxicity Reference Values for Aquatic Species (Cont'd)

Aquatic Receptor	Arsenic (mg/L)				
	Test Species	**LC/EC_{50}**	**Toxicity Reference Value**	**Reference**	**Comments**
Aquatic Plants	Myriophyllum sp.	0.63	0.32	Jenner & Janssen-Mommen (1993)	14-d EC_{50} (pop); derived an EC_{25} by linear extrapolation
Phytoplankton	Scenedesmus sp.	0.05	0.025	Vocke *et al*. (1980)	from CCME (1999); 14-d EC_{50} (growth); derived EC_{25} by linear extrapolation
Benthic Invertebrates	Calanus sp.	--	0.34	Borgmann *et al.* (1980)	from CCME (1999); 14-d EC_{20}; used as toxicity reference value
Zooplankton	*Daphnia* sp.	--	0.91	Call *et al.* (1983), Lima *et al.* (1984)	from Suter and Tsao (1996); lowest chronic test EC_{20} – life-cycle tests; used as TRV
Predator Fish	Rainbow Trout	0.55	0.14	Birge *et al.* (1979a)	from CCME (1999); 28-d LC_{50}; derived benchmark using a factor of 4 based on an empirical relationship between chronic LC_{50} and EC_{20}.
Forage Fish	Goldfish	0.49	0.12	Birge *et al.* (1979b)	from U.S. EPA AQUIRE; Lowest value for fathead minnow and goldfish based on 7-d LC_{50} (mortality); derived benchmark using a factor of 4 based on an empirical relationship between a chronic LC_{50} and an EC_{20}.

	Barium (mg/L)				
Aquatic Receptor	**Test Species**	**LC/EC_{50}**	**Toxicity Reference Value**	**Reference**	**Comments**
Aquatic Plants	*Lemna minor*	26	13	Wang (1986)	from U.S. EPA AQUIRE; 4-d EC_{50} (growth) ; derived an EC_{25} by linear extrapolation
Phytoplankton	*Chlorella vulgaris*	4	4	Den Dooren de Jong (1965)	from U.S. EPA AQUIRE; NOEC
Benthic Invertebrates	--	--	--	--	No data available
Zooplankton	*Daphnia* sp.	-	0.004	Biesinger and Christensen (1972)	from Suter and Tsao (1996); chronic value – 21-d test; based on 16% reproductive impairment; used as TRV
Predator Fish	Rainbow Trout	42.7	10.7	Birge *et al*. (1980)	from U.S. EPA AQUIRE; 28-d LC_{50} (mortality); derived TRV using a factor of 4 based on empirical relationship between a chronic LC_{50} and an EC_{20}
Forage Fish	--	--	--	--	No data available

Table 5.1-1 Summary of Toxicity Reference Values for Aquatic Species (Cont'd)

Aquatic Receptor	Boron (mg/L)				
	Test Species	**LC/EC_{50}**	**Toxicity Reference Value**	**Reference**	**Comments**
Aquatic Plants	*Myriophyllum spicatum*	40	20	Butterwick *et al*. 1989	50% inhibition of root growth after 32 days; used an EC_{25} from linear extrapolation
Phytoplankton	*Scenedesmus quadricauda*		0.58	Bringmann and Kuhn, 1978	LOEC for population growth rate
Benthic Invertebrates	*Chironomus decorus*	1376	137.6	Maier and Knight (1991)	48-h LC_{50} for mortality; derived TRV using a factor of 10 based on an empirical relationship between an acute LC_{50} and EC_{50}
Zooplankton	*Daphnia magna.*	141	14.1	Maier and Knight (1991)	48- h LC_{50} for mortality; derived TRV using a factor of 10 based on an empirical relationship between an acute LC_{50} and EC_{50}
Predator Fish	Coho salmon (*O. kisutch*)	447	45	Hamilton and Buhl (1990)	LC_{50}; derived TRV using a factor of 10 based on an empirical relationship between an acute LC_{50} and EC_{50}
Forage Fish	--	--	--	--	no data available

Aquatic Receptor	Cadmium (mg/L)				
	Test Species	**LC/EC_{50}**	**Toxicity Reference Value**	**Reference**	**Comments**
Aquatic Plants	*Myriophyllum*	7.4	3.0	Stanley (1974)	from U.S. EPA AQUIRE; EC_{50} (population) 32-d; used an EC_{20} from linear extrapolation
Phytoplankton	*Scenedesmus*	0.008	0.003	Fargasova (1994)	from U.S. EPA AQUIRE; EC_{50} (population) 12-d; used an EC_{20} from linear extrapolation
Benthic Invertebrates	*Chironomus sp.*	1.2	0.12	Rehwoldt *et al.* (1973)	from U.S. EPA AQUIRE; LC_{50} (mortality) 96-hr; derived TRV using a factor of 10 based on an empirical relationship between an acute LC_{50} and EC_{50}
Zooplankton	*Daphnia sp.*	--	$7.5x10^{-4}$	Elnabarawy *et al.* (1986)	from Suter and Tsao (1996); lowest chronic test EC_{20} – life-cycle tests
Predator Fish	Rainbow Trout	--	0.002	Carlson *et al.* (1982)	from Suter and Tsao (1996); lowest chronic test EC_{20} – early life stage tests
Forage Fish	Fathead Minnow	0.09	0.009	Hall *et al.* (1986)	from IPCS; 96-hr LC_{50}; derived TRV using a factor of 10 based on an empirical relationship between an acute LC_{50} and EC_{50}

Table 5.1-1 Summary of Toxicity Reference Values for Aquatic Species (Cont'd)

Aquatic Receptor	Chloride (mg/L)				
	Test Species	**LC/EC_{50}**	**Toxicity Reference Value**	**Reference**	**Comments**
Aquatic Plants	*Lemna minor*	4880	1958	Buckley *et al.*(1996)	From U.S. EPA AQUIRE; EC_{50} (population); 7 days, linearly extrapolated to EC_{20}.
Phytoplankton	*Chlorella vulgaris*	--	590	Den Dooren de Jong (1965)	From U.S. EPA AQUIRE; NOEC (population); 31 days
Benthic Invertebrates	*Chironomus attenuatus*	7946	795	Thornton and Sauer (1972)	From U.S. EPA AQUIRE; LC_{50} (mortality); 2 days, derived TRV using a factor of 10 based on an empirical relationship between an acute LC_{50} and an EC_{20}
Zooplankton	*Daphnia pulex*	--	314	Birge *et al.* (1985)	From U.S. EPA AQUIRE; NOEC (reproduction); 21 days
Predator Fish	*Oncorhynchus mykiss*	--	355	Spehar (1986)	From U.S. EPA AQUIRE; NOEC (growth); 56 days
Forage Fish	*Fathead minnow*	--	252	Birge *et al.* (1985)	From U.S. EPA AQUIRE; NOEC (mortality); 3 days

Aquatic Receptor	Chromium – based on Cr (VI) (mg/L)				
	Test Species	**LC/EC_{50}**	**Toxicity Reference Value**	**Reference**	**Comments**
Aquatic Plants	*Microcystis aeruginosa*	--	0.002	U.S. EPA (1985)	from Suter and Tsao (1996); lowest chronic test EC20 – early life stage test
Phytoplankton	--	--	--	--	No data available
Benthic Invertebrates	--	--	--	--	No data available
Zooplankton	*Daphnia* sp.	--	0.006	Mount (1982)	from Suter and Tsao (1996); lowest chronic test EC20 – early life stage test
Predator Fish	Rainbow Trout	--	0.073	Sauter *et al*. (1976)	from Suter and Tsao (1996); lowest chronic test EC20 – early life stage test
Forage Fish	--	--	--	--	No data available

Table 5.1-1 Summary of Toxicity Reference Values for Aquatic Species (Cont'd)

Aquatic Receptor	Cobalt (mg/L)				
	Test Species	**LC/EC_{50}**	**Toxicity Reference Value**	**Reference**	**Comments**
Aquatic Plants	--	--	--	--	no data available
Phytoplankton	*Chlorella*	0.55	0.27	Coleman *et al.* (1971)	from MOE (1996); EC_{50} 21-d; derived EC_{25} by linear extrapolation
Benthic Invertebrates	Cyclops	16	1.6	Baudouin and Scoppa (1974)	from MOE (1996); this value is the lowest value for all test invertebrate species and is the same as the value for a mayfly. LC_{50} 48-hr (acute); derived TRV using a factor of 10 based on an empirical relationship between an acute LC_{50} and an EC_{20}
Zooplankton	*Daphnia* sp.	--	0.005	Kimball (n.d.)	from Suter and Tsao (1996); lowest chronic test EC_{20} – 28-d life-cycle tests; used as TRV
Predator Fish	Rainbow Trout	0.47	0.12	Birge (1978)	from MOE (1996); LC_{50} embryos 28-d; derived TRV using a factor of 4 based on an empirical relationship between a chronic LC_{50} and an EC_{20}
Forage Fish	Goldfish	0.81	0.20	Birge (1978)	from MOE (1996); lowest value of fathead minnow, tilapia, stickleback and goldfish. LC_{50} 7-d; derived TRV using a factor of 4 based on an empirical relationship between a chronic LC_{50} and an EC_{20}

Aquatic Receptor	Copper (mg/L)				
	Test Species	**LC/EC_{50}**	**Toxicity Reference Value**	**Reference**	**Comments**
Aquatic Plants	*Myriophyllum* sp.	0.30	0.15	Stanley (1974)	from U.S. EPA AQUIRE; EC_{50} (population) 32-d; derived EC_{25} by linear extrapolation
Phytoplankton	*Chlorella* sp.	--	0.0040	Franklin *et al.* (2000)	from EC/HC PSL2 (2003); EC_{20} for cell growth, cell division and cell size for *Chlorella* and *Selenastrum*
Benthic Invertebrates	*Calanus* sp.	0.8	0.080	Hooftman *et al.* (1989)	from U.S. EPA AQUIRE; LC_{50} (mortality) 72-hr; derived TRV using factor of 10 based on an empirical relationship between an acute LC_{50} and an EC_{20}
Zooplankton	*Daphnia* sp.	0.02	0.0041	Mastin and Rodgers (2000)	LC_{50} (mortality) 48-hr; derived TRV using a factor of 10 based on an empirical relationship between an acute LC_{50} and an EC_{20}; used CCME value since EC_{20} was less than CCME value
Predator Fish	Bass	--	0.0086	U.S. DOE RAIS (2005)	EC_{25} bass population surface water screening benchmark
Forage Fish	--	--	0.0041	--	used CCME value since calculated EC_{20} was less than CCME value

Table 5.1-1 Summary of Toxicity Reference Values for Aquatic Species (Cont'd)

Aquatic Receptor	Cyanate (mg/L)				
	Test Species	**LC/EC50**	**Toxicity Reference Value**	**Reference**	**Comments**
Aquatic Plants					no data available
Phytoplankton					no data available
Benthic Invertebrates					no data available
Zooplankton					no data available
Predator Fish	Rainbow Trout	30.7 12.5	3.1 (Soft water) 1.3 (Hard water)	Vaughn, Parker and Doe (1985).	applied factor of 0.10 to LC50
Forage Fish					no data available

Aquatic Receptor	Iron (mg/L)				
	Test Species	**LC/EC_{50}**	**Toxicity Reference Value**	***Reference***	**Comments**
Aquatic Plants	--	--	--	--	--
Phytoplankton	--	--	--	--	--
Benthic Invertebrates	--	--	--	--	--
Zooplankton	*Daphnia* sp.	5.9	1.48	Biesinger and Christensen (1972)	from CCME (1995); LC_{50} (mortality) 3-week; derived benchmark using a factor of 4 based on an empirical relationship between a chronic LC_{50} and an EC_{20}.
Predator Fish	Brook Trout	--	7.5	Sykora *et al.* (1972), Smith *et al.* (1973)	from CCME (1995); safe concentration based on mortality of juveniles
Forage Fish	Fathead minnow	1.5	0.75	Sykora *et al.* (1972)	from CCME (1995); EC_{50} based on 50% reduction in hatchability of fathead minnow eggs; derived EC_{25} by linear extrapolation

Table 5.1-1 Summary of Toxicity Reference Values for Aquatic Species (Cont'd)

Aquatic Receptor	Lead (mg/L)				
	Test Species	**LC/EC_{50}**	**Toxicity Reference Value**	**Reference**	**Comments**
Aquatic Plants	*Myriophyllum* sp.	363	182	Stanley (1974)	from U.S. EPA AQUIRE; EC_{50} (population) 32-d; derived EC_{25} by linear extrapolation
Phytoplankton	*Chlorella* sp.	--	0.63	U.S. EPA (1985)	from Suter and Tsao (1996); EC_{20} (growth inhibition)
Benthic Invertebrates	*Hyallela azteca*	0.018	0.002	Mackie (1989)	96-hr LC_{50}; derived benchmark using a factor of 10 based on an empirical relationship between an acute LC_{50} and an EC_{20}.
Zooplankton	*Daphnia* sp.	--	0.02	Chapman *et al.* (1980)	from Suter and Tsao (1996); lowest chronic EC_{20} 21-d tests
Predator Fish	Rainbow Trout	--	0.028	Sauter *et al.* (1976)	from Suter and Tsao (1996); lowest chronic test EC_{20};
Forage Fish	Goldfish	1.66	0.415	Birge *et al.* (1979b)	from U.S. EPA AQUIRE; lowest value of fathead minnow, snakehead catfish and goldfish LC_{50} (mortality) 7-d; derived benchmark using a factor of 4 based on an empirical relationship between a chronic LC_{50} and an EC_{20}.

Aquatic Receptor	Manganese (mg/L)				
	Test Species	**LC/EC_{50}**	**Toxicity Reference Value**	**Reference**	**Comments**
Aquatic Plants	*Lemna minor*	31	15.5	Wang (1986)	from U.S. EPA AQUIRE; 4-d EC_{50} (growth); derived EC_{25} by linear extrapolation
Phytoplankton	*Spirostomum ambiguum*	92.8	46.4	Nalecz-Jawecki and Sawicki (1998)	From U.S. EPA AQUIRE; 24-hr EC_{50} (deformation); derived EC_{25} by linear extrapolation
Benthic Invertebrates	*Dugesia gonocephala*	46	46	Palladini *et al.* (1980)	From U.S. EPA AQUIRE; 8-d NOEC (locomotion);
Zooplankton	*Daphnia magna*	4.7	2.35	Baird *et al.* (1991)	Lowest value from U.S. EPA AQUIRE; 48-hr EC_{50} (immobility); derived EC_{25} by linear extrapolation
Predator Fish	Rainbow Trout	2.91	0.73	Birge (1978)	Lowest value from U.S. EPA AQUIRE; 28-d LC_{50} (mortality); derived benchmark using a factor of 4 based on an empirical relationship between a chronic LC_{50} and an EC_{20}.
Forage Fish	Goldfish	8.22	2.06	Birge (1978)	From U.S. EPA AQUIRE; 7-d LC_{50} (mortality); derived benchmark using a factor of 4 based on an empirical relationship between a chronic LC_{50} and an EC_{20}.

Table 5.1-1 Summary of Toxicity Reference Values for Aquatic Species (Cont'd)

Aquatic Receptor	Selenium (mg/L)				
	Test Species	**LC/EC_{50}**	**Toxicity Reference Value**	**Reference**	**Comments**
Aquatic Plants	*Lemna* sp.	1.7	0.9	Jenner *et al.* (1993)	from U.S. EPA AQUIRE; EC_{50} (population) 14-d; derived EC_{25} by linear extrapolation
Phytoplankton	*Scenedesmus* sp.	--	0.19	Vocke *et al.* (1980)	from Suter and Tsao (1996); chronic 14-d EC_{20} for reduced growth
Benthic Invertebrates	*Chironomus* sp.	1.8	0.2	Ingersoll *et al.* (1990)	from U.S. EPA AQUIRE; LC_{50} (ITX) 48-hr; derived TRV using a factor of 10 based on an empirical relationship between an acute LC_{50} and an EC_{20}
Zooplankton	Daphnia sp.	--	0.04	Johnston (1987)	from Suter and Tsao (1996); lowest chronic test EC_{20}, 28-d; derived an EC_{25} value from empirical equation provided in Suter and Tsao (1996)
Predator Fish	Rainbow Trout	--	0.05	Goettl and Davies (1976)	from Suter and Tsao (1996); lowest chronic test EC_{20}, early life stage tests
Forage Fish	Fathead Minnow	0.6	0.15	Halter *et al.* (1980)	from U.S. EPA AQUIRE; LC_{50} (mortality) 14-d; derived TRV using a factor of 4 based on an empirical relationship between a chronic LC_{50} and an EC_{20}

Aquatic Receptor	Silver (mg/L)				
	Test Species	**LC/EC_{50}**	**Toxicity Reference Value**	**Reference**	**Comments**
Aquatic Plants	--	--	--	--	no data available
Phytoplankton	--	--	--	--	no data available
Benthic Invertebrates	--	--	--	--	no data available
Zooplankton	*Daphnia* sp.	$5.8x10^{-3}$	$5.8x10^{-4}$	Erickson *et al.* (1998)	96-h LC_{50} (mortality); derived benchmark using a factor of 10 based on an empirical relationship between an acute LC_{50} and an EC_{20}.
Predator Fish	Rainbow Trout	$9.2x10^{-3}$	$9.2x10^{-4}$	Erickson *et al.* (1998)	96-h LC_{50} (mortality); derived benchmark using a factor of 10 based on an empirical relationship between an acute LC_{50} and an EC_{20}.
Forage Fish	Goldfish	$1.04x10^{-2}$	$1.04x10^{-3}$	Erickson *et al.* (1998)	96-h LC_{50} (mortality); derived benchmark using a factor of 10 based on an empirical relationship between an acute LC_{50} and an EC_{20}.

Table 5.1-1 Summary of Toxicity Reference Values for Aquatic Species (Cont'd)

Aquatic Receptor	**Strontium (mg/L)**				
	Test Species	**LC/EC_{50}**	**Toxicity Reference Value**	**Reference**	**Comments**
Aquatic Plants	--	--	--	--	no data available
Phytoplankton	*Chlorella vulgaris*		150	Den Dooren de Jong (1965)	from U.S. EPA AQUIRE; LOEC (general population changes)
Benthic Invertebrates	*Biomphalaria glabrata*	--	10	Harry and Aldrich (1963)	from U.S. EPA AQUIRE; observed stress in snails, endpoint not reported but value is lower than other chronic values so is treated as a chronic EC value
Zooplankton	*Daphnia sp.*	--	42	Biesinger and Christensen (1972)	from Suter and Tsao (1996); results from a 21-d test resulting in 16% reproductive impairment
Predatory Fish	Striped bass	92.8	9.3	Dwyer *et al.* (1992)	from U.S. EPA AQUIRE; LC_{50} 96-h; derived TRV using a factor of 10 based on an empirical relationship between an acute LC_{50} and an EC_{20}
Forage Fish	Goldfish	8.5	4.3	Birge (1978)	from U.S. EPA AQUIRE; LC_{50} 7-d; derived an EC_{25} by linear extrapolation

Aquatic Receptor	**Sulphate (mg/L)**				
	Test Species	**LC/EC_{50}**	**Toxicity Reference Value**	**Reference**	**Comments**
Aquatic Plants	*Myriophyllum spicatum*	928	371	Stanley .(1974)	From U.S. EPA AQUIRE; EC_{50} (growth); 32 days, linearly extrapolated to EC_{20}.
Phytoplankton	*Microcystus aeruginosa*	800	320	Yamane *et al.*(1984)	From U.S. EPA AQUIRE; EC_{50} (population); linearly extrapolated to EC_{20}.
Benthic Invertebrates	Mayfly	660	165	Goetsch and Palmer (1997)	From U.S. EPA AQUIRE; LC_{50} (mortality); 4 days, derived benchmark using a factor of 4 based on an empirical relationship between an acute LC_{50} and an EC_{20}
Zooplankton	*Ceriodaphnia dubia*	3150	1260	Birge *et al.* (1985)	From U.S. EPA AQUIRE; EC_{50} (ITX); 2 days, linearly extrapolated to EC_{20}.
Predator Fish	*Oncorhynchus mykiss*	--	704	Department of Scientific and Industrial Research (1956)	From U.S. EPA AQUIRE; No response , 2 day
Forage Fish	Fathead minnow	7960	796	Mount *et al.* (1997)	From U.S. EPA AQUIRE; LC_{50} (mortality); 2 days, derived TRV using a factor of 10 based on an empirical relationship between an acute LC_{50} and an EC_{20}

Table 5.1-1 Summary of Toxicity Reference Values for Aquatic Species (Cont'd)

Aquatic Receptor	**Thiocyanate (mg/L)**				
	Test Species	**LC/EC50**	**Toxicity Reference Value**	**Reference**	**Comments**
Aquatic Plants					no data available
Phytoplankton					no data available
Benthic Invertebrates					no data available
Zooplankton	Daphnia sp.	57.4	5.74	Parkhurst et al. (1979)	LC50, 48-h; applied factor of 0.1 to LC50
Predator Fish	Brook Trout	31.3	3.13	Parkhurst et al. (1979)	LC50, 96-h; applied factor of 0.1 to LC50
Forage Fish	Fathead Minnow		7.3	Lanno and Dixon (1994)	NOEC for reproductive effects

Aquatic Receptor	**Vanadium (mg/L)**				
	Test Species	**LC/EC_{50}**	**Toxicity Reference Value**	**Reference**	**Comments**
Aquatic Plants	--	--	--	--	no data available
Phytoplankton	*Scenedesmus quadricauda*	2.2	1.6	Fargasova *et al.* (1999)	12-day EC_{50} for growth inhibition; derived an EC_{25} based on linear extrapolation
Benthic Invertebrates	*Chironomus plumosus*	0.24	0.024	Fargasova (1997)	Increasing mortality from 24 to 96 hours; derived TRV using a factor of 10 based on an empirical relationship between an acute LC_{50} and an EC_{20}
Zooplankton	*Daphnia sp.*	--	1.9	Kimball n.d.	from Suter and Tsao (1996); lowest chronic test EC_{20}
Predator Fish	Fish species	--	0.04	Holdway and Sprague (1979)	from Suter and Tsao (1996); lowest chronic test EC_{20}
Forage Fish	Fish species	--	0.04	Holdway and Sprague (1979)	from Suter and Tsao (1996); lowest chronic test EC_{20}

Table 5.1-1 Summary of Toxicity Reference Values for Aquatic Species (Cont'd)

Aquatic Receptor	**Zinc (mg/L)**				
	Test Species	**LC/EC_{50}**	**Toxicity Reference Value**	**Reference**	**Comments**
Aquatic Plants	*Myriophyllum* sp.	21.6	10.8	Stanley (1974)	from U.S. EPA AQUIRE; EC_{50} (growth) 32-d; derived EC_{25} by linear extrapolation
Phytoplankton	*Selenastrum* sp.		0.04	Bartlett and Rabe (1974)	from Suter and Tsao (1996); 7-d test EC_{20} for growth inhibition
Benthic Invertebrates	*Chironomus* sp.	1.13	0.6	Phipps *et al.* (1995)	from U.S. EPA AQUIRE; LC_{50} (mortality) 10-d; used LC_{25}
Zooplankton	*Daphnia* sp.		0.04	Chapman *et al.* (1980)	from Suter and Tsao (1996); lowest chronic value, life-cycle tests
Predator Fish	Rainbow Trout		0.06	Spehar (1976)	from Suter and Tsao (1996); lowest chronic test EC_{20}
Forage Fish	Fathead Minnow	0.238	0.1	Norberg and Mount (1985)	from U.S. EPA AQUIRE; LC_{50} (mor) 7-d; derived an EC_{25} value based on empirical equation obtained from data provided in Suter (1992)

Note: LC_{50} – Lethal concentration that results in mortality to 50% of population in short-term acute exposure tests.
EC_{50} – Effects concentration that inhibits the growth rate on reproductive success of species in long-term chronic exposure tests.
Toxicity Reference Value – Inhibitory concentration (EC_{20} or EC_{25} value) that affects growth or reproductive success in 20 to 25% of species population.

5.2 SEDIMENT TOXICITY EVALUATIONS

The potential ecological effects on benthic invertebrates from COPC in sediments were addressed in part through a comparison to sediment toxicity benchmarks. Table 5.2-1 summarizes selected sediment toxicity benchmarks reported in the literature. As seen in the table, where several toxicity benchmarks exist for a particular COPC, there is a range of data for possible effects. No sediment toxicity benchmarks exist for chloride, sulphate, ammonia, cyanate, thiocyanate, antimony, barium, boron, cobalt, iron, silver, and strontium; hence they are not included in the table.

The Canadian Council of Ministers of the Environment (CCME 2003) guidelines provide what are designated Interim Sediment Quality Guidelines (ISQGs) and Probable Effect Levels (PELs). In narrative description, an ISQG represents the concentration below which adverse biological effects are expected to occur rarely (i.e., an ISQG represents the upper limit of the range of sediment constituent concentrations dominated by no effects data). A PEL defines the level above which adverse effects are expected to occur frequently (*i.e.,* the PEL represents the lower limit of the range of constituent concentrations that are usually or always associated with adverse biological effects). The CCME acknowledge the associative basis of the guidelines and acknowledges that the use of SQGs in exclusion of other information (such as background concentrations of naturally occurring substances and biological tests) can lead to erroneous conclusions.

The sediment toxicity benchmarks from Thompson *et al*. (2005) were developed for mining industry applications in northern Saskatchewan. The benchmark values reported by these authors are seen to cover a much wider range than those proposed by the CCME.

Given the differences noted in Table 5.2-1 and the uncertainties associated with sediment toxicity evaluations, the assessment was carried out using the various toxicity benchmarks presented in the table. It is important to note that these benchmarks should only be used for screening purposes. An exceedance of any of these benchmarks does not mean that an adverse effect would be observed rather it means that further investigation is necessary.

Table 5.2-1 Sediment Quality Toxicity Benchmarks

COPC (μg/g)	CCME 2003		Thompson *et al.* 2005	
	ISQG	PEL	LEL	SEL
Arsenic	5.9	17	10	346
Cadmium	0.6	3.5	-	-
Chromium	37.3	90	47.6	115.4
Copper	35.7	197	22	269
Lead	35	91.3	37	412
Manganese [a]	460	1100	-	-
Selenium	-	-	2.9	16.1
Vanadium	-	-	35.2	160
Zinc	123	315	-	-

Note:

ISQG – Interim sediment quality guideline. PEL - probable effect level.

LEL - lowest effect level. SEL - severe effect level.

Dash (-) no data available.

a - Manganese sediment quality guidelines taken from MOE (2008) as they were not available from any other source.

5.3 TOXICITY TO WILDLIFE

In the absence of toxicity data for most of the terrestrial animal receptors, data for laboratory animals were used in the risk assessment calculations. For mammals, the data are generally available for mice and rats. For avian receptors the test species are generally ducks or chicks. Lowest Observable Adverse Effects Levels (LOAELs) were obtained from the literature for mammals and avian receptors.

Toxicity reference values for the test species were collected primarily from the U.S. Department of Energy database by Sample *et al*. (1996). The background information for the toxicity reference values developed for the test species are provided in Table 5.3-1 for mammals and Table 5.3-2 for birds. These tables include test species, study duration and toxicological endpoint. Both NOAELs (no observable adverse effect levels) and LOAELs are presented on the tables. A summary of the LOAEL toxicity benchmarks (or toxicity reference values) used in the study is presented in Table 5.3-3. The LOAELs were chosen for this assessment based on the consideration that all pathways of exposure were taken into account for the receptors and no credit was taken into account for the fact that not all of the COPC intake by the receptor is bioavailable (i.e. it was assumed that 100% of the metal intake was dissolved in the gut of the species and taken into the body) and the fact that the LOAEL is a determination of whether an effect will occur.

Table 5.3-1 Summary of Toxicity Reference Values from Laboratory Animal Studies

COPC	Antimony	Arsenic	Barium	Boron	Cadmium	Chromium	Cobalt	Copper	Iron
Source of Reference values	Sample et al. (1996)	Sample *et al*. (1996)	Sample et al. (1996)	Sample *et al*. (1996)	Sample *et al.* (1996)	Sample et al. (1996)	ATSDR (2004)	Sample *et al.* (1996)	No toxicity data available
Original Reference	Schroeder et al. (1968)	Schroeder & Mitchener (1971)	Borzelleca et al. (1988)	Weir and Fisher (1972)	Sutou *et al.* (1980)	MacKenzie et al. (1958)	Pedigo et al. (1988)	Auerlich *et al.* (1982)	
Form of chemical	Antimony Potassium Tartrate	Arsenite (As^{3+})	Barium chloride	Boric Acid	Cadmium Chloride	Cr+6 as K2Cr2O4	Cobalt Chloride	Copper Sulphate	
Test Species	Mouse	mouse	Rat	rat	rat	Rat	Mouse	mink	
Body Weight (g)	30	30	350	35	303	350	35	1000	
Study Duration	lifetime (>1 yr)	3 generations (>1yr)	10 days	3 generations (>1yr)	6 weeks	1 year	13 weeks	357 days	
Endpoint	Lifespan, longevity	Reproduction	Mortality	Reproduction	Reproduction	Body weight and food consumption	Reproduction	Reproduction	
Comments	The study was carried out during a critical life stage and is considered to be chronic exposure.	The study was carried out during a critical life stage and is considered to be chronic exposure	Resulted in 30% mortality; no other effects were observed at other levels.	The study was carried out during a critical life stage and is considered to be chronic exposure	The study was carried out through mating and gestation and was considered to be chronic exposure.	Study carried out during critical life stage – taken as chronic exposure.	Study carried out during critical life stage – taken as chronic exposure.	The study was carried out during a critical life stage and is considered to be chronic exposure	
Logic	Median lifespan was reduced among female mice exposed to the 5 ppm dose level and the study considered exposure throughout the entire lifespan, this dose was considered to be a chronic LOAEL. NOAEL derived by applying an uncertainty factor of 0.1 to the LOAEL.	Mice displayed declining litter sizes with each successive generation at a dose of 1.26 mg/kg/d and thus this dose was considered to be a chronic LOAEL. NOAEL derived by applying an uncertainty factor of 10 to the LOAEL.	The 300 mg/kg/d dose was considered a subchronic LOAEL. A chronic LOAEL was estimated by multiplying the subchronic LOAEL by a subchronic to chronic uncertainty factor of 0.1.	No adverse effects were observed at the 28 mg/kg-d dose level. At the 93.6 mg/kg-d dose level, sterility resulted.	No adverse effects were observed at the 1 mg/kg-d dose level. At the 10 mg/kg-d dose level, fetal implantations were reduced by 28%, fetal survivorship was reduced by 50% and fetal resorptions increased by 400%.	No significant differences were observed at any dose level studied and the study considered exposure over 1 year, the maximum dose was considered to be a chronic NOAEL.	Reversible testicular degeneration was observed at 23 mg/kg/d which were considered the LOAEL.	The survival of kits at 25 ppm was actually higher than the controls and this level was taken to be the NOAEL. At 50 ppm the percentage mortality in kits was increased and this was considered to be a LOAEL.	
NOAEL (mg/(kg d))	0.125	0.13	-	28	1	3.28	-	11.7	
LOAEL (mg/(kg d))	1.25	1.26	19.8	93.6	10	-	23	15.14	

Table 5.3-1 Summary of Toxicity Reference Values from Laboratory Animal Studies (Cont'd)

COPC	**Lead**	**Manganese**	**Selenium**	**Silver**	**Strontium**	**Tin**	**Vanadium**	**Zinc**
Source of Reference values	Sample *et al*. (1996)	Sample *et al*. (1996)	Sample *et al.* (1996)	ATSDR (1990)	Sample *et al.* (1996)	Sample *et al*. (1996)	Sample et al. (1996)	Sample *et al.* (1996)
Original Reference	Azar *et al*. (1973)	Laskey *et al*. (1982)	Rosenfeld and Beath (1954)	Walker (1971)	Skoryna 1981	Davis *et al.* (1987)	Domingo et al. (1986)	Schlicker & Cox (1968)
Form of chemical	Lead Acetate	Manganese Oxide	Potassium Selenate	Silver Nitrate	Strontium Chloride	bis(Tributyltin) oxide (TBTO)	Sodium Metavanadate	Zinc Oxide
Test Species	rat	rat	rat	Rat	rat	mouse	Rat	rat
Body Weight (g)	350	350	350	350	350	30	260	350
Study Duration	3 generations (>1yr)	From gestation to 224 days	1 year through 2 generations	14 days	3 years	Days 6 to 15 of gestation	60 d prior to gestation as well as gestation, delivery and lactation	Days 1 to 16 of gestation
Endpoint	Reproduction	Reproduction	Reproduction	Mortality	Body weight / bone changes	Reproduction	Reproduction	Reproduction
Comments	The study was carried out during a critical life stage and is considered to be chronic exposure	The study was carried out during a critical life stage and is considered to be chronic exposure	Study carried out during critical life stage – taken as chronic exposure.	This study was based on short term exposure	Because the study considered exposure over three years the endpoint is considered to be chronic.	The study was carried out during a critical life stage and is considered to be chronic exposure	The study was carried out during a critical life stage and is considered to be chronic exposure.	The study was carried out during a critical life stage and is considered to be chronic exposure
Logic	None of the Pb exposure levels affected pregnancy rate, live birth rate or other reproductive indices. However Pb exposure of 1000 ppm reduced offspring weights and produced kidney damage in young thus a LOAEL. 100 ppm is a NOAEL.	Decreased pregnancy percentage and fertility noted at the highest dose of 3550 ppm, while other reproductive parameters were not affected. This was taken as the LOAEL. No effects seen at 1100 ppm or lower and therefore NOAEL.	No adverse effects on reproduction at a concentration of 1.5 mg/L. This value is the NOAEL. At 2.5 mg/L the number of second-generation young was reduced by 50% among females. This value is the LOAEL.	A 2-week study on rats exposed to silver nitrate in their drinking water resulted in the death of 3 out of 12 test animals. Test animals were observed to drastically decrease their drinking water intake and appeared listless and poorly groomed. Lethality was not observed in the lower dose group.	No adverse effects were observed for any Sr dosage level.	Reduced fetal weight and fetal survival as well as increased frequency of litter resorption were noted at 35 mg/kg-d TBTO, thus LOAEL. No effects noted at lower doses, thus NOAEL is 23.4 mg/kg-d.	Significant differences noted in reproductive parameters such as litter size, number of dead per litter, weight of offspring etc. at all dose levels. Lowest dose of 2.1 mg/kg d considered to be a chronic LOAEL.	No effects seen at 2000 ppm Zn therefore NOAEL. At 4000 ppm there was increased rates of fetal resorption and reduced fetal growth rates.
NOAEL (mg/(kg d))	8	88	0.2	181.2	263	23.4	-	160
LOAEL (mg/(kg d))	80	284	0.33	362.4	-	35	2.1	320

Table 5.3-2 Summary of Toxicity Reference Values from Laboratory Bird Studies

COPC	Antimony	Arsenic	Barium	Boron	Cadmium	Chromium	Cobalt	Copper	Iron
Source of Reference values	No toxicity data available	Sample *et al*. (1996)	Sample et al. (1996)	Sample *et al*. (1996)	Sample *et al.* (1996)	Sample et al. (1996)	No toxicity data available	Sample *et al*. (1996)	No toxicity data available
Original Reference		USFWS 1964	Johnson et al. 1960	Smith and Anders (1989)	White and Finley (1978)	Haseltine et al., unpubl. data		Mehring *et al*. (1960)	
Form of chemical		Arsenite (As^{3+})	Barium hydroxide	Boric Acid	Cadmium chloride	Cr+3 as CrK(SO4)2		Copper oxide	
Test Species		mallard duck	1 day old chicks	mallard duck	mallard duck	black duck		1 day old chicks	
Body Weight (g)		1000	121	1000	1153	1250		534	
Study Duration		128 d (>10 wks)	4 wk	6 wks	90d (>10wks)	10 months		10 weeks	
Endpoint		Mortality	Mortality	Reproduction	Reproduction	Reproduction		Growth, mortality	
Comments		The study was carried out over a period greater than 10 weeks and is considered to be chronic exposure	Study considered to be subchronic.	The study was carried out 3 weeks prior to, during and 3 weeks post reproduction and is considered to be chronic exposure.	The study was carried out over a period greater than 10 weeks during reproduction and is considered to be chronic exposure.	The study was carried out over 10 weeks and is considered to be chronic exposure.		The 10-week study was considered to be chronic in duration.	
Logic		Over 128 days at a dose of 100 ppm sodium arsenite the ducks experienced no mortality and thus this value is considered to be a NOAEL. A dose of 250 ppm resulted in 12% mortality and is considered to be a chronic LOAEL	2000 ppm was the highest non-lethal dose and considered to be a subchronic LOAEL. Chronic NOAELs and LOAELs were estimated by multiplying the subchronic NOAELs and LOAELs by a subchronic to chronic uncertainty factor of 0.1.	Consumption of 1000 ppm (100 mg/kg/d) resulted in reduced egg fertility and duckling growth and increased embryo and duckling mortality and is thus considered to be a chronic LOAEL. No adverse rep. effects were observed at the other dose levels and thus 288 ppm (28.8 mg/kg/d) was considered to be the NOAEL.	At a dose of 15.2 ppm, no change in egg production was observed therefore this is considered to be a NOAEL. At 210 ppm, there was a significant decrease in egg production.	While duckling survival was reduced at the 50 ppm dose level, no significant differences were observed at the 10 ppm Cr+3 dose level. Because the study considered exposure throughout a critical lifestage (reproduction), the dose 50 ppm dose was considered to be a chronic LOAEL and the 10 ppm dose was considered to be a chronic NOAEL.		Consumption of copper up to 570 ppm had no effect on the growth of chicks and was considered to be the NOAEL. At 749 ppm there was a 30% reduction in growth and a 15% mortality. This level is considered the LOAEL.	
NOAEL (mg/(kg d))		5.14	20.8	28.8	1.45	1		47	
LOAEL (mg/(kg d))		12.84	41.7	100	20	5		61.7	

Table 5.3-2 Summary of Toxicity Reference Values from Laboratory Bird Studies (Cont'd)

COPC	**Lead**	**Manganese**	**Selenium**	**Silver**	**Strontium**	**Tin**	**Vanadium**	**Zinc**
Source of Reference values	Sample *et al*. (1996)	Sample *et al*. (1996)	Sample *et al.* (1996)	No toxicity data available	No toxicity data available	Sample *et al.* (1996)	Sample et al. (1996)	Sample *et al.* (1996)
Original Reference	Edens *et al*. (1976)	Laskey and Edens (1985)	Heinz *et al*. (1987)			Schlatterer *et al*. (1993)	White and Dieter (1978)	Stahl *et al.* (1990)
Form of chemical	Lead Acetate	Manganese Oxide	Sodium Selenite			bis(Tributyltin) oxide (TBTO)	Vanadyl Sulphate	Zinc sulphate
Test Species	Japanese Quail	Japanese Quail	mallard duck			Japanese Quail	Mallard duck	White leghorn Hens
Body Weight (g)	150	150	1000			150	1170	1935
Study Duration	12 weeks	75 d (>10 wks)	78 d (>10 wks)			6 weeks	12 weeks	44 weeks (>10 wks)
Endpoint	Reproduction	Growth, aggressive behaviour	Reproduction			Reproduction	Mortality, body weight, blood chemistry	Reproduction
Comments	The study was carried out over 10 weeks and was considered to be chronic	The study was carried out over longer than 10 weeks and was considered to be chronic.	The study was carried out through the reproductive cycle and is considered to be chronic exposure.			This study was carried out during a reproduction and was considered to be chronic	The study was carried out over longer than 10 weeks and was considered to be chronic.	The study was carried out over 10 weeks and was considered to be chronic
Logic	Reproduction not impaired by the 10 ppm dose but egg hatching success reduced at the 100 ppm dose. Therefore considered the NOAEL and LOAEL respectively.	The study noted no effect on growth in birds fed 5056 ppm Mn in the diet. Aggressive behaviour was noted to be reduced by 25 to 50% relative to controls but this was not considered an adverse effect. NOAEL was taken as 977 mg/kg-d.	Consumption of 1, 5 and 10 ppm had no effect on weight and survival of adults but 10 and 25 ppm resulted in significantly larger frequency of lethally deformed embryos as compared to 1 or 5 ppm. Therefore 10 ppm is the LOAEL and 5 ppm is the NOAEL.			Consumption of up to 60 ppm TBTO in diet did not affect reproduction, thus NOAEL. At 150 ppm, reduced egg weight and hatchability were noted and thus LOAEL.	No effects observed at any dose level. The maximum dose of 11.4 mg/kg-d considered to be chronic NOAEL.	No adverse effects seen at 228 ppm Zn therefore NOAEL. At 2028 ppm Zn a 20% decrease in egg hatchability over controls was observed. Therefore LOAEL.
NOAEL (mg/(kg d))	1.13	977	0.5			6.8	11.4	14.5
LOAEL (mg/(kg d))	11.3	-	1			16.9	-	130.9

Table 5.3-3 Summary of LOAEL Toxicological Reference Values for Terrestrial Ecological Receptors

Ecological Receptor	LOAEL Toxicity Reference Values (mg/(kg d))																
	Antimony	**Arsenic**	**Barium**	**Boron**	**Cadmium**	**Chronium**	**Cobalt**	**Copper**	**Iron**	**Lead**	**Manganese**	**Selenium**	**Silver**	**Strontium**	**Tin**	**Vanadium**	**Zinc**
Black Bear	1.25	1.26	19.8	93.6	10	13.1	20	15.14	n/a	80	284	0.33	0.375	263[a]	35	2.1	320
Bison	1.25	1.26	19.8	93.6	10	13.1	20	15.14	n/a	80	284	0.33	0.375	263[a]	35	2.1	320
Caribou	1.25	1.26	19.8	93.6	10	13.1	20	15.14	n/a	80	284	0.33	0.375	263[a]	35	2.1	320
Grouse	n/a	12.84	41.7	100	20	5	n/a	61.7	n/a	11.3	977[a]	1	n/a	n/a	16.9	11.4	130.9
Hare	1.25	1.26	19.8	93.6	10	13.1	20	15.14	n/a	80	284	0.33	0.375	263[a]	35	2.1	320
Gray Jay	n/a	12.84	41.7	100	20	5	n/a	61.7	n/a	11.3	977[a]	1	n/a	n/a	16.9	11.4	130.9
Marten	1.25	1.26	19.8	93.6	10	13.1	20	15.14	n/a	80	284	0.33	0.375	263[a]	35	2.1	320
Mallard	n/a	12.84	41.7	100	20	5	n/a	61.7	n/a	11.3	977[a]	1	n/a	n/a	16.9	11.4	130.9
Merganser	n/a	12.84	41.7	100	20	5	n/a	61.7	n/a	11.3	977[a]	1	n/a	n/a	16.9	11.4	130.9
Moose[a]	1.25	1.26	19.8	93.6	10	13.1	20	15.14	n/a	80	284	0.33	0.375	263[a]	35	2.1	320
Porcupine	1.25	1.26	19.8	93.6	10	13.1	20	15.14	n/a	80	284	0.33	0.375	263[a]	35	2.1	320
Scaup	n/a	12.84	41.7	100	20	5	n/a	61.7	n/a	11.3	977[a]	1	n/a	n/a	16.9	11.4	130.9
Wolf	1.25	1.26	19.8	93.6	10	13.1	20	15.14	n/a	80	284	0.33	0.375	263[a]	35	2.1	320

Note:

Please refer to Tables 5.3-1 and 5.3-2 for discussion of laboratory toxicity reference values.

a - LOAELs for manganese for birds and strontium for mammals were not available, so the values presented are NOAELs.

n/a – not available

5.4 TOXICITY TO HUMANS

Exposure of humans to COPC is conventionally assessed against toxicity reference values (TRVs). Toxicity is the potential of a chemical to cause some type of damage, either permanent or temporary, to the structure or functioning of any part of the body. The toxicity depends on the amount of the chemical taken into the body (generally termed the intake or dose) and the length of time a person is exposed. Every chemical has a specific dose and duration of exposure that is necessary to produce a toxic effect in humans. Toxicity assessments generally involve the evaluation of scientific studies, based either on laboratory animal tests or on workplace exposure investigations, by a number of experienced scientists in a wide range of scientific disciplines in order to determine the maximum dose that a human can be exposed to without having an adverse health effect. Levels that are likely to result in no appreciable risks or no measurable adverse effects are known as exposure limits.

For many non-carcinogenic effects, protective biological mechanisms must be overcome before an adverse effect from exposure to the chemical is manifested. For this reason, scientists generally agree that there is a level (threshold) below which no adverse effects would be measurable or expected to occur. These toxicity reference values are generally called reference doses (RfDs), tolerable daily intakes (TDIs) or acceptable daily intakes (ADIs) and are generally derived by regulatory agencies such as Health Canada and the United States Environmental Protection Agency (U.S. EPA). These TRVs are usually expressed as the quantity of a chemical per unit body weight per unit time (mg/(kg d)).

These TRVs have generally been derived for sensitive individuals in the public using the most sensitive endpoint available. Additionally, these factors involve the incorporation of "safety factors" by regulatory agencies to provide additional protection for members of the public. As discussed above, there are several regulatory sources that report TRVs. Some of the most used sources are Health Canada, U.S. EPA Integrated Risk Information System (IRIS) database; U.S. EPA health assessment reports (HEAST), U.S. EPA National Center for Environmental Assessment (NCEA), the World Health Organization (WHO) and the Agency for Toxic Substances and Disease Registry (ATSDR). Given that this assessment is being conducted under the Federal Contaminated Sites Action Program (FCSAP), TRVs provided by Health Canada were preferentially selected for evaluation of the health impacts on people. The Toxicology Evaluation Section of the Health Products and Food Branch of Health Canada has published Tolerable Daily Intakes for a number of trace elements found in foodstuff. These values were also considered for use in this assessment. In addition, the U.S. EPA IRIS database is another major source for TRVs and was used to infill data gaps in the Health Canada database.

Table 5.4-1 provides a summary of the selected oral TRVs. Oral and dermal pathways are considered in this assessment; however, there are no dermal TRVs and it is a generally accepted practice in risk assessments to use the oral TRV to assess dermal exposure. The value, toxicological endpoint and reference for each TRV are provided in the table.

Table 5.4-1 Human Toxicity – Oral Dermal Pathway

COPC	Oral/Dermal				Reference
	Carcinogenic Effects		Non-carcinogenic Effects		
	Carcinogenic TRV $(mg/(kg\ d))^{-1}$	Endpoint	Non-Carcinogenic TRV (mg/(kg d))	Endpoint	
Arsenic	1.2	Internal Cancers	n/a		Health Canada Arsenic Drinking Water Guideline (2004)
Boron	n/a		0.0175	Reproductive effects	Health Canada (2004)
Cadmium	n/a		0.008	Not given	Health Canada (2004)
Copper	n/a		0.03	Not given but possible liver effects	Health Canada (2004)
Lead	n/a		0.0036	Neurological Effects in children at 10 µg/dl	Health Canada (2004)
Manganese	n/a		0.14	CNS Effects	U.S. EPA IRIS
Selenium	n/a		0.005	Clinical selenosis (environmental exposure)	U.S. EPA IRIS
Strontium	n/a		0.6	Rachitic bone	U.S. EPA IRIS
Tin	n/a		0.6	Liver and Kidney Lesions	HEAST
Zinc	n/a		0.566	Not given Oral = dermal	Health Canada (2005) (Personal communication with M. Richardson)

Note:

IRIS Integrated Risk Information System (U.S. EPA, 2002).
HEAST Health Effects Assessment Summary Tables (U.S. EPA, 1997).
n/a not applicable.

When data were available from more than one information source, a chain of precedence was established. Data from Health Canada were generally chosen first, followed by the IRIS database as the next choice. If data were not available in these two sources, then data were obtained from HEAST, which is part of the U.S. EPA.

Non Carcinogenic TRVs

The remaining COPC are considered to be non-classifiable with respect to human carcinogenicity, indicating that there are no human or animal data to indicate that they are carcinogens. The COPC falling into this category include boron, cadmium, copper, lead, manganese, selenium, strontium, tin and zinc.

For many non-carcinogenic effects, protective biological mechanisms must be overcome before an adverse effect is manifested from chronic exposure to a toxicant. This is known as a "threshold" concept. Non-carcinogens are often referred to as "systemic toxicants" because of their effects on the function of various organ systems.

Boron

Boron is a solid substance that widely occurs in nature. It usually does not occur alone, but is often found in the environment combined with other substances to form compounds called borates. Borax (sodium borate $Na_2B_4O_7.10H_2O$) and boric acid are used in Canada as insecticides; borax is also used as an antimicrobial agent. Borax is used extensively as a cleaning compound.

Urinary excretion studies in humans suggest there is very little absorption of boron through intact skin. Evidence suggests that boron is readily absorbed following contact with damaged skin (ATSDR 1992, Health Canada 2002). The most sensitive non-cancer endpoint was developmental (ATSDR 1992).

Studies in humans, particularly infants, show that boron (as boric acid) can be lethal following ingestion. Boron (as boron oxide and boric acid dusts) has been shown to cause irritation of the upper respiratory tract in humans. Ingestion of boron in humans can cause gastrointestinal effects. Nausea, persistent vomiting, diarrhea, and colicky abdominal pain in infants has been observed. Vomiting was the only sign of boron toxicity in two adult females who had ingested boron however the subjects did not develop any further symptoms (ATSDR 1992).

Health Canada (2002) derived an Acceptable Daily Intake (ADI) based on the lowest reported NOAEL for adverse testicular effects of 8.75 mg/kg bw per day in dogs (Weir and Fisher 1972). The actual intake may have been higher, as the boron content of the basal diet was not specified. The NOAEL is based on testicular atrophy and spermatogenesis obtained in a two-year study in dogs. An uncertainty factor of 500 was applied (10 for interspecies variation; 10 for intraspecies variation; and 5 for limitations of the critical study [i.e., small number of experimental animals exposed for a small proportion of their life span]). This results in an ADI of 0.0175 mg/kg bw per day.

Although a TRV is available from Health Canada (2002) for boron, the value from the U.S. EPA IRIS database (U.S. EPA 2006 – updated in 2004) was selected for use in this assessment, as this is based on a more recent re-evaluation of the available toxicity data. The toxicity value is based on a study that examined rat dietary gestational exposure to boric acid. The overall confidence in this RfD is reported to be high. The only inhalation toxicity value located was specific to anhydrous borax, which is not appropriate for application in this assessment.

Cadmium

Environmental exposure to cadmium can occur via the diet and drinking water. Cadmium is transported in the blood and widely distributed in the body but accumulates primarily in the liver and kidneys (Goyer, 1991). Cadmium is excreted primarily in the urine.

Long-term exposure to cadmium primarily affects the kidneys, resulting in tubular proteinosis although other conditions such as "itai-itai" disease may involve the skeletal system.

Health Canada provides a TDI of 0.0008 mg/(kg-d) in their PQRA Guidance Manual (2004); however, no health endpoint is provided it is assumed that kidney effects are what this TRV is based on. Cadmium is considered to be carcinogenic via the inhalation pathway. However, this pathway is not being considered in this assessment. Therefore the non-carcinogenic oral TRV of 0.0008 mg/(kg-d) was used in this assessment.

Copper

Toxicity resulting from acute oral exposure to copper has been shown to occur but is quite rare because copper is a potent emetic. There is very limited data available on the effects of chronic oral exposure to copper. The liver has been demonstrated to be the sensitive target organ for copper toxicity. Rat studies suggest that kidney damage is possible at doses causing liver damage, although kidney damage may be associated with a latency period (ATSDR 2002).

Dermal exposure to copper has been shown to result in pruritic and contact allergic dermatitis, and eye irritation (ATSDR 2002, Askergren and Mellgren 1975).

Health Canada (2004) in their PQRA Guidance Manual suggest the use of a chronic TDI of 0.03 mg/kg-d, based on CCME Soil Quality Guidelines and the supporting documentation on health-based guidelines by Health Canada (1995). The supporting document (Health Canada 1995) recommends the use of an “adequate and safe” TDI of 2.0 mg/day based on HWC (1990). Normalizing to an adult’s body weight of 70.7 kg, this translates into a TDI of 0.03 mg/(kg-d). The toxicological basis of this exposure limit is not known.

Lead

The most sensitive target organs for lead are thought to be the nervous system, the hematopoetic system, and the cardiovascular system. Toxic effects of lead are also manifested through the kidneys, immunological and reproductive systems (ATSDR 1999).

Lead has been designated as a probable human carcinogen, but currently its critical effect endpoint is considered to be neurological effects in children. Chronic exposure to lead can also lead to nephropathy in adults and children, but has not been detected at blood levels below 40 µg/dL (Health Canada 1992).

The Joint FAO/WHO Expert Committee on Food Additives (JECFA) established a provisional tolerable weekly intake (pTWI) of 0.025 mg/kg in 1986 for lead exposure to children, and has reconfirmed this value (WHO 2000a). This is equivalent to an RfD (or tolerable daily intake, TDI) of 0.0035 mg/(kg-d). This exposure limit is prescribed based on the knowledge that lead is a cumulative toxin and that any increase in lead body burdens should be avoided. The NOAEL of 0.003 to 0.004 mg/(kg-d) is taken from metabolic studies in infants, and was not associated with any increases in blood lead levels or lead body burdens. A LOAEL of 0.005 mg/(kg-d) was identified to be associated with body retention of lead. An uncertainty factor of 2 was selected because the endpoint and receptor selected were conservative, and because the studies selected were of good quality.

Health Canada (1992) adopted the JECFA pTWI. Health Canada (2004) provide a very similar oral TDI of 0.0036 mg/(kg-d). However, the toxicological rationale and endpoint are not explicitly stated in Health Canada (2003) but it has been assumed to correspond to a blood lead level of 10 µg/dL.

Manganese

Manganese is essential for normal physiologic functioning in all animal species. Several diseases in humans have been associated with deficiencies and excesses of manganese intakes. Thus, any quantitative risk assessment for manganese must take into account aspects of both the essentiality and the toxicity of manganese. In humans, there is a lot of information about the range of essentiality for manganese. Additionally, there are many reports of toxicity to humans exposed to manganese by inhalation; however, very little is known about the oral toxicity of manganese. Therefore, the toxicity information on oral exposures is related to safe dietary intakes.

Health Canada (2004) has not provided a TRV for manganese.

The World Health Organization (1973) reported the average daily consumption of manganese in diets to range from 2.0-8.8 mg Mn/day. Higher manganese intakes are associated with diets high in whole-grain cereals, nuts, green leafy vegetables, and tea. From manganese balance studies, the WHO concluded that 2-3 mg/day is adequate for adults and 8-9 mg/day is "perfectly safe."

An evaluation of diets from the United States, England, and Holland reveal average daily intakes of 2.3-8.8 mg Mn/day. However, a normal intake may be well over 10 mg Mn/day, especially from a vegetarian diet. From this information taken together, the U.S. EPA concludes that an appropriate reference dose for manganese is 10 mg/day (0.14 mg/(kg-day)). The U.S. EPA cautions that in applying the reference dose for manganese to a risk assessment, it is important to consider the ubiquitous nature of manganese, in that many individuals may consume about 2-5 mg Mn/day in their diet.

Selenium

The U.S. EPA (2009, last updated 1991) provides an oral RfD of 0.005 mg/kg-day, based on a NOAEL of 0.015 mg/(kg-day) from a study of clinical and biochemical signs of selenium intoxication in individuals living in an area of China with unusually high environmental concentrations of selenium (Yang and Zhou 1989, as cited in IRIS (2009)). To derive the RfD, a factor of 3 was applied to account for human variability, and was considered appropriate because the individuals in the study were sensitive individuals drawn from the larger study population. Health Canada (2002) provides a food-based provisional TDI of 0.75 mg/day. Using a body weight of 70.7kg, this equates to a TDI of 0.01 mg/(kg-d). The toxicological endpoint and effects are not reported. The U.S. EPA value is used in this report since it provides a more conservative estimate of health hazards, and since its toxicological endpoint is known.

No other exposure guidelines were available from the literature.

Strontium

Once in the body, strontium behaves very much like calcium. A large portion of the strontium will accumulate in bone. In adults, strontium mostly attaches to the surfaces of bones. In juveniles, especially those with poor nutrition, strontium behaves as an imperfect surrogate for calcium and interferes with bone mineralization in the developing skeleton. Animal studies strongly support the identification of bone as the most sensitive target of strontium toxicity.

The U.S. EPA IRIS database provides a chronic RfD for oral exposure to strontium of 0.6 mg/(kg-d) based on liver rachitic bone in rats. This value was used in the assessment.

Tin

Swallowing large amounts of inorganic tin compounds may cause stomach ache, anemia, and liver and kidney problems. Humans exposed for a short period of time to some organic tin compounds have experienced skin and eye irritation and neurological problems; exposure to very high amounts may be lethal.

Neither Health Canada or the U.S. EPA IRIS database have reported TRVs for Tin. HEAST (1997) provides a chronic RfD for tin of 0.6 mg/(kg-d) based on liver and kidney lesions in rats. This value was used in the assessment.

Zinc

Zinc is an essential nutrient with Recommended Daily Allowance (RDA) values ranging from 5 to 15 mg/day for different age and sex categories. The RDA is an estimate of the zinc needed for growth, development, metabolism, and tissue maintenance for over 98% of the healthy population.

The Health Canada PQRA Guidance Manual does not provide a TRV for zinc; however, a personal discussion with Mark Richardson at Health Canada indicated that a value of 0.566 mg/(kg-d) was appropriate to use as a TRV for zinc. This value was used in the assessment.

Carcinogenic TRVs

Carcinogenesis is generally assumed to be a "non-threshold" type phenomenon whereby it is assumed that any level of exposure to a carcinogen poses a finite probability of generating a carcinogenic response. Carcinogenic TRVs or slope factors are used to estimate an upper-bound lifetime probability of an individual developing cancer as a result of exposure to a particular level of a potential carcinogen. The carcinogenic TRV is, therefore, the lifetime cancer risk per unit of dose.

Arsenic

Of the COPC selected for evaluation in this study, only arsenic is considered to be a human carcinogen or probable human carcinogen. The slope factor used in this assessment represents an upper bound (95^{th} percentile) dose-response estimate. The slope factor is conservative and is meant to protect susceptible members of the public. The slope factor for arsenic of 2.8 $(mg/(kg\ d))^{-1}$ was obtained from Health Canada FCSAP program and is related to the development of skin cancers. However, the Drinking Water Division of Health Canada has recently conducted an evaluation of the toxicological data relating to cancer from exposure to arsenic. In their analysis, a slope factor of 1.2 $(mg/(kg\ d))^{-1}$ was developed for internal cancers such as stomach and liver. The analysis of arsenic risk was carried out using the slope factor of 1.2 $(mg/(kg\ d))^{-1}$ from the Drinking Water guidance since it is a more recently derived guideline and considered more recent toxicological studies on arsenic.

6.0 RISK CHARACTERIZATION

The risk characterization results presented in this chapter combines the information provided in prior chapters on COPC levels in the environment (Chapter 2), selection and characterization of ecological species and human receptors and their exposure pathways (Chapter 3), pathways modelling results of COPC intakes by the ecological species and human receptors (Chapter 4) and identification of safe levels (toxicity reference values) for the COPC for each species (Chapter 5). In this chapter measured water quality and sediment quality for the COPC are compared to relevant TRVs to determine risks in the aquatic environment. Risks to aquatic species are assessed by comparing measured water concentrations to aquatic toxicity reference values and measured or predicted sediment concentrations of COPC to sediment benchmarks. Risks to terrestrial ecological species are assessed by comparing exposure estimates for the COPC from all pathways to toxicity reference values and the potential effects on human health of individuals who may spend time on the Mt. Nansen site are evaluated by comparing estimated intakes of the COPC to toxicity reference values for non-carcinogenic metals and estimating the incremental lifetime risk from exposure to carcinogenic COPC (i.e. arsenic in the current assessment).

6.1 AQUATIC ENVIRONMENT

6.1.1 Water Quality – Comparison to CCME Guidelines

The measured concentrations in Dome Creek, Pony Creek and Victoria Creek are compared to Canadian water quality guidelines for the protection of aquatic life and for community water supplies from the Canadian Council of Ministers of the Environment (CCME 2003).

Existing water quality in Dome Creek, Pony Creek and Victoria Creek was measured at the Mt. Nansen Mine between January 1999 and November 2008. Measurements from reference sampling locations Victoria Creek Reference and Dry Creek were evaluated to determine baseline conditions.

There are several uncertainties involved in this assessment that the reader should take into consideration. For example, there are limitations in the pre-2007 water quality database for Dome Creek and Victoria Creek; in particular, several of the measurements were reported as less than method detection limits and some measurements were reported with high method detection limits. For the purpose of calculating summary statistics, concentrations reported as less than the method detection limit (“<”) were considered as equal to ½ the detection.

Table 6.1-1 provides a summary of the maximum (represented by the 95^{th} percentile when more than 20 samples were available) COPC concentrations for Dome Creek, Pony Creek and Victoria

Creek. The use of the 95th percentile value results in the removal of outliers. Thus, the use of the reasonable maximum concentration of each COPC in the aquatic assessment ensures that exposure is not under-estimated. The table also includes a column of maximum measured background/baseline concentrations. The reference sites were established based on discussion with the Yukon Government using the criteria of being free of mine (both Mt. Nansen and surrounding placer activity) influence and being reasonably accessible.

A review of COPC concentration data presented in Table 6.1-1 indicates the following:

- Baseline – the measured maximum concentrations of the COPC at the reference locations are above the CCME water quality guidelines for protection of aquatic life for arsenic, cadmium, copper, iron, lead, selenium, and silver. Comparison of the measured concentrations to CCME community water supply guidelines indicates that antimony, arsenic, iron, lead, manganese, and selenium at the reference locations are above the respective drinking water guidelines.

- Dome Creek - the maximum measured concentrations of the COPC in Dome Creek are above the CCME water quality guidelines for protection of aquatic life for ammonia (un-ionized), arsenic, cadmium, copper, iron, lead, selenium, silver, and zinc. Comparison of the measured concentrations in Dome Creek to CCME community water supply guidelines indicates that sulphate, antimony, arsenic, iron, lead, manganese, and selenium are above the respective drinking water guidelines. There are no available CCME guidelines in water for cyanate, thiocyanate, cobalt, strontium, and vanadium; however, the concentrations of these COPC in Dome Creek are above the maximum measured baseline concentrations.

- Pony Creek – the maximum measured concentrations of the COPC in Pony Creek are above the CCME water quality guidelines for protection of aquatic life for arsenic, cadmium, copper, iron, lead, silver, and zinc. Comparison of the measured concentrations in Pony Creek to CCME community water supply guidelines indicates that arsenic, cadmium, iron, lead, and manganese are above the respective drinking water guidelines. There are no available CCME guidelines in water for cyanate, thiocyanate, cobalt, strontium, and vanadium; however, the concentrations of these COPC (with the exception of strontium) in Pony Creek are below the maximum measured baseline concentrations.

- Victoria Creek - the maximum measured concentrations of the COPC in Victoria Creek are above the CCME water quality guidelines for protection of aquatic life for arsenic, cadmium, copper, iron, lead, selenium, and silver. Comparison of the measured concentrations in Victoria Creek to CCME community water supply guidelines indicates that antimony, arsenic, iron, lead, manganese, and selenium are above the respective drinking water guidelines. There are no available CCME guidelines in water for cyanate, thiocyanate, cobalt, strontium, and vanadium; however, the concentrations of these COPC (with the exception of cobalt and vanadium) in Victoria Creek are above the maximum measured baseline concentrations.

Table 6.1-1 Water Quality Comparison with Available CCME Criteria

COPC	Units	CCME Aquatic Life Guideline	CCME Drinking Water Guideline	Background	Dome	Pony	Victoria
				Measured Maximum	Measured 95th Percentile	Measured 95th Percentile	Measured 95th Percentile
Routine Parameters and Nutrients							
Chloride	µg/L	-	250000 d)	1100	2860	2400	1200
Sulphate	µg/L	-	500000 d)	2600	<u>996500</u>	129000	95340
Un-ionized Ammonia a)	µg/L	19	-	0.29	91.5	0.29	1.6
Cyanide Compounds							
Cyanate	µg/L	-	-	250	4584	200	455
Thiocyanate	µg/L	-	-	1700	6202	1400	2168
Total Metals							
Antimony	µg/L	-	6	<u>100</u>	<u>100</u>	4.5	<u>100</u>
Arsenic	µg/L	5	25	<u>100</u>	<u>180</u>	<u>242</u>	<u>100</u>
Barium	µg/L	-	1000	66	174	98	116
Boron	µg/L	-	5000	50	110	3	50
Cadmium	µg/L	0.017	5	5	5	<u>6.1</u>	5
Chromium	µg/L	8.9	50	6.1	8	3.3	5
Cobalt	µg/L	-	-	5	31	1.9	5
Copper b)	µg/L	2	1000 d)	9	266	93.3	18.9
Iron	µg/L	300	300 d)	<u>1700</u>	<u>12070</u>	<u>8276</u>	<u>1839</u>
Lead c)	µg/L	1	10	<u>25</u>	<u>25</u>	<u>170</u>	<u>25</u>
Manganese	µg/L	-	50 d)	<u>72</u>	<u>5641</u>	<u>774</u>	<u>176</u>
Selenium	µg/L	1	10	<u>100</u>	<u>100</u>	0.59	<u>100</u>
Silver	µg/L	0.1	-	5	5	1.6	5
Strontium	µg/L	-	-	269	802	363	371.8
Vanadium	µg/L	-	-	15	23.5	8.0	15
Zinc	µg/L	30	5000 d)	16	178	416	18

Notes:

(shaded) predicted concentrations greater than CCME Aquatic Life Guideline

<u>Underline</u> predicted concentrations greater than CCME Drinking Water Guideline

a) Guideline for ammonia is represented as un-ionized ammonia; measured ammonia concentrations were converted to un-ionized ammonia by applying a factor of 0.0116 based on an average pH of 7.7 and an estimated temperature of 50 deg F.

b) Copper guideline for water with hardness ≤ 120 mg/L $CaCO_3$

c) Lead guideline for water with hardness ≤ 60 mg/L as $CaCO_3$

d) Guidelines are for aesthetic concerns "-" no data available

6.1.2 Sediment Quality

The sediment concentrations in the three different watersheds considered in this assessment were derived from measured data. A summary of the maximum (represented by the 95th percentile when more than 20 samples were available) measured quality for Dome Creek, Pony Creek, and Victoria Creek, as well as baseline conditions represented by reference locations, is presented in Table 6.1-2.

Table 6.1-2 Sediment Quality Considered in the Risk Assessment

COPC	Units	Background	Dome Creek	Pony Creek	Victoria Creek
		Measured Maximum	Measured 95th Percentile	Measured Maximum	Measured 95th Percentile
Antimony	mg/kg	-	70	310	20
Arsenic	mg/kg	120	2,500	4,480	63
Barium	mg/kg	129	412	669	375
Boron	mg/kg	-	63	-	51
Cadmium	mg/kg	0.89	26	32	0.92
Chromium	mg/kg	14	55	27	35
Cobalt	mg/kg	20	20	11	20
Copper	mg/kg	12	157	1,150	77
Iron	mg/kg	14,900	52,390	106,000	40,471
Lead	mg/kg	29	530	4,090	80
Manganese	mg/kg	376	14,100	3,360	1,372
Selenium	mg/kg	-	8	1.0	8
Silver	mg/kg	2	7	99	2
Strontium	mg/kg	30	77	93	79
Vanadium	mg/kg	45	110	61	100
Zinc	mg/kg	116	3,030	2,070	151

Notes: - - not available. Concentrations of chloride, sulphate, ammonia, cyanate, and thiocyanate are not available in sediment and therefore, these COPC are not included in the table.

To simplify the review, the maximum sediment COPC concentrations, presented on Table 6.1-2, were divided by the toxicity benchmarks presented on Table 5.2-1 to obtain the screening index values. The SI values are presented on Table 6.1-3. Screening index values less than 1 indicate that the predicted levels are below the corresponding benchmarks. Values greater than 1 suggest that there is potential of observing adverse effects on some species. These numbers are shown as **bold and shaded** numbers on the tables. It is noted that many factors affect the availability of metals in sediment and hence their toxicity (e.g. grain size distribution and organic content).

Table 6.1-3 Sediment Screening Index Values for the Mt. Nansen Site

COPC, Source and Type of Sediment Toxicity Benchmark		Sediment Toxicity Benchmark (mg/kg)	Background	Dome Creek	Pony Creek	Victoria Creek
			Measured Maximum	Measured 95th Percentile	Measured Maximum	Measured 95th Percentile
Arsenic						
CCME 2003	TEL	5.9	**20**	**424**	**759**	**11**
	PEL	17.0	**7**	**147**	**264**	**4**
Thompson *et al.* 2002	LEL	10.0	**12**	**250**	**448**	**6**
	SEL	346.0	0.3	**7**	**13**	0.2
Cadmium						
CCME 2003	TEL	0.6	**1**	**44**	**53**	**2**
	PEL	3.5	0.3	**8**	**9**	0.3
Chromium						
CCME 2003	TEL	37.3	0.4	**1.5**	0.7	0.9
	PEL	90.0	0.2	0.6	0.3	0.4
Thompson *et al.* 2002	LEL	47.6	0.3	**1.1**	0.6	0.7
	SEL	115.4	0.1	0.5	0.2	0.3
Copper						
CCME 2003	TEL	35.7	0.3	**4**	**32**	**2**
	PEL	197.0	0.1	0.8	**6**	0.4
Thompson *et al.* 2002	LEL	22.0	0.5	**7**	**52**	**3**
	SEL	269.0	0.0	0.6	**4**	0.3
Lead						
CCME 2003	TEL	35.0	0.8	**15**	**117**	**2**
	PEL	91.3	0.3	**6**	**45**	0.9
Thompson *et al.* 2002	LEL	37.0	0.8	**14**	**111**	**2**
	SEL	412.0	0.1	**1**	**10**	0.2
Manganese[a]						
CCME 2003	TEL	460.0	0.8	**31**	**7**	**3**
	PEL	1100.0	0.3	**13**	**3**	**1**
Selenium						
Thompson *et al.* 2002	LEL	1.9	<0.001	**4**	0.5	**4**
	SEL	16.1	<0.001	0.5	0.1	0.5
Vanadium						
Thompson *et al.* 2002	LEL	35.2	**1.3**	**3.1**	**1.7**	**2.8**
	SEL	160.0	0.3	0.7	0.4	0.6
Zinc						
CCME 2003	TEL	123.0	0.9	**25**	**17**	**1**
	PEL	315.0	0.4	**10**	**7**	0.5

Notes: - - not available. Concentrations of chloride, sulphate, ammonia, cyanate, and thiocyanate are not available in sediment and therefore these COPC are not included in the table. Sediment toxicity values for antimony, barium, boron, cobalt, iron, silver, and strontium are not available and therefore, these COPC are not included in the table.

a - Manganese sediment quality guidelines taken from MOE (1993) as they were not available from any other source.

Bold and shaded values indicate a SI value greater than 1.

6.1.2.1 Dome Creek

The SI values presented in Table 6.1-3 indicate that arsenic, cadmium, chromium, copper, lead, manganese, selenium, vanadium, and zinc were above effects levels. This is not surprising given that mining has occurred in the area. The sediment concentrations in Dome Creek are higher than the measured background concentrations from reference locations for all COPC except cobalt (see Table 6.1-2). These results are indicative of some level of potential effect. Again, this finding is not surprising considering the past mining activities at the Mt. Nansen site.

Benthic invertebrate sampling was completed in 2007 by EDI and is described in the report *Benthic Invertebrate Communities at the Mt. Nansen Mine Site* (EDI 2007). A sampling location was located in the lower portion of Dome Creek to represent the receiving environment. An upstream sampling location was also sampled in Victoria Creek to represent the environment upstream of the mine site. The EDI (2007) report states:

> *"The apparent decline in relative abundance of Plecoptera and increase in relative abundance of Diptera (and specifically Chironomidae), in 1997 and 2000, suggests a response to disturbance. In contrast, the apparent similarity in relative abundance of Plecoptera in 1988 (prior to the most recent mining activity) and the present study (following almost a decade of remediation efforts), suggests that the community composition of benthic invertebrates in Dome Creek may be responding to improved aquatic conditions. "*

In summary, benthic sampling in Dome Creek indicates that there are healthy benthic communities currently present, although the taxa abundance and richness and lack of the most sensitive species indicates the effects from mine activity in the recent past. There is some evidence to suggest that the benthic community is returning to its pre-mining composition.

6.1.2.2 Pony Creek

The SI values presented in Table 6.1-3 indicate that arsenic, cadmium, copper, lead, manganese, vanadium, and zinc were above effects levels. This is not surprising given that mining has occurred in the area. The sediment concentrations in Pony Creek are higher than the measured background concentrations from reference locations for all COPC except cobalt (see Table 6.1-2). These results are indicative of some level of potential effect. Again, this finding is not surprising considering the past mining activities at the Mt. Nansen site.

EDI did not complete benthic invertebrate sampling in Pony Creek as reported in the *Benthic Invertebrate Communities at the Mt. Nansen Mine Site* (EDI 2007). However, a sampling location was placed in Victoria Creek between Back Creek and Dome Creek and this location shows some impacts from mining activities on Pony Creek and placer activities on Back Creek.

The EDI (2007) report states:

> *"… Victoria Creek downstream of Back Creek was also identified as lightly turbid through visual observation during the field sampling component of this study, and is in closest proximity to a potential source of sediment originating from upstream placer mining activity in Back Creek.*
>
> *… Ephemeroptera and Plecoptera are considered to be sensitive to disturbance, and particularly to fine sediments. In one Alaskan study, Weber (1986) found Ephemeroptera and Plecoptera to be most common in clear water sites and least common in sites directly downstream of active placer activity. Benthic invertebrate density was also significantly and negatively correlated with increased turbidity and total suspended solids (TSS). The slightly lower relative abundance of Plecoptera and Ephemeroptera in Victoria Creek downstream of Back Creek relative to the other Victoria Creek sampling locations in this study, and the replacement of Plecoptera and Ephemeroptera with Diptera over time as the dominant order at all Victoria Creek locations, are potentially attributable to increased sediment, particularly in the vicinity of the mouth of Back Creek.*
>
> *The apparent increase in relative abundance of Diptera since 2000 appears to be the result of an increase in the relative abundance of members of the family Chironomidae. In 2000, individuals of the family Chironomidae comprised 52% of the Diptera sampled in Victoria Creek downstream of the mine site, whereas in this study, Chironomidae comprised 94% of the Diptera. In 1988, individuals of the family Chironomidae comprised less than 50% of the Diptera at each Victoria Creek sampling location, whereas Chironomidae comprised over 80% of the Diptera at each Victoria Creek location in this study. Apparent temporal trends (and minor spatial trends) in relative abundance of Diptera (Chironomidae), as well as sediment-sensitive taxa (Ephemeroptera and Plecoptera) suggest that it is possible that benthic invertebrate community composition has been influenced by sediment release associated with placer mining activity in Back Creek (as well as natural sources of sediment). These comparisons should be interpreted with caution, given that the sampling method applied in 1988 differed from the current study and that the sample sizes in the 2000 and present studies varied considerably. Further study is needed to confirm this possibility. "*

In summary, benthic sampling in Victoria Creek downstream from Back Creek (and Pony Creek) suggests potential benthic community impacts from mining activities in the area, which is supported by the calculated SI values for Pony Creek.

6.1.2.3 Victoria Creek

The SI values presented in Table 6.1-3 indicate that arsenic, cadmium, copper, lead, manganese, selenium, vanadium, and zinc were above effects levels. This is not surprising given that mining has occurred in the area. The sediment concentrations in Victoria Creek are higher than the measured background concentrations from reference locations for all COPC except arsenic, cadmium, cobalt, and silver (see Table 6.1-2). These results are indicative of some level of potential effect. Again, this finding is not surprising considering the past mining activities at the Mt. Nansen site and on-going placer activity on Back Creek.

EDI completed benthic invertebrate sampling at three locations on Victoria Creek as described in the report *Benthic Invertebrate Communities at the Mt. Nansen Mine Site* (EDI 2007). One sampling location on Victoria Creek between Back Creek and Dome Creek was discussed previously with respect to benthic invertebrates in Pony Creek. Of the two remaining sampling locations on Victoria Creek, one was a reference location upstream of Back Creek and the other location was downstream of Dome Creek.

The EDI (2007) report states:

> *"…Diptera was found to be the dominant order of benthic invertebrates in all sampling locations in Victoria Creek. Aquatic invertebrates of the order Diptera have diverse life histories and are adapted to a variety of conditions. …*
>
> *… Victoria Creek downstream of Dome Creek was identified as very turbid in this study.*
>
> *… The apparent increase in relative abundance of Diptera since 2000 appears to be the result of an increase in the relative abundance of members of the family Chironomidae. In 2000, individuals of the family Chironomidae comprised 52% of the Diptera sampled in Victoria Creek downstream of the mine site, whereas in this study, Chironomidae comprised 94% of the Diptera. In 1988, individuals of the family Chironomidae comprised less than 50% of the Diptera at each Victoria Creek sampling location, whereas Chironomidae comprised over 80% of the Diptera at each Victoria Creek location in this study. …..*

> *Apparent temporal trends (and minor spatial trends) in relative abundance of Diptera (Chironomidae), as well as sediment-sensitive taxa (Ephemeroptera and Plecoptera) suggest that it is possible that benthic invertebrate community composition has been influenced by sediment release associated with placer mining activity in Back Creek (as well as natural sources of sediment).*
>
> *... the possibility of elevated metals levels as an influencing factor in the receiving environment in Victoria, as well as in Dome Creek, cannot be ruled out."*

In summary, benthic sampling in Victoria Creek downstream from Dome Creek suggests potential benthic community impacts from mining activities in the area, which is supported by the calculated SI values for Victoria Creek.

6.2 AQUATIC ECOLOGY

This section of the report evaluates the risks to aquatic species via comparison of water concentrations to toxicity reference values for different aquatic receptors to determine a screening index (SI). Screening index values provide an integrated description of the potential hazard, the exposure (or dose) response relationship and the exposure evaluation (U.S. EPA 1992, AIHC 1992). A screening index (SI) is calculated by dividing the water concentration by the selected toxicity reference value for each aquatic receptor.

The aquatic receptors chosen for the assessment represent several trophic levels in typical creek and river ecosystems. The aquatic screening index values for all species were estimated using the maximum (or 95th percentile when more than 20 samples were available) measured concentration.

It should be noted that the screening index (SI) values reported in this section are not estimates of the probability of ecological effect. Rather, the index values are positively correlated with the potential of an effect, that is, higher index values imply greater potential of an effect. Different magnitudes of the screening index have been used in other studies to screen for the potential ecological effects. A screening index value of 1.0 has been used in some instances (e.g. Suter 1991). In other work, Cadwell *et al.* (1993) suggested an index value of 0.3, based upon a cautious approach designed to account for potential chronic toxicity and chemical synergism. In this study, an index value of 1.0 was used to examine the potential adverse effects of COPC as the assessment is based on the application of chronic effects concentration (EC_{20}) endpoints for the aquatic species. Another reason for selecting an SI value of 1.0 is that calculations of COPC in water incorporate background levels in addition to the mine impacts and are based on the maximum/95th percentile measured concentrations.

Aquatic SI values were calculated for each of Dome Creek, Pony Creek, Victoria Creek and background. The results are provided in Table 6.2-1.

6.2.1 Dome Creek

The results of the assessment of Dome Creek (Table 6.2-1) indicate that SI values are above 1 for maximum concentrations of sulphate, thiocyanate, arsenic, barium, cadmium, chromium, cobalt, copper, iron, lead, manganese, selenium, silver, and zinc. Aquatic plant exposure to sulphate, chromium, and copper; benthic invertebrate exposure to sulphate, copper, and lead; phytoplankton exposure to sulphate, arsenic, cadmium, copper, and zinc; zooplankton exposure to thiocyanate, barium, cadmium, chromium, cobalt, copper, iron, lead, manganese, selenium, silver, and zinc result in SI values above one. Background concentrations of cadmium, lead, selenium, and silver result in similar SI values above one indicating that these COPC concentrations in Dome Creek are at background levels.

Considering that SI values are greater than 1 for Dome Creek, there may be potential adverse effects observed in Dome Creek for aquatic plants, benthic invertebrates, phytoplankton, and zooplankton. The benthic invertebrate study completed by EDI (2007) found that "*taxa richness was lowest in Dome Creek, a finding that is likely related primarily to the physical characteristics of this creek. Smaller streams have been shown to have lower benthic invertebrate diversity than larger streams (Slack et al., 1979). Dome Creek is a narrower channel and has lower flow velocities in comparison to Victoria Creek.*" The results of the risk assessment and the field studies on benthic invertebrates indicate that Dome Creek has been influenced by past mining activities and elevated concentrations of some metals still exist; however, the biological studies also indicate that Dome Creek may not provide appropriate habitat for aquatic receptors.

Table 6.2-1 Aquatic Screening Index Values for the Mt. Nansen Site

COPC and Aquatic Receptor	Aquatic Toxicity Reference Value (mg/L)	Background	Dome	Pony	Victoria
		Measured Maximum	Measured 95th Percentile	Measured 95th Percentile	Measured 95th Percentile
Un-ionized Ammonia					
Aquatic Plants	-	-	-	-	-
Phytoplankton	1.0	<0.01	0.1	<0.01	<0.01
Benthic Invertebrates	0.12	<0.01	0.8	<0.01	0.01
Zooplankton	0.16	<0.01	0.6	<0.01	0.01
Predator Fish	0.09	<0.01	-	-	0.02
Forage Fish	0.173	<0.01	-	-	<0.01
Antimony					
Aquatic Plants	-	-	-	-	-
Phytoplankton	0.15	0.7	0.7	0.03	0.7
Benthic Invertebrates	2.6	0.04	0.04	<0.01	0.04
Zooplankton	1.35	0.1	0.1	<0.01	0.1
Predator Fish	4	0.03	-	-	0.03
Forage Fish	2.31	0.04	-	-	0.04
Arsenic					
Aquatic Plants	0.32	0.3	0.6	0.8	0.3
Phytoplankton	0.025	**4.0**	**7.2**	**9.7**	**4.0**
Benthic Invertebrates	0.34	0.3	0.5	0.7	0.3
Zooplankton	0.91	0.1	0.2	0.3	0.1
Predator Fish	0.14	0.7	-	-	0.7
Forage Fish	0.12	0.8	-	-	0.8
Chloride					
Aquatic Plants	1958	<0.01	<0.01	<0.01	<0.01
Phytoplankton	590	<0.01	<0.01	<0.01	<0.01
Benthic Invertebrates	795	<0.01	<0.01	<0.01	<0.01
Zooplankton	314	<0.01	<0.01	<0.01	<0.01
Predator Fish	355	<0.01	-	-	<0.01
Forage Fish	252	<0.01	-	-	<0.01
Cyanate					
Aquatic Plants	-	-	-	-	-
Phytoplankton	-	-	-	-	-
Benthic Invertebrates	-	-	-	-	-
Zooplankton	-	-	-	-	-
Predator Fish	1.3	0.2	-	-	0.4
Forage Fish	-	-	-	-	-

Table 6.2-1 Aquatic Screening Index Values for the Mt. Nansen Site (Cont'd)

COPC and Aquatic Receptor	Aquatic Toxicity Reference Value (mg/L)	Background	Dome	Pony	Victoria
		Measured Maximum	Measured 95th Percentile	Measured 95th Percentile	Measured 95th Percentile
Barium					
Aquatic Plants	13	<0.01	0.01	<0.01	<0.01
Phytoplankton	4	0.02	0.04	0.02	0.03
Benthic Invertebrates	-	-	-	-	-
Zooplankton	0.004	**16.5**	**43.6**	**24.4**	**29.0**
Predator Fish	10.7	<0.01	-	-	0.01
Forage Fish	-	-	-	-	-
Boron					
Aquatic Plants	20	<0.01	<0.01	<0.01	<0.01
Phytoplankton	0.58	0.1	0.2	<0.01	0.1
Benthic Invertebrates	137.6	<0.01	<0.01	<0.01	<0.01
Zooplankton	14.1	<0.01	<0.01	<0.01	<0.01
Predator Fish	45	<0.01	-	-	<0.01
Forage Fish	-	-	-	-	-
Cadmium					
Aquatic Plants	3	<0.01	<0.01	<0.01	<0.01
Phytoplankton	0.003	**1.7**	**1.7**	**2.0**	**1.7**
Benthic Invertebrates	0.12	0.04	0.04	0.1	0.04
Zooplankton	0.00075	**6.7**	**6.7**	**8.1**	**6.7**
Predator Fish	0.002	**2.5**	-	-	**2.5**
Forage Fish	0.009	0.6	-	-	0.6
Chromium					
Aquatic Plants	0.002	**3.1**	**4.0**	**1.7**	**2.5**
Phytoplankton	-	-	-	-	-
Benthic Invertebrates	-	-	-	-	-
Zooplankton	0.006	**1.0**	**1.3**	0.6	0.8
Predator Fish	0.073	0.1	-	-	0.1
Forage Fish	-	-	-	-	-
Cobalt					
Aquatic Plants	-	-	-	-	-
Phytoplankton	0.27	0.02	0.1	<0.01	0.02
Benthic Invertebrates	1.6	<0.01	0.02	<0.01	<0.01
Zooplankton	0.005	**1.0**	**6.1**	0.4	**1.0**
Predator Fish	0.12	0.04	-	-	0.04
Forage Fish	0.2	0.03	-	-	0.03

Table 6.2-1 Aquatic Screening Index Values for the Mt. Nansen Site (Cont'd)

COPC and Aquatic Receptor	Aquatic Toxicity Reference Value (mg/L)	Background	Dome	Pony	Victoria
		Measured Maximum	Measured 95th Percentile	Measured 95th Percentile	Measured 95th Percentile
Copper					
Aquatic Plants	0.15	0.1	**1.8**	0.6	0.1
Phytoplankton	0.004	**2.3**	**66.6**	**23.3**	**4.7**
Benthic Invertebrates	0.08	0.1	**3.3**	**1.2**	0.2
Zooplankton	0.0041	**2.2**	**65.0**	**22.8**	**4.6**
Predator Fish	0.0086	**1.0**	-	-	**2.2**
Forage Fish	0.0041	**2.2**	-	-	**4.6**
Iron					
Aquatic Plants	-	-	-	-	-
Phytoplankton	-	-	-	-	-
Benthic Invertebrates	-	-	-	-	-
Zooplankton	1.48	**1.1**	**8.2**	**5.6**	**1.2**
Predator Fish	7.5	0.2	-	-	0.2
Forage Fish	0.75	**2.3**	-	-	**2.5**
Lead					
Aquatic Plants	182	<0.01	<0.01	<0.01	<0.01
Phytoplankton	0.63	0.04	0.04	0.3	0.04
Benthic Invertebrates	0.002	**12.5**	**12.5**	**85.0**	**12.5**
Zooplankton	0.02	**1.3**	**1.3**	**8.5**	**1.3**
Predator Fish	0.028	0.9	-	-	0.9
Forage Fish	0.415	0.1	-	-	0.1
Manganese					
Aquatic Plants	15.5	<0.01	0.4	0.05	0.01
Phytoplankton	46.4	<0.01	0.1	0.02	<0.01
Benthic Invertebrates	46	<0.01	0.1	0.02	<0.01
Zooplankton	2.35	0.03	**2.4**	0.3	0.1
Predator Fish	0.73	0.1	-	-	0.2
Forage Fish	2.06	0.03	-	-	0.1
Selenium					
Aquatic Plants	0.9	0.1	0.1	<0.01	0.1
Phytoplankton	0.19	0.5	0.5	<0.01	0.5
Benthic Invertebrates	0.2	0.5	0.5	<0.01	0.5
Zooplankton	0.04	**2.5**	**2.5**	0.01	**2.5**
Predator Fish	0.05	**2.0**	-	-	**2.0**
Forage Fish	0.15	0.7	-	-	0.7
Silver					
Aquatic Plants	-	-	-	-	-
Phytoplankton	-	-	-	-	-
Benthic Invertebrates	-	-	-	-	-
Zooplankton	0.00058	**8.6**	**8.6**	**2.7**	**8.6**
Predator Fish	0.0092	**5.4**	-	-	**5.4**
Forage Fish	0.0104	**4.8**	-	-	**4.8**

Table 6.2-1 Aquatic Screening Index Values for the Mt. Nansen Site (Cont'd)

COPC and Aquatic Receptor	Aquatic Toxicity Reference Value (mg/L)	Background	Dome	Pony	Victoria
		Measured Maximum	Measured 95th Percentile	Measured 95th Percentile	Measured 95th Percentile
Strontium					
Aquatic Plants	-	-	-	-	-
Phytoplankton	150	<0.01	<0.01	<0.01	<0.01
Benthic Invertebrates	10	0.03	0.1	0.04	0.04
Zooplankton	42	<0.01	0.02	<0.01	<0.01
Predatory Fish	9.3	0.03	-	-	0.04
Bottom Feeder Fish	4.3	0.1	-	-	0.1
Sulphate					
Aquatic Plants	371	<0.01	**2.7**	0.3	0.3
Phytoplankton	320	<0.01	**3.1**	0.4	0.3
Benthic Invertebrates	165	0.02	**6.0**	0.8	0.6
Zooplankton	1260	<0.01	0.8	0.1	0.1
Predator Fish	704	<0.01	-	-	0.1
Forage Fish	796	<0.01	-	-	0.1
Thiocyanate					
Aquatic Plants	-	-	-	-	-
Phytoplankton	-	-	-	-	-
Benthic Invertebrates	-	-	-	-	-
Zooplankton	5.74	0.3	**1.1**	0.2	0.4
Predator Fish	3.13	0.5	-	-	0.7
Forage Fish	7.3	0.2	-	-	0.3
Vanadium					
Aquatic Plants	-	-	-	-	-
Phytoplankton	1.6	<0.01	0.01	<0.01	<0.01
Benthic Invertebrates	0.024	0.6	1.0	0.3	0.6
Zooplankton	1.9	<0.01	0.01	<0.01	<0.01
Predator Fish	0.04	0.4	-	-	0.4
Forage Fish	0.04	0.4	-	-	0.4
Zinc					
Aquatic Plants	10.8	<0.01	0.02	0.04	<0.01
Phytoplankton	0.04	0.4	**4.5**	**10.4**	0.5
Benthic Invertebrates	0.6	0.0	0.3	0.7	0.0
Zooplankton	0.04	0.4	**4.5**	**10.4**	0.5
Predator Fish	0.06	0.3	-	-	0.3
Forage Fish	0.1	0.2	-	-	0.2

Notes: - - not available.
Bold and shaded values indicate a SI value greater than 1.

6.2.2 Pony Creek

The results of the assessment of Pony Creek (Table 6.2-1) indicate that SI values are above 1 for maximum concentrations of thiocyanate, arsenic, barium, cadmium, chromium, copper, iron, lead, silver, and zinc. Aquatic plant exposure to chromium; benthic invertebrate exposure to copper, and lead; phytoplankton exposure to arsenic, cadmium, copper, and zinc; zooplankton exposure to barium, cadmium, copper, iron, lead, silver, and zinc result in SI values above one. Background concentrations of chromium and silver result in similar (or greater) SI values above one indicating that these COPC concentrations in Pony Creek are at background levels.

Considering that SI values are greater than 1 for Pony Creek, there may be potential adverse effects observed in Pony Creek for benthic invertebrates, phytoplankton, and zooplankton. Fish were not assessed in Pony Creek since Pony Creek is not a fish-bearing stream due to topographical changes and seasonal underground flow. Therefore, there seems to be an influence in Pony Creek due to past mining activities; however, Pony Creek may not provide suitable habitat for

6.2.3 Victoria Creek

The results of the assessment of Victoria Creek (Table 6.2-1) indicate that SI values are above 1 for maximum concentrations of arsenic, barium, cadmium, chromium, cobalt, copper, iron, lead, selenium, and silver. Benthic invertebrate exposure to lead; phytoplankton exposure to arsenic, cadmium, and copper; zooplankton exposure to barium, cobalt, copper, iron, lead, selenium, silver, and zinc; bottom-feeder fish exposure to copper, iron, and silver; predatory fish exposure to cadmium, copper, selenium, and silver result in SI values above one. Background concentrations of arsenic, cadmium, chromium, cobalt, iron, lead, selenium, and silver result in similar SI values above one indicating that these COPC concentrations in Victoria Creek are at background levels.

The results of the risk assessment demonstrate that there is very little evidence of influence of the Mt. Nansen Mine site on Victoria Creek with the possible exception of copper. Concentrations of copper in Victoria Creek are twice as high as background levels and SI values are greater than 1 indicating that there may be potential adverse effects observed in Victoria Creek for phytoplankton, zooplankton, forage fish and predatory fish. However, biological sampling indicates the presence of different fish species in Victoria Creek (EDI 2007). Therefore, it is unlikely that there are any adverse effects on aquatic receptors in Victoria Creek.

6.3 TERRESTRIAL ECOLOGY

This section presents the results of the risk characterization for terrestrial receptors assessed at the Mt. Nansen Mine site.

Potential toxic effects can be measured at different levels of biological and ecological organization. Screening index values provide an integrated description of the potential hazard, the exposure (or dose)-response relationship, and the exposure evaluation (U.S. EPA 1992, AIHC 1992). In this study, ecological effects for terrestrial receptors exposed to COPC in the terrestrial and aquatic environment were characterized by the value of a simple screening index. This index was calculated by dividing the predicted exposure (intake see Chapter 4) by the toxicity reference value (TRV) for each ecological receptor, as shown in equation (6.3-1).

$$Screening\ Index = \frac{\mathrm{Pr}\,edicted\ \ Intake}{TRV} \qquad (6.3\text{-}1)$$

The screening index values reported in this section are not estimates of the probability of ecological effect. Rather, the index values are positively correlated with the potential of an effect, i.e. higher index values imply a greater potential of an effect. Different magnitudes of the screening index have been used in other studies to screen for potential ecological effects. A screening index value of 1.0 has been used in some instances (e.g. Suter 1991). In this study, screening index benchmark values of less than 1 are used to reflect the home range of the species as presented in Table 3.1-2. That is, index values were chosen based on the time that each species is assumed to spend at the site and the components of the species diet accounted for in the assessment. The SI benchmark values used in this assessment are presented on each of the tables discussed below.

The screening index values for the terrestrial animals in the study area are presented in Tables 6.3-1 and 6.3-2. Any screening index values that exceed the corresponding SI benchmark values listed along the bottom row of the tables are shown in **bold and shaded**. For additional emphasis the cells are also shaded.

As seen from Table 6.3-1, the predicted intakes of COPC for grouse, hare, gray jay, marten, moose, and wolf, as well as all receptors in the background terrestrial environment, do not exceed the corresponding SI benchmark values; therefore, it is concluded that these receptors are not likely to experience adverse effects at any of the locations considered at the Mt. Nansen Mine site.

The bear, caribou, and porcupine (at the mill, tailings, and pit) have predicted SI values that are above the SI benchmark values from exposure to arsenic through the ingestion of soil, while bison, hare (at the mill and tailings), and porcupine (to a lesser extent than soil, at the mill, tailings, and pit) have predicted SI values that are above the SI benchmark values from arsenic exposure through the ingestion of browse and forage. Both soil and vegetation are represented by either the 95th percentile or maximum measured concentrations. It should be noted that it has been assumed that ecological receptors are present for the entire time on site at the area of maximum concentration when in reality they will be roaming across the assessment. A calculation with the mean concentrations indicates that all SI values are below the respective SI benchmarks. This indicates that it is unlikely that COPC concentrations in the terrestrial environment are a cause for concern for ecological receptors with a terrestrial-based diet.

Copper exposure for the porcupine results in SI values above 1 based on estimated concentrations of aquatic vegetation in the Tailings Pond. Aquatic vegetation concentrations in the Tailings Pond are estimated using water-to-aquatic vegetation transfer factors which may over-estimate the concentrations. It should be noted that there is no aquatic vegetation present in the Tailings Pond, therefore it is unlikely that porcupine populations would be at risk from copper in the Tailings Pond.

Table 6.3-1 Predicted SI Values for Terrestrial Animals in the Terrestrial Environment of the Mt. Nansen Site

COPC	Screening Index Value								
	Black Bear		Bison		Caribou	Grouse			
	BG	Mine	BG	Mine	Mine	BG	Mill	Tailings	Pit
Arsenic	0.13	**1.11**	0.09	**1.80**	**0.76**	0.03	0.55	0.13	0.04
Boron	<0.01	<0.01	<0.01	0.01	<0.01	0.01	0.07	0.07	0.03
Cadmium	<0.01	<0.01	<0.01	<0.01	<0.01	0.12	0.12	0.11	0.16
Copper	<0.01	0.05	0.01	0.13	0.02	<0.01	0.02	0.26	0.02
Lead	<0.01	<0.01	<0.01	0.02	<0.01	0.03	0.32	0.06	0.04
Manganese	0.10	0.19	0.24	0.35	0.07	0.18	0.11	0.17	0.12
Selenium	0.07	0.10	0.03	0.03	0.03	0.09	0.09	0.10	0.09
Strontium	<0.01	<0.01	<0.01	<0.01	<0.01	n/a	n/a	n/a	n/a
Tin	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	<0.01	0.01	<0.01	0.03	<0.01	0.44	0.63	0.52	0.84
SI Benchmark	1	1	1	1	0.5	1	1	1	1

Intake	Hare				Gray Jay				Marten	
mg/(kg d)	BG	Mill	Tailings	Pit	BG	Mill	Tailings	Pit	BG	Mine
Arsenic	0.30	**4.20**	**2.60**	0.64	0.05	0.31	0.15	0.04	0.05	0.27
Boron	0.02	0.06	0.06	0.03	<0.01	0.02	0.01	0.02	<0.01	<0.01
Cadmium	0.15	0.15	0.14	0.20	<0.01	0.02	0.02	0.02	<0.01	0.03
Copper	0.04	0.06	0.33	0.07	0.03	0.05	0.10	0.04	<0.01	0.02
Lead	<0.01	0.03	0.03	<0.01	0.02	0.10	0.02	0.02	<0.01	<0.01
Manganese	0.63	0.45	0.75	0.49	0.07	0.13	0.13	0.05	<0.01	0.03
Selenium	0.06	0.08	0.08	0.06	0.11	0.32	0.31	0.31	0.04	0.11
Strontium	0.03	0.02	0.03	0.04	n/a	n/a	n/a	n/a	<0.01	<0.01
Tin	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	0.11	0.17	0.16	0.24	0.09	0.17	0.16	0.17	<0.01	<0.01
SI Benchmark	1	1	1	1	1	1	1	1	1	1

Table 6.3-1 Predicted SI Values for Terrestrial Animals in the Terrestrial Environment of the Mt. Nansen Site (Cont'd)

COPC	Screening Index Value					
	Moose	Porcupine				Wolf
	Mine	BG	Mill	Tailings	Pit	Mine
Arsenic	0.69	0.24	**5.78**	**2.15**	**1.14**	0.11
Boron	0.01	<0.01	0.02	0.02	<0.01	<0.01
Cadmium	0.06	0.10	0.10	0.09	0.19	<0.01
Copper	0.02	0.03	0.57	**53.71**	0.16	<0.01
Lead	<0.01	<0.01	0.03	0.03	<0.01	<0.01
Manganese	0.07	0.17	0.29	0.97	0.19	<0.01
Selenium	0.10	0.61	0.67	0.64	0.64	<0.01
Strontium	0.01	0.02	0.03	0.06	0.05	<0.01
Tin	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	0.06	0.05	0.11	0.09	0.23	<0.01
SI Benchmark	1	1	1	1	1	0.25

Note: n/a – not assessed due to lack of TRV

BG – background

Bold and shaded values indicate a SI value greater than the SI benchmark.

Only terrestrial COPC considered for the terrestrial environment assessment.

Table 6.3-2 Predicted SI Values for Waterfowl in the Aquatic Environment of the Mt. Nansen Site

COPC	**Screening Index Value**					
	Mallard					
	BG	**Dome Creek at Mill**	**Tailings Pond**	**Brown-McDadePit**	**Pony Creek**	**Victoria Creek**
Antimony	n/a	n/a	n/a	n/a	n/a	n/a
Arsenic	**1.14**	**2.2**	**2.3**	**1.17**	**3.0**	**1.14**
Barium	0.05	0.14	0.05	0.02	0.09	0.09
Boron	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium	0.10	0.10	0.10	0.31	0.12	0.10
Chromium	<0.01	0.01	0.01	0.01	<0.01	<0.01
Cobalt	n/a	n/a	n/a	n/a	n/a	n/a
Copper	0.02	0.50	**37**	0.10	0.19	0.04
Iron	n/a	n/a	n/a	n/a	n/a	n/a
Lead	0.03	0.07	0.14	0.04	0.48	0.03
Manganese	<0.01	0.04	0.12	0.01	<0.01	<0.01
Selenium	**6.0**	**6.0**	**6.0**	**6.0**	0.04	**6.0**
Silver	n/a	n/a	n/a	n/a	n/a	n/a
Strontium	n/a	n/a	n/a	n/a	n/a	n/a
Vanadium	0.09	0.14	0.21	0.11	0.05	0.09
Zinc	0.42	**4.7**	**6.6**	**36**	**11**	0.47
SI Benchmark	0.5	0.5	0.5	0.5	0.5	0.5

COPC	**Screening Index Value**					
	Merganser					
	BG	**Dome Creek at Mill**	**Tailings Pond**	**Brown-McDadePit**	**Pony Creek**	**Victoria Creek**
Antimony	n/a	n/a	n/a	n/a	n/a	n/a
Arsenic	<0.01	0.11	0.05	0.03	0.19	<0.01
Barium	0.02	0.02	0.02	0.02	0.03	0.02
Boron	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium	<0.01	0.01	0.01	0.01	<0.01	<0.01
Cobalt	n/a	n/a	n/a	n/a	n/a	n/a
Copper	<0.01	<0.01	**0.85**	<0.01	0.01	<0.01
Iron	n/a	n/a	n/a	n/a	n/a	n/a
Lead	<0.01	0.03	0.03	0.01	0.19	<0.01
Manganese	<0.01	0.01	0.05	<0.01	<0.01	<0.01
Selenium	0.19	0.31	0.31	0.31	0.31	0.31
Silver	n/a	n/a	n/a	n/a	n/a	n/a
Strontium	n/a	n/a	n/a	n/a	n/a	n/a
Vanadium	<0.01	0.01	0.03	0.02	0.01	0.01
Zinc	0.03	0.04	0.03	0.06	0.03	0.02
SI Benchmark	0.5	0.5	0.5	0.5	0.5	0.5

Table 6.3-2 Predicted SI Values for Waterfowl in the Aquatic Environment of the Mt. Nansen Site (Cont'd)

COPC	Screening Index Value					
	Scaup					
	BG	**Dome Creek at Mill**	**Tailings Pond**	**Brown-McDadePit**	**Pony Creek**	**Victoria Creek**
Antimony	n/a	n/a	n/a	n/a	n/a	n/a
Arsenic	**1.86**	**3.96**	**3.96**	**1.97**	**5.62**	**1.85**
Barium	0.07	0.18	0.06	0.02	0.14	0.13
Boron	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium	0.15	0.15	0.15	0.45	0.18	0.15
Chromium	0.01	0.04	0.05	0.05	0.02	0.03
Cobalt	n/a	n/a	n/a	n/a	n/a	n/a
Copper	0.02	**0.67**	**52.64**	0.14	0.29	0.05
Iron	n/a	n/a	n/a	n/a	n/a	n/a
Lead	0.04	0.20	0.31	0.10	**1.48**	0.06
Manganese	<0.01	0.06	0.31	0.03	0.01	<0.01
Selenium	**9.50**	**9.53**	**9.51**	**9.51**	0.06	**9.53**
Silver	n/a	n/a	n/a	n/a	n/a	n/a
Strontium	n/a	n/a	n/a	n/a	n/a	n/a
Vanadium	0.07	0.12	0.28	0.14	0.05	0.09
Zinc	**0.68**	**7.62**	**10.61**	**58.66**	**17.65**	**0.77**
SI Benchmark	0.5	0.5	0.5	0.5	0.5	0.5

Note: n/a – not assessed due to lack of TRV
BG – background
Bold and shaded values indicate a SI value greater than the SI benchmark.
Only aquatic COPC considered for the aquatic environment assessment.

Potential adverse effects in waterfowl were only evaluated at the Mt. Nansen site (Table 6.3-2) for the COPC identified by the aquatic screening process. Arsenic, copper, lead, selenium, and zinc result in SI values above the SI benchmark of 0.5 for waterfowl. It should be noted that arsenic and selenium exposures are essentially the same as background and thus the remaining discussion will focus on copper lead and zinc.

In Dome Creek at the Mill site, copper, and zinc intakes for mallard and scaup are due to the ingestion of benthic invertebrates, which have concentrations represented by water-to-benthic invertebrate transfer factors. Dome Creek is influenced by the mine activities, therefore it is not surprising that potential effects in wildfowl are predicted. However, it should be noted that Dome Creek is a fast moving stream and may not represent a conducive environment for waterfowl.

Copper and zinc concentrations are also potential issues in the Tailings Pond and zinc concentrations in the Pit are also predicted to result in SI values above the SI benchmark for scaup due to the ingestion of sediment. Sediment concentrations in the Tailings Pond and Pit are estimated using site-specific water-to-sediment distribution coefficients; nonetheless, it is not surprising that potential issues have been identified in the Tailings Pond and Pit due to the presence of copper and zinc.

In Pony Creek, which has also been influenced by the mine activities, zinc concentrations may potentially result in adverse effects in waterfowl. Lead concentrations are predicted to result in a SI value for scaup that is above the SI benchmark due to sediment ingestion. A review of the lead concentrations in Pony Creek indicate that there are a few high concentrations of lead in sediment; however, if it is assumed that the scaup moves along Pony Creek and is therefore more likely to be exposed to the mean lead concentration, no exceedances of the SI benchmark is predicted.

The results of the risk assessment indicate that concentrations of COPC in the terrestrial environment will not result in adverse effects on ecological receptors with a terrestrial based diet. There are some elevated concentrations of copper in the Tailings Pond. Copper and zinc in Dome Creek, the Tailings Pond, Brown-McDade Pit and zinc concentrations in Pony Creek have the potential to adversely affect individual waterfowl under the conservative assumptions considered in this assessment. However, populations of waterfowl are unlikely to experience adverse effects.

6.4 HUMAN HEALTH

Human health risk characterization involves the integration of the information from the exposure assessment and the toxicity assessment. As indicated in Section 5.4, the COPC selected have mainly non-carcinogenic endpoints with the exception of arsenic which is considered to be a carcinogen.

Non-Carcinogens

For many non-carcinogenic effects, protective biological mechanisms must be overcome before an adverse effect is manifested from exposure to the COPC. This is known as a "threshold" concept. For non-carcinogenic COPC, the hazard quotient (HQ) was evaluated for the ingestion and dermal exposure pathways as follows:

$$HQ = \frac{D_o}{TRV_o} + \frac{D_d}{TRV_d} \qquad (6\text{-}1)$$

where:

D_o = Dose due to oral (ingestion) exposure (mg/(kg d));
D_d = Dose due to dermal exposure (mg/(kg d));
TRV_o = Non-carcinogenic toxicity reference value for oral exposure (mg/(kg d));
TRV_d = Non-carcinogenic toxicity reference value for dermal exposure (mg/(kg d)) (assumed equal to TRV_o).

In risk assessments, 20% of the dose or a hazard quotient of 0.2 is generally used to assess acceptable exposure from each individual pathway. In this assessment, soil and dermal exposures as well as water intakes and traditional food consumption over the year were evaluated; therefore, a hazard quotient benchmark of 0.5 was considered to be appropriate for use at this site.

Carcinogens

For carcinogenic COPC such as arsenic, a risk is calculated by multiplying the estimated dose (in mg/(kg d)) by the appropriate slope factor (in $(mg/(kg\ d))^{-1}$). This is shown in equation (6-2). The estimate corresponds to an incremental risk of an individual developing cancer over a lifetime as a result of exposure. Risk is defined as follows:

$$Risk = \left(D_o \times SF_o\right) + \left(D_d \times SF_d\right) \tag{6-2}$$

where:

D_o = Dose due to oral (ingestion) exposure (mg/(kg d));
D_d = Dose due to dermal exposure (mg/(kg d));
SF_o = Slope Factor for oral exposure $(mg/(kg\ d))^{-1}$;
SF_d = Slope Factor for dermal exposure $(mg/(kg\ d))^{-1}$ (assumed equal to SF_o).

The doses or intakes for the different pathways of exposure are presented in Chapter 4 and the slope factor for arsenic used in this assessment is presented in Chapter 5. The calculated risk is then compared to acceptable benchmarks. In this assessment, a risk level of 1×10^{-5} (1 in 100,000) was used to assess carcinogenic effects. Health Canada considers this value to represent an “essentially negligible” risk. Risk levels for child receptors are generally not calculated since the exposure of a child is not sufficient for carcinogenic effects to be observed. In this case, a composite receptor is assessed. This composite receptor encompasses the exposure of a child being on the site for 10 years and the exposure of this child as an adult for another 60 years. In simple terms, the assessment considers that someone would visit the site throughout their lifetime from child to an adult.

6.4.1 Chronic (Non-carcinogenic) Effects

Estimated doses (exposures) for the human receptors were presented in Section 4.4. Estimated doses (exposures) were divided by the TRVs, presented in Section 5.4, to calculate the hazard quotients (HQ).

Table 6.4-1 summarizes the results for Camper 1 and Table 6.4-2 summarizes the results for Camper 2. **Bold and shaded** values indicate that the hazard quotient exceeds a value of 0.5 selected for this assessment.

Table 6.4-1 Hazard Quotient Values for Camper 1 - Background

Camper 1 Background	Hazard Quotient								
	Toddler			Child			Adult		
	Ingestion	Dermal	Total	Ingestion	Dermal	Total	Ingestion	Dermal	Total
Arsenic	-	-	-	-	-	-	-	-	-
Boron	0.03	<0.001	0.03	0.02	<0.001	0.02	0.03	<0.001	0.03
Cadmium	0.14	<0.001	0.14	0.1	<0.001	0.1	0.07	<0.001	0.07
Copper	0.15	<0.001	0.15	0.11	<0.001	0.11	0.07	<0.001	0.07
Lead	**0.76**	<0.001	**0.76**	**0.54**	<0.001	**0.54**	0.35	<0.001	0.35
Manganese	0.09	<0.001	0.09	0.07	<0.001	0.07	0.05	<0.001	0.05
Selenium	0.3	<0.001	0.3	0.22	<0.001	0.22	0.15	<0.001	0.15
Strontium	0.03	<0.001	0.03	0.02	<0.001	0.02	0.02	<0.001	0.02
Tin	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	0.23	<0.001	0.23	0.17	<0.001	0.17	0.11	<0.001	0.11

Note: Values in **bold and shade** exceed a hazard quotient of 0.5.

Table 6.4-2 Hazard Quotient Values for Camper 2 – Mine Site

Camper 2 Mine	Hazard Quotient								
	Toddler			Child			Adult		
	Ingestion	Dermal	Total	Ingestion	Dermal	Total	Ingestion	Dermal	Total
Arsenic	-	-	-	-	-	-	-	-	-
Boron	0.03	<0.001	0.03	0.03	<0.001	0.03	0.02	<0.001	0.02
Cadmium	**1.05**	<0.001	**1.05**	**0.75**	<0.001	**0.75**	0.48	<0.001	0.48
Copper	0.09	<0.001	0.09	0.07	<0.001	0.07	0.05	<0.001	0.05
Lead	0.1	<0.001	0.1	0.06	<0.001	0.06	0.05	<0.001	0.05
Manganese	0.17	0.01	0.17	0.1	0.01	0.1	0.06	<0.001	0.06
Selenium	0.28	<0.001	0.28	0.21	<0.001	0.21	0.14	<0.001	0.14
Strontium	0.02	<0.001	0.02	0.02	<0.001	0.02	0.01	<0.001	0.01
Tin	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.01	<0.001	0.01
Zinc	0.08	<0.001	0.08	0.06	<0.001	0.06	0.04	<0.001	0.04

Note: Values in **bold and shade** exceed a hazard quotient of 0.5.

As seen from the tables above, the predicted hazard quotient values for Camper 1 (toddler and childe) for lead exceed the benchmark value of 0.5. The Camper 1 is assessed at background locations and the intake of lead is largely (~95%) due to the ingestion of moose. Moose concentrations for the Campe 1 are represented by Yukon background concentrations. .

The toddler and child Camper 2 have predicted hazard quotient values for cadmium that exceed the benchmark value of 0.5. This is due to the ingestion of squirrels at measured concentrations from the site. Measured concentrations for squirrel were available for liver and kidney only (not muscle) and concentrations in these organs were conservatively assumed to represent the concentrations in muscle. It is known that cadmium accumulates in the liver and kidneys, so it is not unusual that high levels of cadmium would be found in the liver and kidneys of the squirrel. This is likely an overestimate of exposure. Hazard quotients calculated for the remaining COPC do not indicate a concern for human receptors under the assumptions considered in this assessment.

6.4.2 Carcinogenic Effects of Arsenic

Arsenic is the carcinogenic COPC identified at the Mt. Nansen mine site. The intakes for the different pathways of exposure for carcinogens (Table 4.4-1 and 4.4-2) are combined with the slope factor for arsenic presented in Section 5.4. It should be noted that these risks represent total risks and not incremental risks as background exposures are also included in the calculations. Thus the comparison to the Health Canada “essentially negligible” incremental risk level of 1×10^{-5} (i.e. 1 in 100,000) is not appropriate.

Table 6.4-3 shows the risk levels for arsenic calculated for the adult and composite receptors for the Camper 1 and Camper 2 scenarios considered in the assessment. A composite person is used to capture the exposure from being resident in the local area over a lifetime (75 years of exposure) spanning the childhood and adult years. The use of the composite receptor provides a cautious estimate of the risk due to arsenic exposure as it considers that individuals go to the site from childhood through adulthood. Baseline exposures are not separated in these calculations, so the risks presented are total risks and not incremental values.

Table 6.4-3 Predicted Total Risks for Human Receptors Using the Mt. Nansen Site

Receptors	Incremental Risk for Arsenic - Adult	Incremental Risk for Arsenic - Composite
Camper 1	3.41×10^{-4}	4.42×10^{-4}
Camper 2	5.09×10^{-4}	6.79×10^{-4}

As seen in the above table, baseline risks for the composite Camper 1 are 4.4×10^{-4} and for Camper 2 at the mine site are 6.8×10^{-4}. Water ingestion dominates the exposure for Camper 1 and water ingestion, followed by fish and soil ingestion, dominates the exposure for Camper 2.

Water concentrations are at background levels for both Camper 1 and Camper 2. Therefore maximum concentrations of fish and soil dominate the exposure. It has been assumed that Camper 2 is exposed to the maximum concentration of arsenic in soil for 1.5 months of the year every year for a lifetime and that he/she consumes the maximum concentration of arsenic in fish six months of the year for a lifetime. This results in an overestimate of exposures and risks. If an average concentration of arsenic in soil and fish are used, the risks for the camper receptor are around 4×10^{-4} which are close to background concentrations.

Therefore, given that the risk calculated due to arsenic exposure at the Mt. Nansen site are essentially baseline risks, it can thus be reasonably concluded that there will be no adverse effects from exposure to arsenic at the Mt. Nansen site.

6.5 UNCERTAINTY

Many areas of uncertainty attend a risk assessment. This is due to the fact that assumptions have to be made throughout the assessment either due to data gaps, environmental fate complexities or in the generalization of receptor characteristics. To be able to place a level of confidence in the results, an accounting of the uncertainty, the magnitude and type of which are important in determining the significance of the results, must be completed. In recognition of these uncertainties, some conservative assumptions are used throughout the assessment to ensure that the potential for an adverse effect would not be underestimated. Several of the major assumptions are outlined below.

The measured COPC concentrations used in the assessment were based on data on the aquatic and terrestrial environments provided by EDI. Site-specific transfer factors and literature values were used in the absence of site data for aquatic vegetation and benthic invertebrates. There is some uncertainty involved in the use of these transfer factors to predict concentrations in environmental media. Additionally, there is uncertainty in applying site-specific water-to-sediment distribution coefficients developed from Dome Creek, Pony Creek and Victoria Creek to the sediment material in the Tailings Pond and Brown-McDade Pit, since it is likely that the sediment material is different in these waterbodies.

Reasonable maximum concentrations were used in the assessment which tend to overestimate exposures for terrestrial ecological receptors and humans since they are mobile and will not be exposed to maximum concentrations.

The characteristics (food, water and soil consumption) of ecological receptors were obtained from the literature. These values are generally obtained from animals in captivity and may not be fully representative of free-range animals in the wild. An underestimate of exposure might result from this but there are other conservative assumptions that may compensate (e.g. time spent in area exposed to the highest level of contamination).

Similarly, the Yukon dietary survey (Receveur *et al* 1998) was used to characterize the exposure to humans. This survey is based on a 24-hour recall. The use of a 24-hour recall may overestimate exposures for some food items and underestimate exposures for other food items.

Toxicity reference values for the COPC are obtained from reputable sources (e.g., Health Canada, U.S. DOE and U.S. EPA); however, some assumptions are made in the absence of available data. For aquatic species, toxicity reference values for indicator species that were most similar to the receptor species were used. Given that no adequate toxicological database is available that determines the concentrations of COPC that cause adverse effects in all terrestrial ecological species, toxicity data from laboratory species such as rats and mice were used and scaled to the appropriate terrestrial receptor. Additionally, for terrestrial mammals and birds, toxicity information for a chemical was used regardless of its form in the test procedure, even though this may not be the same form used in the assessment (e.g., an oxide form compared to a more soluble form). It is hard to determine the effect of these assumptions. Only COPC with available toxicity data were considered in the assessment, because toxicity data is a necessary component for quantifying risk.

Another area of uncertainty is the use of a single value for toxicity. The slope factor is selected to be very protective. The slope factor for arsenic used in the human health assessment represent risks from upper bound (95th percentile) dose-response estimates. The reference doses represent an exposure day-after-day for a lifetime. The use of an upper bound for the toxicity values ensures that the risk to humans is not underestimated.

It is currently not possible or practical to develop approaches to evaluate the validity of the toxicity benchmark assumptions on the overall assessment. As improvements occur in toxicological/human health research and assessments, the uncertainties may be reduced. However, given that the predicted impacts are not significant, it is not anticipated that these improvements would change the overall conclusions of the assessment.

The amount of Labrador tea (leaves and stems) used to brew medicinal tea and the amount of tea consumed was assumed as the Yukon dietary survey (Receveur *et al.* 1998) did not provide this information. This leads to uncertainty in the assessment. As the consumption of Labrador tea only represented a small fraction (< 6%) of the intake for most of the COPC it is unlikely that the uncertainty in the consumption of Labrador tea would change the results of the assessment.

It was assumed that the concentrations of COPC in the livers and kidneys of squirrels were representative of the whole body concentrations. Concentrations of COPC in organs are generally higher than in whole body samples. This would lead to an over-estimate of exposure.

In the risk assessment it has been assumed that humans only consume animal (i.e. caribou, moose, porcupine, hare, grouse) flesh (i.e. muscle). A sensitivity analysis was carried out to determine the effect of consumption of moose and caribou organs on the intakes of COPC under the Camper 2 scenario. The Yukon dietary survey (Receveur *et al* 1998) indicates that about 5 % of the population consumes caribou liver or kidneys 0.2 to 0.3 days a week and 25 % of the population consumes moose liver and kidneys 0.3 to 0.4 days per week. It has been assumed that only adults consume the organs.

There is little information provided on how much organ meat an individual may consume. From the dietary survey, it was reported that 1 individual consumed 112g of moose liver. This is about ½ a moose meat portion and about the same portion of someone consuming dry moose meat. Therefore, for the purposes of the sensitivity analysis, it was assumed that people would consume about 112 g of liver or kidneys at a sitting. Using the maximum measured concentrations of COPC provided in Table 2.3-11 results in the following intakes of COPC as presented in Table 6.5-1. In the assessment it is assumed that individuals consume both 112 g/d moose liver and kidney meat 0.35 days per week and caribou liver and kidney meat 0.25 days per week over the course of a year. This is a conservative assumption as it is unlikely that individuals would consume both moose and caribou organs during the same week. The table also provides a comparison with the predicted intakes from the other dietary pathways.

From Table 6.5-1 it can be seen that, with the exception of cadmium and copper, the intake of COPC through the ingestion of moose and caribou kidney and livers is less than the ingestion of COPC through other ingestion routes. For cadmium, the intake from moose kidney is comparable to the intake through other ingestion pathways. For copper, the intake from moose liver is greater than the intake through other ingestion pathways. . It is known that cadmium accumulates in the liver and kidneys so that it is not unusual that high levels of cadmium would be found in the kidneys of moose. Therefore, consumption of moose kidneys should only occur on an occasional basis.

Table 6.5-1 Predicted Intakes for Human Receptors Considering Moose and Caribou Organs – Camper 2 Adult

COPC	Ingestion mg/(kg d)					Total Intake mg/(kg d)	
	Moose Kidney	**Moose Liver**	**Caribou Kidney**	**Caribou Liver**	**Other**	**Ingestion**	**Dermal**
Arsenic	$6.97x10^{-8}$	$1.52x10^{-7}$	$8.25x10^{-8}$	$7.83x10^{-8}$	$5.00x10^{-4}$	$5.00x10^{-4}$	$4.70x10^{-6}$
Boron	n/a	n/a	n/a	n/a	$3.15x10^{-4}$	$3.15x10^{-4}$	$5.15x10^{-7}$
Cadmium	$2.08x10^{-4}$	$7.42x10^{-5}$	$5.44x10^{-5}$	$4.51x10^{-5}$	$3.78x10^{-4}$	$7.60x10^{-4}$	$2.76x10^{-7}$
Copper	$2.92x10^{-5}$	$2.14x10^{-3}$	$4.23x10^{-5}$	$5.10x10^{-4}$	$1.21x10^{-3}$	$3.93x10^{-3}$	$3.33x10^{-6}$
Lead	$5.22x10^{-8}$	$7.59x10^{-8}$	$4.67x10^{-7}$	$3.12x10^{-7}$	$1.48x10^{-4}$	$1.49x10^{-4}$	$2.34x10^{-7}$
Manganese	$1.61x10^{-5}$	$3.25x10^{-5}$	$1.40x10^{-5}$	$3.49x10^{-5}$	$7.68x10^{-3}$	$7.78x10^{-3}$	$2.99x10^{-4}$
Selenium	$6.62x10^{-6}$	$1.06x10^{-5}$	$4.33x10^{-6}$	$3.42x10^{-6}$	$6.99x10^{-4}$	$7.24x10^{-4}$	$1.21x10^{-9}$
Strontium	$1.28x10^{-6}$	$6.58x10^{-7}$	$2.27x10^{-7}$	$1.32x10^{-6}$	$5.60x10^{-3}$	$5.60x10^{-3}$	$4.54x10^{-6}$
Tin	n/a	n/a	n/a	n/a	$8.81x10^{-4}$	$8.81x10^{-4}$	$1.82x10^{-7}$
Zinc	$2.31x10^{-4}$	$2.62x10^{-4}$	$2.08x10^{-4}$	$3.09x10^{-4}$	$1.94x10^{-2}$	$2.04x10^{-2}$	$1.53x10^{-6}$

Table 6.5-2 Percentage of Intakes for Human Receptors Considering Moose and Caribou Organs – Camper 2 Adult

COPC	Ingestion for Adult					Total Intake	
	Moose Kidney	**Moose Liver**	**Caribou Kidney**	**Caribou Liver**	**Other**	**Ingestion**	**Dermal**
Arsenic	0%	0%	0%	0%	99%	99%	1%
Boron	n/a	n/a	n/a	n/a	100%	100%	0%
Cadmium	27%	10%	7%	6%	50%	100%	0%
Copper	1%	54%	1%	13%	31%	100%	0%
Lead	0%	0%	0%	0%	99%	100%	0%
Manganese	0%	0%	0%	0%	95%	96%	4%
Selenium	1%	1%	1%	0%	97%	100%	0%
Strontium	0%	0%	0%	0%	100%	100%	0%
Tin	n/a	n/a	n/a	n/a	100%	100%	0%
Zinc	1%	1%	1%	2%	95%	100%	0%

As seen from Table 6.5-2, the contribution from the organs to the total intake from other dietary pathways are between 0% and 2 % for arsenic, lead, manganese, selenium, strontium, and zinc. For cadmium, the intakes of organs account for about 50% of the intake and this is mainly due to the consumption of moose kidney. Copper concentrations in organs account for about 70% of the intake and are mainly due to the consumption of moose livers.

The effect of consideration of moose and caribou organ consumption in the risk characterization step is summarized in Table 6.5-3. As seen from this table, with the exception of cadmium exposure, consideration of organ consumption does not materially alter the risk assessment.

Table 6.5-3 Comparison of Hazard Quotients With and Without Organ Consumption – Camper 2 Adult

COPC	Hazard Quotient for Adult	
	With Organ Consumption	Without Organ Consumption
Arsenic	-	-
Boron	0.02	0.02
Cadmium	**0.96**	0.48
Copper	0.14	0.05
Lead	0.05	0.05
Manganese	0.06	0.06
Selenium	0.15	0.14
Strontium	0.01	0.01
Tin	0.01	0.01
Zinc	0.04	0.04

Another area of uncertainty in the risk assessment is the effect of multiple COPC. When dealing with toxic chemicals, there is potential interaction with other chemicals that may be found at the same location. It is well established that synergism, potentiation, antagonism or additivity of toxic effects occurs in the environment. A quantitative assessment of these interactions is outside the scope of this study and, in any event, would be constrained, as there is not an adequate base of toxicological evidence to quantify these interactions. This may result in an underestimate of the risk for some COPC.

Measured levels of some COPC were not available in all environmental media, specifically boron, strontium, and tin in moose and caribou; all COPC in squirrel from background locations; all COPC in fungi from background, Tailings Site, and Brown-McDade Pit; and all COPC in evergreen from background. This leads to an underestimate of the risk for some COPC and receptors.

Table 6.5-4 provides a summary of the uncertainties discussed above. It can be seen from the table, that in general the uncertainties lead to an over-estimate of exposures and thus the conclusions of the assessment would remain unchanged.

Table 6.5-4 Summary of Uncertainties in the Assessment

Uncertainty	Leads to Overestimate	Leads to Underestimate	Neither Overestimate or Underestimate
Use of Site-Specific and Literature-based Transfer Factors to estimate concentrations in sediments, benthic invertebrates and aquatic vegetation	X		
Use of maximum concentrations to characterize exposures	X		
Use of literature characteristics for ecological receptors		X	
Use of literature characteristics for human receptors	X	X	
Toxicity reference values for ecological receptors			X
Single value for toxicity for human receptors	X		
Assumption for the consumption of Labrador tea			X
Concentrations in liver and kidney assumed to represent muscle in porcupine	X		
Consumption of muscle vs. organs			X
Synergism, potentiation, antagonism, additivity of toxic effects		X	
Absence of data		X	

7.0 SUMMARY AND CONCLUSIONS

The Mt. Nansen Mine site, a former gold mine, is located about 60 km west of Carmacks and 180 km north of Whitehorse, Yukon Territory. Currently, the site is comprised of an old mill site with nearby low-grade ore stockpile, an accumulation of water in the Brown-McDade Pit, and a tailings pond and containment system. Upland areas that transition to high standing outcrops dominate the surrounding area. The area is used by the Little Salmon Carmacks First Nation (LSCFN) and the general Yukon community for subsistence and recreational purposes.

The Assessment and Abandoned Mines Branch of the Yukon Government commissioned SENES Consultants Limited to carry out a Preliminary Quantitative Risk Assessment (PQRA) ecological and human health risk assessment for the Mt. Nansen Mine site to support the remediation planning process. The assessment considered the effects of measured chemical levels in the aquatic and terrestrial environment at the site.

The assessment included the following elements which are proposed and readily accepted by regulatory agencies such as Environment Canada and the U.S. EPA:

- receptor characterization;
- exposure assessment;
- hazard assessment; and
- risk characterization.

The COPC identified for the risk assessment included: chloride, sulphate, ammonia, cyanate, thiocyanate, antimony, arsenic, barium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, selenium, silver, strontium, vanadium, and zinc in the aquatic environment. COPC identified for the terrestrial environment included: arsenic, boron, cadmium, copper, lead, manganese, selenium, strontium, tin, and zinc.

For the ecological risk assessment, a range of ecological receptors were examined from different trophic levels in the aquatic and terrestrial environments. The results of the ERA showed that:

- Levels of COPC in the water columns of Dome Creek, Pony Creek, and Victoria Creek exceed applicable CCME water quality guidelines for the protection of aquatic life and/or CCME community water supply guidelines for sulphate, unionized ammonia, antimony, arsenic, cadmium, copper, iron, lead, manganese, selenium, silver, and zinc;
- Comparison of measured COPC concentrations in sediment with sediment toxicity benchmarks indicates the potential for adverse effects in benthic organisms in Dome

Creek and Pony Creek, and these results are supported by benthic invertebrate community sampling completed by EDI;

- The risk assessment for the aquatic receptors demonstrated that Dome Creek and Pony Creek are influenced by mining activities and may result in adverse effects in aquatic receptors in the food chain; however, biological surveys indicate that these two waterbodies may not be ideal habitat for aquatic receptors. In Victoria Creek there is very little evidence of the influence of mining activities at the Mt. Nansen site;
- For terrestrial ecological receptors, concentrations of COPC in the terrestrial environment will not result in adverse effects for ecological receptors with a terrestrial based diet. There are some elevated concentrations of copper in the Tailings Pond. Copper and zinc in Dome Creek, the Tailings Pond, Brown-McDade Pit and zinc concentrations in Pony Creek have the potential to adversely affect individual waterfowl under the conservative assumptions considered in this assessment. However, populations of waterfowl are unlikely to experience adverse effects.

For the human health assessment, a number of hypothetical individuals (toddler, child, adult) were considered to use the site for the gathering of berries, trapping, hunting, and fishing; therefore, it was considered that individuals would be on site for only 1.5 months per year during these activities with consumption of food items from the site over a 6 month period. For comparison, it was assumed that individuals would also be present at the background/reference area for 1.5 months per year for the same activities, with consumption of food items from the reference location for 6 months of the year. The results of the HHRA showed that:

- While cadmium concentrations indicated a potential for an adverse effect due to the consumption of squirrel, the assumption in the assessment was that the cadmium concentrations in liver and kidney were the same as squirrel flesh. It is well known that cadmium accumulates in the organs of various species. If average cadmium concentrations are used no potential adverse effects are predicted. Therefore, there are no adverse effects from exposure to non-carcinogenic COPC at the Mt. Nansen site.
- The risk calculated due to arsenic exposure at the Mt. Nansen site are essentially baseline risks, it can thus be reasonably concluded that there will be no adverse effects from exposure to arsenic at the Mt. Nansen site.

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APPENDIX A

SELECTION OF COPC

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APPENDIX A: SELECTION OF CHEMICALS OF POTENTIAL CONCERN

A selection process was performed to identify chemicals of potential concern (COPC) at the Mt. Nansen Mine. The following sections describe the process followed for the selection of chemicals of concern.

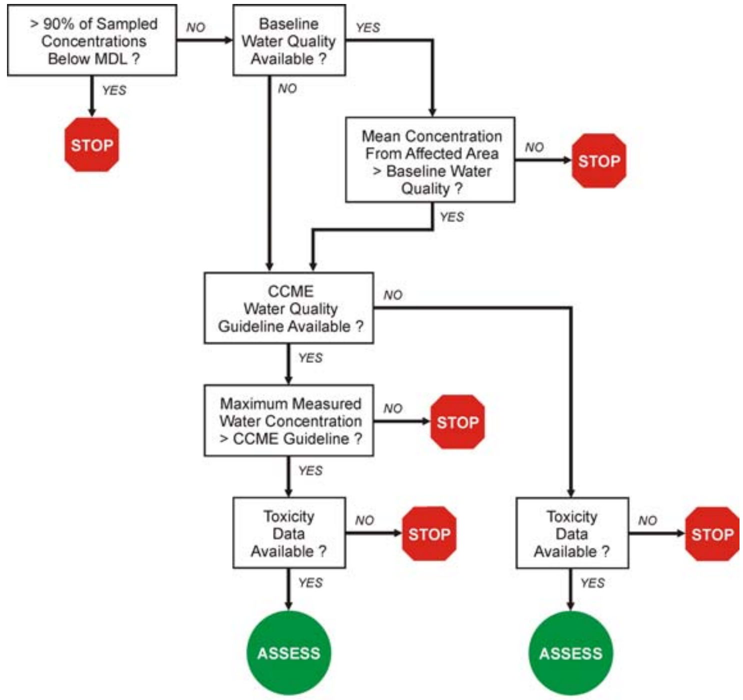
The 45 chemicals that were considered for this assessment include: aluminum (Al), antimony (Sb), arsenic (As), barium (Ba), beryllium (Be), bismuth (Bi), boron (B), cadmium (Cd), calcium (ca), chromium (Cr), cobalt (Co), copper (Cu), iron (Fe), lead (Pb), lithium (Li), magnesium (Mg), manganese (Mn), mercury (Hg), molybdenum (Mo), nickel (Ni), phosphorus (P), potassium (K), selenium (Se), silicon (Si), silver (Ag), sodium (Na), strontium (Sr), sulphur (S), tellurium (Te), thallium (Tl), tin (Sn), titanium (Ti), uranium (U), vanadium (V), zinc (Zn) and zirconium (Zr) plus the cyanide compounds total cyanide, cyanate, thiocyanate, CN-WAD, and CN-SAD and the routine parameters and nutrients chloride, sulphate, ammonia and nitrate.

Hydrocarbon and volatile organic compound (VOC) data were not available for the receiving environment as these have never been identified as a significant issue at the site. There is past evidence of very localized soil staining, however, it has never been considered as a general site problem with the potential to impact the larger area or receiving environment. All unused or waste containerized products have been removed and fuel containment has not been an issue under government care. The historic site spills are believed to have been cleaned up around the time they occurred. There is no reason to believe that the tailings would be impacted with hydrocarbons, as they are a mill process waste and with the exception of lubricants in the machinery, there is no process function that would input hydrocarbons. Additionally, there have been no spills to warrant the testing of water or sediments for hydrocarbons. Therefore, hydrocarbons and VOCs were not considered in the selection of COPCs for the risk assessment.

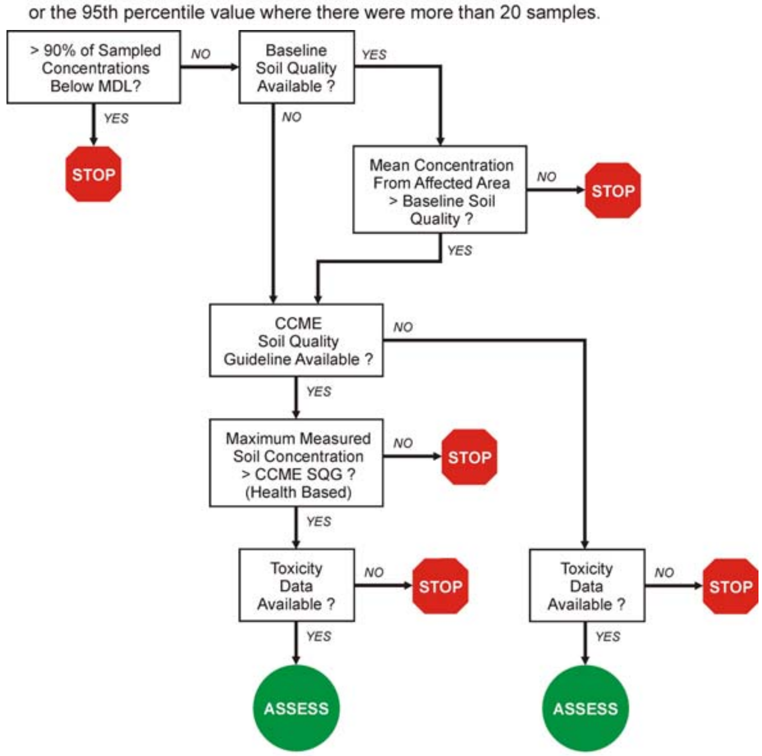
A.1 SELECTION PROCESS

A selection process for chemicals in water and soil (see Figure A.1-1) was used to identify the COPC for the risk assessment and follows the general methodology outlined in Health Canada's Guidance on Human Health Preliminary Quantitative Risk Assessment (2004). Measured concentrations in sediment and vegetation were also considered as part of a secondary screening process to ensure that all potential COPCs were identified for the aquatic and terrestrial environments.

Figure A.1-1 Selection Procedure for Chemicals of Potential Concern



Note:
Maximum is either the absolute maximum measured value or the 95th percentile value where there were more than 20 samples.



Note:
Maximum is either the absolute maximum measured value or the 95th percentile value where there were more than 20 samples.

In general, the COPC selection process for surface water and soil involved four steps:

Step 1 – Chemicals with more than 90% of sampled concentrations from the affected area reported as below method detection limit (MDL) were considered as heavily censored and were not considered further. Measurements reported as below the MDL were assumed to be at half of the MDL.

Step 2 – Concentrations in the affected areas were compared to concentrations obtained from reference sites. If the mean concentration from the affected area was higher than the reference mean, then the chemical was indicated as being higher than reference concentration and was kept for further assessment. Otherwise the chemical was not considered further.

Step 3 – The chemicals identified to have higher concentrations in the affected area than those at reference sites (i.e. from Step 2) were then compared to the appropriate screening criteria (e.g., the CCME guidelines for fresh water and soil). For chemicals with at least 20 site measurements, the 95th percentile was compared to the screening criteria. For chemicals with less than 20 site measurements, the maximum was used instead. Chemicals with concentrations not higher than the screening criteria were dropped from further assessment.

Step 4 – The chemicals identified in Step 3 were then checked to see if corresponding toxicity data were available. Chemicals without appropriate toxicity data were not assessed further since there was no means of quantifying risks.

The screening process in the surface water and soil is the general methodology used to select COPC for the risk assessment. However, the screening for the sediment and vegetation samples was carried out only to identify chemicals that were possibly not selected in the general screening process. A slightly different methodology was used in this case. Samples were still compared to background; however only chemicals with sediment quality criteria or reported phytotoxic levels were considered further to select additional COPC. If no sediment quality guidelines or phytotoxic levels were available, then these chemicals were not considered further. A chemical in the affected area above background concentrations and above sediment quality criteria or reported phytotoxic levels was selected as an additional COPC; otherwise, the chemical was not considered further.

The following sections discuss the selection results, using the above methodology, for the different environmental media including surface water and sediment in the aquatic environment (in Dome Creek, Pony Creek and Victoria Creek) and soil and vegetation in the terrestrial environment (at the Mill Site, Tailings Site, and Brown-McDade Pit).

A.2 AQUATIC ENVIRONMENT

Measured concentrations were available for surface water and sediments in Dome Creek, Pony Creek and Victoria Creek. Reference concentrations were also available for surface water and sediment in the vicinity of the site, but outside of the potential for effects from the Mt. Nansen Mine or other placer operations.

A.2.1 Surface Water Quality Data

The total metals concentrations in surface water measured at the Mt. Nansen Mine between January 1999 and November 2008 were used in the assessment. Dome Creek (sampling locations Dome-X, Dome 1, Dome 2, Dome 3, Upper Dome, Dome @ Road), Pony Creek (Pony D/S, Back Creek), and Victoria Creek (Upper Victoria Creek and Victoria Creek @ Road) were assessed separately. Measurements from reference sampling locations Victoria Creek Reference and Dry Creek were used to determine the background concentrations. The reference sites were established based on information provided in the EDI 2007 document entitled "*Mount Nansen Terrestrial and Aquatic Effects Study 2005-2006*". Reference locations were sampled in 2007 and 2008. Measured concentrations from sampling locations at the Tailings Pond, Seep, and Brown-McDade Pit were not considered for the screening process.

Due to concerns regarding high detection limits in surface water data prior to November 2007, a separate assessment was completed to evaluate the selection of COPC using post-November 2007 data only. A number of COPC (i.e., antimony, arsenic, cadmium, selenium, silver, and vanadium) identified using the entire dataset would not be selected with the reduced dataset. Therefore, it was determined to use the entire dataset (including data prior to November 2007) for the surface water screening in order to represent a more conservative process. However, chromium was identified as a COPC using the reduced dataset, but was not identified through the entire dataset screening. Therefore, chromium is added as a COPC in water (Section A.4).

<u>*Dome Creek*</u>

Table A.2-1 provides a summary of the data set and selection process for Dome Creek based on 258 samples. As seen from Table A.2-1, beryllium, bismuth, molybdenum, thallium, and tin were dropped from the selection process because more than 90% of the measurements were below the MDL. In the case of thallium in Dome Creek, there were several detection limits; for the 2005 to 2007 sampling programs the detection limit was 0.2 mg/L which is above the CCME guideline of 0.0008 mg/L and there is an instance where the detection limit is 1.0 mg/L; however, in the 2008 sampling campaign, the detection limits for thallium were 0.0001 mg/L and in most instances 0.00005 mg/L, these detection limits are appropriate to use in comparison to the CCME guideline. Of the 2008 sampling, the maximum measured concentration of thallium was 0.00015 mg/L which is below the CCME guideline therefore thallium would not be considered to be a COPC. The mean concentration that is above the CCME guidelines is driven by the use of ½ MDL for the higher detection limits of 1.0 mg/L and 0.4 mg/L.

The second step involved a comparison of the affected areas to reference locations. The mean concentrations measured from Dome Creek were compared to the mean concentrations measured at the reference sites for the chemicals with concentrations above the MDL. The reference concentrations were measured at stations that were not affected by mining activities. No chemicals in Dome Creek were found to be below reference concentrations.

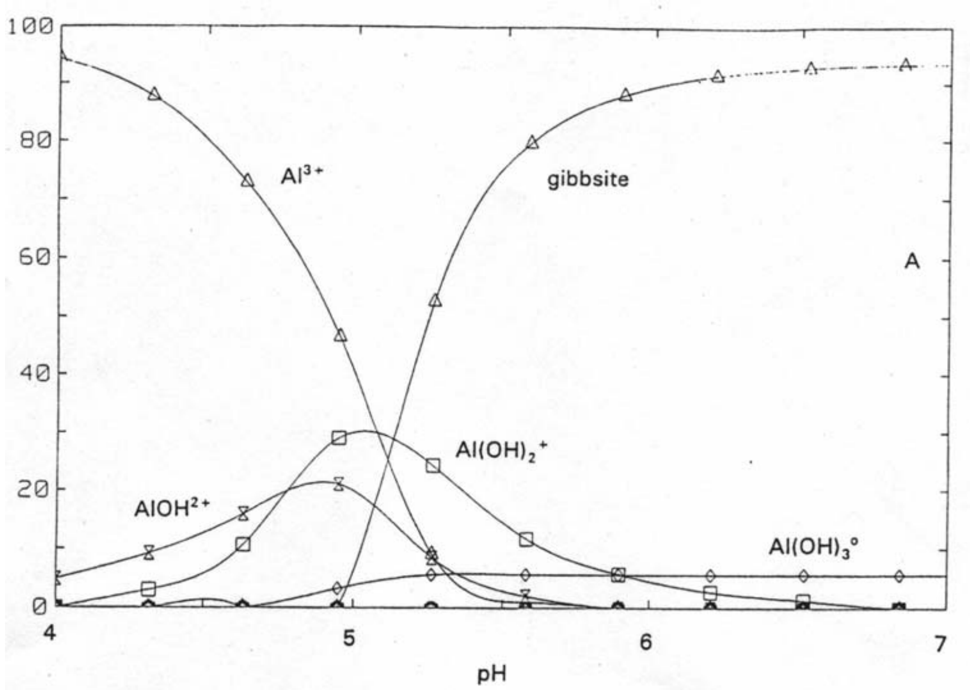
The next step involved the comparison of the measured concentrations of the remaining chemicals to CCME guidelines (CCME 2007) for the protection of aquatic life. Nitrate, chromium, nickel and uranium were dropped in this step. For uranium, the comparison was done to the CCME drinking water guideline of 20 µg/L since the CCME does not provide a guideline for the protection of aquatic life. The use of the drinking water guideline was considered to be reasonable as Saskatchewan has developed an aquatic life guideline of 15 µg/L; thus these values are very similar and would result in the protection of aquatic life. Uranium concentrations were below this value and were not considered further. Aquatic toxicity data are not available for total cyanide, CN-WAD, CN-SAD, calcium, lithium, magnesium, potassium, silicon, sodium, sulphur, and titanium and thus they are dropped from further consideration.

Overall, the chemicals in Dome Creek that satisfied the conditions in all of the four selection steps were chloride, sulphate, ammonia, cyanate, thiocyanate, aluminum, antimony, arsenic, barium, boron, cadmium, cobalt, copper, iron, lead, manganese, selenium, silver, strontium, vanadium, and zinc. In natural environments, aluminum is complexed by both inorganic and organic ligands. Below pH 6, organic complexes and the hydrated free ion tend to be the principal forms. As seen in Figure A.2-1, at higher pH, the dissolved species are only a small fraction of the total aluminum present (Gensmer and Playle 1999). Thus, at pH values between 5.5 and 9, there is very little aluminium that is in true solution and available for uptake by biological species. The pH in the water of Dome Creek typically measures between 6.6 and 8.4 pH units, thus it is not expected that aluminium is in solution to exert a toxic effect and it is dropped from further assessment.

Therefore, the chemicals considered as COPC and carried through in the risk assessment include chloride, sulphate, ammonia, cyanate, thiocyanate, antimony, arsenic, barium, boron, cadmium, cobalt, copper, iron, lead, manganese, selenium, silver, strontium, vanadium, and zinc.

EDI (2008) concluded that total cyanide and CN-WAD are no longer found in high concentrations at the sampling locations on the Mt. Nansen Mine. Total cyanide and CN-WAD were not selected through the screening process for Dome Creek, however, thiocyanate and cyanate were identified through the screening process for Dome Creek and will be considered in the risk assessment.

Figure A.2-1 Aluminum Speciation in Water from pH 4 to 7



from Gensmer and Playle (1999).

Pony Creek

Approximately 22 samples were collected for most of the chemicals of interest as shown in Table A.2-2 (sampling location Pony U/S was not considered for the screening procedure). As seen in the table, three chemicals had a significant number of sample concentrations below detection limits and hence they were not considered further. These include bismuth, molybdenum, and tin.

The second step involved a comparison of the affected areas to reference locations. The results of the comparison showed that nitrate, cyanate, thiocyanate, CN-SAD, antimony, beryllium, boron, nickel, potassium, selenium, silver, and thallium at Pony Creek were not higher than the background.

The next step involved the comparison of the measured concentrations of the remaining chemicals to CCME guidelines (CCME 2007) for the protection of aquatic life. Ammonia, chromium and uranium were dropped in this step. For uranium, the comparison was done to the CCME drinking water guideline of 20 µg/L since the CCME does not provide a guideline for the protection of aquatic life. The use of the drinking water guideline was considered to be reasonable as Saskatchewan has developed an aquatic life guideline of 15 µg/L; thus these values are very similar and would result in the protection of aquatic life. Uranium concentrations were below this value and were not considered further. Aquatic toxicity data are not available for CN-WAD, calcium, lithium, magnesium, silicon, sodium, sulphur, and titanium and thus they are dropped from further consideration.

In natural environments, aluminum is complexed by both inorganic and organic ligands. Below pH 6, organic complexes and the hydrated free ion tend to be the principal forms. As seen in Figure A.2-1, at higher pH, the dissolved species are only a small fraction of the total aluminum present (Gensmer and Playle 1999). Thus, at pH values between 5.5 and 9, there is very little aluminium that is in true solution and available for uptake by biological species. The pH in the water of Pony Creek typically measures between 6.9 and 8.2 pH units, thus it is not expected that aluminium is in solution to exert a toxic effect and it is dropped from further assessment.

In summary, the COPC considered from Pony Creek were chloride, sulphate, arsenic, barium, cadmium, cobalt, copper, iron, lead, manganese, strontium, vanadium, and zinc.

Victoria Creek

Approximately 263 samples were collected for most of the chemicals of interest as shown in Table A.2-3. As seen in the table, ten chemicals had a significant number of sample concentrations below detection limits and hence they were not considered further. These include cyanate, antimony, beryllium, bismuth, lithium, molybdenum, selenium, silver, thallium, and tin.

The second step involved a comparison of the affected areas to reference locations. The results of the comparison showed that chloride, total cyanide, thiocyanate, potassium, and zinc at Victoria Creek were not higher than the background.

The next step involved the comparison of the measured concentrations of the remaining chemicals to CCME guidelines (CCME 2007) for the protection of aquatic life. CN-WAD, chromium, nickel, and uranium were dropped in this step. For CN-WAD, the water license standard was used for the comparison. For uranium, the comparison was done to the CCME drinking water guideline of 20 µg/L since the CCME does not provide a guideline for the protection of aquatic life. The use of the drinking water guideline was considered to be reasonable as Saskatchewan has developed an aquatic life guideline of 15 µg/L; thus these values are very similar and would result in the protection of aquatic life. Uranium concentrations were below this value and were not considered further. Aquatic toxicity data are not available for CN-SAD, calcium, magnesium, silicon, sodium, sulphur, and titanium and thus they are dropped from further consideration.

In natural environments, aluminum is complexed by both inorganic and organic ligands. Below pH 6, organic complexes and the hydrated free ion tend to be the principal forms. As seen in Figure A.2-1, at higher pH, the dissolved species are only a small fraction of the total aluminum present (Gensmer and Playle 1999). Thus, at pH values between 5.5 and 9, there is very little aluminium that is in true solution and available for uptake by biological species. The pH in the water of Victoria Creek typically measures between 6.9 and 8.2 pH units, thus it is not expected that aluminium is in solution to exert a toxic effect and it is dropped from further assessment.

In summary, the COPC considered from Victoria Creek were sulphate, arsenic, barium, boron, cadmium, cobalt, copper, iron, lead, manganese, strontium, and vanadium.

Table A.2-1 Selection of Chemicals of Concern in Surface Water in Dome Creek

Routine Params/Nutrients		N	N<MDL	Min	Mean	95th Percentile	Max	Heavily Censored?	Reference Mean	Mean > Reference?	CCME WQ Guideline	Max/95th Percentile > CCME WQ?	Toxicity Data Available?	COPC?
Chloride	mg/L	47	5	0.07	1.02	2.86	3.6	N	0.67	Y	-	-	Y	Y
Sulphate	mg/L	254	0	16.2	449	996.50	3830	N	1.84	Y	-	-	Y	Y
Ammonia-N	mg/L	256	21	0.005	2.06	7.89	46.2	N	0.02	Y	2.2	Y	Y	Y
Nitrate-N	mg/L	244	9	0.0025	0.87	2.84	8	N	0.03	Y	13	N	Y	
Cyanide Compounds														
Cyanide - T	mg/L	135	5	0.0025	0.03	0.06	0.128	N	0.01	Y	-	-		
Cyanate	mg/L	241	154	0.005	2.1	4.6	143	N	0.14	Y	-	-	Y	Y
Thiocyanate	mg/L	240	10	0.025	3.1	6.2	68.7	N	0.98	Y	-	-	Y	Y
CN-WAD	mg/L	249	76	0.0005	0.04	0.06	6.23	N	0.002	Y	-	-		
CN-SAD	mg/L	113	11	0.001	1.1	6.1	24.6	N	0.002	Y	-	-		
Total Metals														
Aluminum	mg/L	258	97	0.005	0.81	3.8	18.3	N	0.22	Y	0.1	Y	Y	N+
Antimony	mg/L	254	200	0.000005	0.06	0.10	0.5	N	0.03	Y	-	-	Y	Y
Arsenic	mg/L	257	138	0.0018	0.08	0.18	0.5	N	0.03	Y	0.005	Y	Y	Y
Barium	mg/L	258	1	0.01	0.07	0.17	0.317	N	0.05	Y	-	-	Y	Y
Beryllium	mg/L	191	190	0.00005	0.002	0.003	0.015	Y	0.001	Y	-	-	Y	
Bismuth	mg/L	217	216	0.00025	0.07	0.10	0.5	Y	0.03	Y	-	-		
Boron	mg/L	198	134	0.001	0.05	0.11	0.57	N	0.01	Y	-	-	Y	Y
Cadmium	mg/L	258	184	0.00001	0.003	0.005	0.025	N	0.001	Y	0.000017	Y	Y	Y
Calcium	mg/L	258	0	12	142	276	1080	N	21.3	Y	-	-		
Chromium	mg/L	258	175	0.00025	0.005	0.0080	0.148	N	0.002	Y	0.0089	N	Y	
Cobalt	mg/L	258	138	0.00005	0.01	0.03	0.073	N	0.001	Y	-	-	Y	Y
Copper	mg/L	258	116	0.001	0.04	0.27	1.1	N	0.003	Y	0.004	Y	Y	Y
Iron	mg/L	258	3	0.04	4.1	12.1	58.4	N	0.39	Y	0.3	Y	Y	Y
Lead	mg/L	258	175	0.00005	0.02	0.03	0.15	N	0.01	Y	0.007	Y	Y	Y
Lithium	mg/L	217	154	0.0005	0.01	0.012	0.025	N	0.002	Y	-	-		

Table A.2-1 Selection of Chemicals of Concern in Surface Water in Dome Creek (Cont'd)

Total Metals		N	N<MDL	Min	Mean	95th Percentile	Max	Heavily Censored?	Reference Mean	Mean > Reference?	CCME WQ Guideline	Max/95th Percentile > CCME WQ?	Toxicity Data Available?	COPC?
Magnesium	mg/L	258	0	3.1	36.6	54.3	176	N	6.4	Y	-	-		
Manganese	mg/L	258	2	0.0025	1.6	5.6	29.7	N	0.02	Y	-	-	Y	Y
Molybdenum	mg/L	258	247	0.000226	0.01	0.02	0.055	Y	0.004	Y	0.073	N	Y	
Nickel	mg/L	258	160	0.00025	0.02	0.025	0.222	N	0.01	Y	0.15	N	Y	
Potassium	mg/L	257	19	0.15	4.3	9.9	40	N	1.2	Y	-	-		
Selenium	mg/L	254	221	0.000005	0.06	0.10	0.5	N	0.03	Y	0.001	Y	Y	Y
Silicon	mg/L	254	0	2.18	6.1	10.7	26.8	N	4.9	Y	-	-		
Silver	mg/L	258	218	0.000005	0.003	0.005	0.03	N	0.001	Y	0.0001	Y	Y	Y
Sodium	mg/L	258	0	0.9	39.7	150	582	N	2.0	Y	-	-		
Strontium	mg/L	258	2	0.01	0.41	0.80	3.06	N	0.15	Y	-	-	Y	Y
Sulphur	mg/L	114	0	5.4	130	295	428	N	3.5	Y	-	-		
Thallium	mg/L	191	184	0.000025	0.08	0.10	0.5	Y	0.03	Y	0.0008	Y		
Tin	mg/L	258	241	0.000005	0.01	0.02	0.079	Y	0.004	Y	-	-	Y	
Titanium	mg/L	253	110	0.0005	0.03	0.16	1.17	N	0.01	Y	-	-		
Uranium	mg/L	50	14	0.00025	0.002	0.004	0.004	N	0.0003	Y	0.02*	N	Y	
Vanadium	mg/L	254	154	0.000005	0.01	0.02	0.1	N	0.005	Y	-	-	Y	Y
Zinc	mg/L	258	4	0.0025	0.06	0.18	1.4	N	0.01	Y	0.03	Y	Y	Y

Note: * - CCME Drinking Water Criteria used for uranium.
+ - dropped due to aluminum speciation considerations.

Table A.2-2 Selection of Chemicals of Concern in Surface Water in Pony Creek

Routine Params/Nutrients		N	N<MDL	Min	Mean	95th Percentile	Max	Heavily Censored?	Reference Mean	Mean > Reference?	CCME WQ Guideline	Max/95th Percentile > CCME WQ?	Toxicity Data Available?	COPC?
Chloride	mg/L	21	3	0.09	0.68	2.40	2.6	N	0.67	Y	-	-	Y	Y
Sulphate	mg/L	21	0	9.41	68.2	129.00	146	N	1.84	Y	-	-	Y	Y
Ammonia-N	mg/L	21	15	0.005	0.02	0.03	0.039	N	0.02	Y	2.2	N	Y	
Nitrate-N	mg/L	21	4	0.005	0.03	0.08	0.1	N	0.03	N	13	N	Y	
Cyanide Compounds														
Cyanide - T	mg/L	0	0	--	--	--	--		0.01		-	-		
Cyanate	mg/L	21	18	0.1	0.11	0.20	0.2	N	0.14	N	-	-	Y	
Thiocyanate	mg/L	21	0	0.4	0.86	1.40	2.1	N	0.98	N	-	-	Y	
CN-WAD	mg/L	21	2	0.001	0.002	0.00	0.004	N	0.002	Y	-	-		
CN-SAD	mg/L	21	11	0.001	0.001	0.00	0.002	N	0.002	N	-	-		
Total Metals														
Aluminum	mg/L	22	0	0.036	2.2	3.21	41.1	N	0.22	Y	0.1	Y	Y	N+
Antimony	mg/L	22	0	0.0002	0.003	0.00	0.0242	N	0.03	N	-	-	Y	
Arsenic	mg/L	22	0	0.0024	0.03	0.24	0.352	N	0.03	Y	0.005	Y	Y	Y
Barium	mg/L	22	0	0.025	0.09	0.10	0.857	N	0.05	Y	-	-	Y	Y
Beryllium	mg/L	22	19	0.00005	0.0001	0.00	0.002	N	0.001	N	-	-	Y	
Bismuth	mg/L	22	20	0.00025	0.0005	0.00	0.003	Y	0.03	N	-	-		
Boron	mg/L	22	9	0.001	0.002	0.00	0.01	N	0.01	N	-	-	Y	
Cadmium	mg/L	22	0	0.00006	0.001	0.0061	0.00624	N	0.001	Y	0.000017	Y	Y	Y
Calcium	mg/L	22	0	10.4	37.4	53.42	55.4	N	21.3	Y	-	-		
Chromium	mg/L	22	10	0.00025	0.003	0.0033	0.0492	N	0.002	Y	0.0089	N	Y	
Cobalt	mg/L	22	4	0.00005	0.002	0.00	0.0294	N	0.0015	Y	-	-	Y	Y
Copper	mg/L	22	0	0.002	0.02	0.09	0.135	N	0.003	Y	0.004	Y	Y	Y
Iron	mg/L	22	1	0.05	3.6	8.28	59.1	N	0.39	Y	0.3	Y	Y	Y
Lead	mg/L	22	0	0.0002	0.02	0.17	0.205	N	0.01	Y	0.007	Y	Y	Y
Lithium	mg/L	22	7	0.0005	0.002	0.00	0.025	N	0.002	Y	-	-		

Table A.2-2 Selection of Chemicals of Concern in Surface Water in Pony Creek (Cont'd)

Total Metals		**N**	**N<MDL**	**Min**	**Mean**	**95th Percentile**	**Max**	**Heavily Censored?**	**Reference Mean**	**Mean > Reference?**	**CCME WQ Guideline**	**Max/95th Percentile > CCME WQ?**	**Toxicity Data Available?**	**COPC?**
Magnesium	mg/L	22	0.00	2.4	8.9	12.00	12.9	N	6.4	Y	-	-		
Manganese	mg/L	22	0	0.011	0.35	0.77	3.03	N	0.02	Y	-	-	Y	Y
Molybdenum	mg/L	22	20	0.0005	0.0007	0.0010	0.005	Y	0.004	N	0.073	N	Y	
Nickel	mg/L	22	4	0.00025	0.002	0.0020	0.032	N	0.01	N	0.15	N	Y	
Potassium	mg/L	22	3	0.2	0.92	1.76	7	N	1.2	N	-	-		
Selenium	mg/L	22	18	0.0001	0.0002	0.0006	0.001	N	0.03	N	0.001	N	Y	
Silicon	mg/L	22	0.00	2.05	7.6	9.84	36.8	N	4.9	Y	-	-		
Silver	mg/L	22	4	0.000005	0.0003	0.0016	0.00287	N	0.001	N	0.0001	Y	Y	
Sodium	mg/L	22	0	1.2	3.7	4.69	4.8	N	2.0	Y	-	-		
Strontium	mg/L	22	0	0.072	0.26	0.36	0.371	N	0.15	Y	-	-	Y	Y
Sulphur	mg/L	22	0	3.7	22.6	41.75	43.3	N	3.5	Y	-	-		
Thallium	mg/L	22	19	0.000025	0.000065	0.00011	0.00075	N	0.03	N	0.0008	N		
Tin	mg/L	22	22	0.0005	0.0005	0.00	0.001	Y	0.004	N	-	-	Y	
Titanium	mg/L	22	1	0.00025	0.07	0.10	1.33	N	0.01	Y	-	-		
Uranium	mg/L	22	11	0.00025	0.0009	0.00	0.0064	N	0.0003	Y	0.02*	N	Y	
Vanadium	mg/L	22	0	0.0001	0.007	0.01	0.125	N	0.005	Y	-	-	Y	Y
Zinc	mg/L	22	0	0.006	0.11	0.42	0.506	N	0.01	Y	0.03	Y	Y	Y

Note: * - CCME Drinking Water Criteria used for uranium.
+ - dropped due to aluminum speciation considerations.

Table A.2-3 Selection of Chemicals of Concern in Surface Water in Victoria Creek

Routine Params/Nutrients		N	N<MDL	Min	Mean	95th Percentile	Max	Heavily Censored?	Reference Mean	Mean > Reference?	CCME WQ Guideline	Max/95th Percentile > CCME WQ?	Toxicity Data Available?	COPC?
Chloride	mg/L	28	4	0.1	0.50	1.2	2.6	N	0.67	N	-	-	Y	
Sulphate	mg/L	262	1	2.13	32.92	95.34	636	N	1.84	Y	-	-	Y	Y
Ammonia-N	mg/L	259	111	0.0025	0.10	0.14	8.3	N	0.02	Y	2.2	N	Y	
Nitrate-N	mg/L	251	14	0.001	0.15	0.47	7.5	N	0.03	Y	13	N	Y	
Cyanide Compounds														
Cyanide - T	mg/L	156	73	0.0025	0.01	0.02	0.064	N	0.01	N	-	-		
Cyanate	mg/L	259	235	0.0025	0.22	0.46	1.5	Y	0.14	Y	-	-	Y	
Thiocyanate	mg/L	257	145	0.015	0.75	2.2	23.9	N	0.98	N	-	-	Y	
CN-WAD	mg/L	262	183	0.0005	0.01	0.01	0.25	N	0.002	Y	-	-		
CN-SAD	mg/L	106	35	0.0005	0.01	0.07	0.389	N	0.002	Y	-	-		
Total Metals														
Aluminum	mg/L	263	129	0.01	0.31	1.1	10.2	N	0.22	Y	0.1	Y	Y	N+
Antimony	mg/L	261	236	0.00005	0.06	0.10	0.2	Y	0.03	Y	-	-	Y	
Arsenic	mg/L	263	193	0.0001	0.06	0.10	0.2	N	0.03	Y	0.005	Y	Y	Y
Barium	mg/L	263	0	0.035	0.08	0.12	0.581	N	0.05	Y	-	-	Y	Y
Beryllium	mg/L	202	200	0.000025	0.002	0.003	0.005	Y	0.001	Y	-	-	Y	
Bismuth	mg/L	232	232	0.000025	0.07	0.10	0.2	Y	0.03	Y	-	-		
Boron	mg/L	204	173	0.001	0.04	0.05	0.1	N	0.01	Y	-	-	Y	
Cadmium	mg/L	263	215	0.000005	0.003	0.01	0.01	N	0.001	Y	0.000017	Y	Y	Y
Calcium	mg/L	263	0	7.3	27.9	40.5	241	N	21.3	Y	-	-		
Chromium	mg/L	263	226	0.000025	0.003	0.005	0.010	N	0.002	Y	0.0089	N	Y	
Cobalt	mg/L	263	223	0.00005	0.003	0.01	0.012	N	0.001	Y	-	-	Y	Y
Copper	mg/L	263	153	0.0005	0.01	0.02	0.066	N	0.003	Y	0.004	Y	Y	Y
Iron	mg/L	263	37	0.015	0.49	1.84	12.1	N	0.39	Y	0.3	Y	Y	Y
Lead	mg/L	263	219	0.000025	0.02	0.03	0.055	N	0.01	Y	0.007	Y	Y	Y
Lithium	mg/L	232	211	0.0005	0.004	0.01	0.023	Y	0.002	Y	-	-		

Table A.2-3 Selection of Chemicals of Concern in Surface Water in Victoria Creek (Cont'd)

Total Metals		N	N<MDL	Min	Mean	95th Percentile	Max	Heavily Censored?	Reference Mean	Mean > Reference?	CCME WQ Guideline	Max/95th Percentile > CCME WQ?	Toxicity Data Available?	COPC?
Magnesium	mg/L	263	0	2.2	9.0	13.1	76.6	N	6.4	Y	-	-		
Manganese	mg/L	263	9	0.0025	0.09	0.18	5.64	N	0.02	Y	-	-	Y	Y
Molybdenum	mg/L	263	260	0.00031	0.01	0.02	0.03	Y	0.004	Y	0.073	N	Y	
Nickel	mg/L	263	217	0.000025	0.02	0.03	0.05	N	0.01	Y	0.15	N	Y	
Potassium	mg/L	263	155	0.1	1.2	2.0	13.3	N	1.2	Y	-	-		
Selenium	mg/L	261	243	0.0001	0.06	0.10	0.2	Y	0.03	Y	0.001	Y	Y	
Silicon	mg/L	261	0	2.39	6.3	8.1	44	N	4.9	Y	-	-		
Silver	mg/L	263	241	0.000005	0.003	0.01	0.011	Y	0.001	Y	0.0001	Y	Y	
Sodium	mg/L	263	29	0.9	4.2	9.0	92.7	N	2.0	Y	-	-		
Strontium	mg/L	263	0	0.079	0.26	0.37	2.28	N	0.15	Y	-	-	Y	Y
Sulphur	mg/L	46	0	1	7.1	10.8	26.5	N	3.5	Y	-	-		
Thallium	mg/L	202	201	0.000025	0.08	0.10	0.2	Y	0.03	Y	0.0008	Y		
Tin	mg/L	262	256	0.00005	0.01	0.02	0.03	Y	0.004	Y	-	-	Y	
Titanium	mg/L	259	168	0.0005	0.01	0.03	0.307	N	0.01	Y	-	-		
Uranium	mg/L	37	21	0.000025	0.0004	0.001	0.0016	N	0.0003	Y	0.02*	N	Y	
Vanadium	mg/L	260	175	0.0002	0.01	0.02	0.03	N	0.005	Y	-	-	Y	Y
Zinc	mg/L	263	133	0.0005	0.01	0.02	0.328	N	0.01	Y	0.03	N	Y	

Note: * - CCME Drinking Water Criteria used for uranium.
+ - dropped due to aluminum speciation considerations.

A.2.2 Sediment Quality Data

The total metals concentrations in sediment measured at the Mt. Nansen Mine between 1988 and 2006 were used in the assessment. Dome Creek (sampling locations D1, D2, D3, D4, D5, D5_1, "at final discharge of tailings dam"), Pony Creek (B1, B1_1, P1, P2, P3), and Victoria Creek (V1, V2, V3, V4, V5) were assessed separately. Measurements from a reference sampling location "upstream of mine development" were used to determine the background concentrations. The three samples from the reference location were collected in 1988.

<u>*Dome Creek*</u>

Approximately 41 samples were collected for most of the chemicals of interest as shown in Table A.2-5. From this dataset it can be seen that boron had more than 90% of the measured concentration below detection limits, and thus was not considered further.

The reference sediment concentrations were measured at a location upstream of the mine site where there would be no influences from mining activities. Aluminum, arsenic, barium, beryllium, cadmium, calcium, chromium, copper, iron, lead, magnesium, manganese, molybdenum, nickel, silicon, sodium, strontium, titanium, vanadium, and zinc were above the reference sediment concentrations. Of these chemicals, only arsenic, cadmium, chromium, copper, lead, nickel, and zinc have CCME Sediment Quality Guidelines. These chemicals were then considered in the screening step.

The screening criteria used for sediment was the CCME ISQG (interim Sediment Quality Guideline) and the PEL (Probable Effects Limit). As seen from Table A.2-5, chromium, copper, and nickel were measured at concentrations above the ISQG but below the PEL and thus were dropped from further consideration.

Only arsenic, cadmium, lead, and zinc were identified from the sediment screening and these were already selected in the water screening process.

<u>*Pony Creek*</u>

Approximately 8 samples were collected for most of the chemicals of interest as shown in Table A.2-6. From this dataset it can be seen that selenium and uranium had more than 90% of the measured concentration below detection limits and were therefore not carried through to the next selection step.

The reference sediment concentrations were measured at a location upstream of the mine site where there would be no influences from mining activities. Aluminum, arsenic, barium, beryllium, cadmium, chromium, copper, iron, lead, magnesium, manganese, nickel, silicon, silver, sodium, strontium, vanadium, and zinc were above the reference sediment concentrations. Of these chemicals, only arsenic, cadmium, copper, lead, and zinc have CCME Sediment Quality Guidelines. These chemicals were then considered in the screening step.

The screening criteria used for sediment was the CCME ISQG (interim Sediment Quality Guideline) and the PEL (Probable Effects Limit). Arsenic, cadmium, copper, lead, and zinc were identified from the sediment screening and these were already selected in the water screening process.

Victoria Creek

Approximately 55 samples were collected for most of the chemicals of interest as shown in Table A.2-7. From this dataset it can be seen that none of the chemicals had more than 90% of the measured concentration below detection limits.

The reference sediment concentrations were measured at a location upstream of the mine site where there would be no influences from mining activities. Aluminum, barium, beryllium, chromium, copper, iron, lead, magnesium, manganese, molybdenum, nickel, phosphorus, silicon, sodium, strontium, titanium, and vanadium were above the reference sediment concentrations. Of these chemicals, only chromium, copper, and lead have CCME Sediment Quality Guidelines. These chemicals were then considered in the screening step.

The screening criteria used for sediment was the CCME ISQG (interim Sediment Quality Guideline) and the PEL (Probable Effects Limit). As seen from Table A.2-7, chromium was measured at concentrations below both the ISQG and the PEL. Copper and lead were measured at concentrations above the ISQG but below the PEL and thus were dropped from further consideration.

Therefore, no chemicals of interest were identified from the sediment screening at Victoria Creek.

Table A.2-4 Selection of Chemicals of Concern in Sediments from Dome Creek

Chemical	Units	N	N<MDL	Min	Mean	95th Percentile	Max	Heavily Censored?	Reference Mean	Mean > Reference?	CCME Sediment Guideline ISQG	CCME Sediment Guideline PEL	Max/95th Percentile > CCME ISQG	Max/95th Percentile > CCME PEL	COPC?
Aluminum	mg/kg	40	0	4680	12437.25	28231	31540	N	12300	Y	-	-	-	-	
Antimony	mg/kg	31	11	0.25	18.85871	70	99.6	N	-	-	-	-	-	-	
Arsenic	mg/kg	41	0	11	569.5683	2500	2760	N	101	Y	5.9	17	Y	Y	Y
Barium	mg/kg	40	0	42	154.4325	411.85	444	N	127	Y	-	-	-	-	
Beryllium	mg/kg	40	9	0.14	0.412	0.81	1	N	0.23	Y	-	-	-	-	
Bismuth	mg/kg	1	1	0.25	0.25	0.25	0.25	Y	-	-	-	-	-	-	
Boron	mg/kg	10	9	0.5	6.75	34.875	63	N	-	-	-	-	-	-	
Cadmium	mg/kg	41	8	0.025	5.988171	26.4	48	N	0.72	Y	0.6	3.5	Y	Y	Y
Calcium	mg/kg	40	0	2520	7591.25	13900	16300	N	5850	Y	-	-	-	-	
Chromium	mg/kg	40	0	8	22.997	54.665	60.4	N	13	Y	37.3	90	Y	N	
Cobalt	mg/kg	41	0	1.9	10.62683	20	29.9	N	20	N	-	-	-	-	
Copper	mg/kg	41	0	5.43	49.57805	157	683	N	11	Y	35.7	197	Y	N	
Iron	mg/kg	40	0	7380	27295.75	52390	88500	N	14133	Y	-	-	-	-	
Lead	mg/kg	41	2	2.5	151.8566	530	1030	N	25.2	Y	35	91.3	Y	Y	Y
Lithium	mg/kg	1	0	6.1	6.1	6.1	6.1	N	-	-	-	-	-	-	
Magnesium	mg/kg	40	0	1860	4055.5	7817	9260	N	2610	Y	-	-	-	-	
Manganese	mg/kg	41	0	88	1952.385	14100	20400	N	331	Y	-	-	-	-	
Mercury	mg/kg	17	8	0.005	0.022118	0.0814	0.207	N	-	-	0.17	0.486	Y	N	
Molybdenum	mg/kg	41	9	0.1	2.813659	9	10	N	2.7	Y	-	-	-	-	
Nickel	mg/kg	41	0	5	12.83024	32	35	N	8	Y	18	35.9	Y	N	
Phosphorus	mg/kg	40	0	420	800.025	1200	1400	N	850	N	-	-	-	-	
Potassium	mg/kg	31	0	324	1901.968	5169	5538	N	-	-	-	-	-	-	
Selenium	mg/kg	31	14	0.1	2.338065	8	8	N	-	-	-	-	-	-	
Silicon	mg/kg	12	0	240	785	1360.5	1410	N	344	Y	-	-	-	-	
Silver	mg/kg	41	15	0.055	1.940854	7	15.7	N	2	N	-	-	-	-	
Sodium	mg/kg	40	0	100	370.025	735.5	2780	N	240	Y	-	-	-	-	
Strontium	mg/kg	40	0	12	38.745	77	77.4	N	29.7	Y	-	-	-	-	
Sulphur	mg/kg	5	0	213	354.2	456.2	465	N	-	-	-	-	-	-	

Table A.2-4 Selection of Chemicals of Concern in Sediments from Dome Creek (Cont'd)

Chemical	Units	N	N<MDL	Min	Mean	95th Percentile	Max	Heavily Censored?	Reference Mean	Mean > Reference?	CCME Sediment Guideline ISQG	CCME Sediment Guideline PEL	Max/95th Percentile > CCME ISQG	Max/95th Percentile > CCME PEL	COPC?
Thallium	mg/kg	1	1	0.15	0.15	0.15	0.15	Y	-	-	-	-	-	-	
Tin	mg/kg	41	9	0.3	5.302683	10	32	N	8	N	-	-	-	-	
Titanium	mg/kg	40	0	172	766.35	2230.8	2310	N	709	Y	-	-	-	-	
Vanadium	mg/kg	41	0	15	54.72683	110	140	N	44	Y	-	-	-	-	
Zinc	mg/kg	41	0	27	600.978	3030	4680	N	111	Y	123	315	Y	Y	Y
Zirconium	mg/kg	22	0	1	2.609091	9.175	15.8	N	-	-	-	-	-	-	

Table A.2-5 Selection of Chemicals of Concern in Sediments from Pony Creek

Chemical	Units	N	N<MDL	Min	Mean	95th Percentile	Max	Heavily Censored?	Reference Mean	Mean > Reference?	CCME Sediment Guideline ISQG	CCME Sediment Guideline PEL	Max/95th Percentile > CCME ISQG	Max/95th Percentile > CCME PEL	COPC?
Aluminum	mg/kg	8	0	6570	17557.5	51425	57900	N	12300	Y	-	-	-	-	
Antimony	mg/kg	8	1	0.8	61.875	233.595	310	N	-	-	-	-	-	-	
Arsenic	mg/kg	8	0	21.5	838.4625	3269	4480	N	101	Y	5.9	17	Y	Y	Y
Barium	mg/kg	8	0	85.4	232.8	576.95	669	N	127	Y	-	-	-	-	
Beryllium	mg/kg	8	0	0.19	0.3625	0.665	0.7	N	0.23	Y	-	-	-	-	
Bismuth	mg/kg	8	5	0.25	9.5125	39.825	54	N	-	-	-	-	-	-	
Boron	mg/kg	0	0	0	-	-	0	N	-	-	-	-	-	-	
Cadmium	mg/kg	8	0	0.3	8.055	28.455	31.5	N	0.72	Y	0.6	3.5	Y	Y	Y
Calcium	mg/kg	8	0	3560	4881.25	8780	10600	N	5850	N	-	-	-	-	
Chromium	mg/kg	8	0	10.4	15.4875	23.375	26.7	N	13	Y	37.3	90	N	N	
Cobalt	mg/kg	8	0	3	6.47375	10.705	11.3	N	20	N	-	-	-	-	
Copper	mg/kg	8	0	7.44	202.805	822.4	1150	N	11	Y	35.7	197	Y	Y	Y
Iron	mg/kg	8	0	14200	37637.5	88360	106000	N	14133	Y	-	-	-	-	
Lead	mg/kg	8	0	12.7	627.6625	2801.65	4090	N	25.2	Y	35	91.3	Y	Y	Y
Lithium	mg/kg	8	0	5.5	9.75	21.36	23.6	N	-	-	-	-	-	-	
Magnesium	mg/kg	8	0	2370	3061.25	5149.5	6420	N	2610	Y	-	-	-	-	
Manganese	mg/kg	8	0	153	1257.25	2877	3360	N	331	Y	-	-	-	-	
Mercury	mg/kg	6	0	0.012	0.047	0.12175	0.136	N	-	-	0.17	0.486	N	N	
Molybdenum	mg/kg	8	2	0.025	0.848125	2.3	3	N	2.7	N	-	-	-	-	
Nickel	mg/kg	8	0	5.97	8.7525	13.645	16.2	N	8	Y	18	35.9	N	N	
Phosphorus	mg/kg	8	0	694	841.75	987.9	990	N	850	N	-	-	-	-	
Potassium	mg/kg	8	0	527	3235.25	12841	17300	N	-	-	-	-	-	-	
Selenium	mg/kg	8	8	0.15	0.3625	1	1	Y	-	-	-	-	-	-	
Silicon	mg/kg	8	0	274	712	2123.05	2990	N	344	Y	-	-	-	-	
Silver	mg/kg	8	0	0.2	15.35	68.73	98.9	N	2	Y	-	-	-	-	
Sodium	mg/kg	8	0	134	394.75	1192.7	1360	N	240	Y	-	-	-	-	
Strontium	mg/kg	8	0	22.1	44.325	84.25	93	N	29.7	Y	-	-	-	-	
Sulphur	mg/kg	2	0	940	11970	21897	23000	N	-	-	-	-	-	-	

Table A.2-5 Selection of Chemicals of Concern in Sediments from Pony Creek (Cont'd)

Chemical	Units	N	N<MDL	Min	Mean	95th Percentile	Max	Heavily Censored?	Reference Mean	Mean > Reference?	CCME Sediment Guideline ISQG	CCME Sediment Guideline PEL	Max/95th Percentile > CCME ISQG	Max/95th Percentile > CCME PEL	COPC?
Thallium	mg/kg	8	7	0.15	0.46875	1.475	2	N	-	-	-	-	-	-	
Tin	mg/kg	8	1	0.4	0.6125	0.93	1	N	8	N	-	-	-	-	
Titanium	mg/kg	8	0	176	368.625	844.6	1140	N	709	N	-	-	-	-	
Uranium	mg/kg	2	2	2.5	2.5	2.5	2.5	Y	-	-	-	-	-	-	
Vanadium	mg/kg	8	0	28.1	44.3875	59.25	61	N	44	Y	-	-	-	-	
Zinc	mg/kg	8	0	69.3	520.575	1677.3	2070	N	111	Y	123	315	Y	Y	Y
Zirconium	mg/kg	8	0	1.4	4.6375	11.52	13.2	N	-	-	-	-	-	-	

Table A.2-6 Selection of Chemicals of Concern in Sediments from Victoria Creek

Chemical	Units	N	N<MDL	Min	Mean	95th Percentile	Max	Heavily Censored?	Reference Mean	Mean > Reference?	CCME Sediment Guideline ISQG	CCME Sediment Guideline PEL	Max/95th Percentile > CCME ISQG	Max/95th Percentile > CCME PEL	COPC?
Aluminum	mg/kg	54	0	4070	13770.93	32090	35000	N	12300	Y	-	-	-	-	
Antimony	mg/kg	42	11	0.25	6.392857	20	21	N	-	-	-	-	-	-	
Arsenic	mg/kg	55	0	2.5	28.78182	63.2	97	N	101	N	5.9	17	Y	Y	
Barium	mg/kg	54	0	54.6	167.1537	375.2	434	N	127	Y	-	-	-	-	
Beryllium	mg/kg	54	9	0.15	0.459815	0.8	0.9	N	0.23	Y	-	-	-	-	
Bismuth	mg/kg	2	1	0.25	0.25	0.25	0.25	N	-	-	-	-	-	-	
Boron	mg/kg	12	9	0.5	4.708333	23.225	51	N	-	-	-	-	-	-	
Cadmium	mg/kg	55	8	0.1	0.520182	0.92	2.3	N	0.72	N	0.6	3.5	Y	N	
Calcium	mg/kg	54	0	2070	5809.815	9897	12800	N	5850	N	-	-	-	-	
Chromium	mg/kg	54	0	7.67	21.68463	35.215	68.7	N	13	Y	37.3	90	N	N	
Cobalt	mg/kg	55	0	2.5	12.02364	20.3	23.5	N	20	N	-	-	-	-	
Copper	mg/kg	55	0	4	28.81091	76.54	127	N	11	Y	35.7	197	Y	N	
Iron	mg/kg	54	0	9580	25242.22	40470.5	49620	N	14133	Y	-	-	-	-	
Lead	mg/kg	55	2	1	33.86309	80.2	387	N	25.2	Y	35	91.3	Y	N	
Lithium	mg/kg	2	0	5.2	5.75	6.245	6.3	N	-	-	-	-	-	-	
Magnesium	mg/kg	54	0	1490	4036.111	7527.5	9170	N	2610	Y	-	-	-	-	
Manganese	mg/kg	55	0	113	566.9345	1372	3560	N	331	Y	-	-	-	-	
Mercury	mg/kg	18	8	0.005	0.010611	0.0197	0.052	N	-	-	0.17	0.486	N	N	
Molybdenum	mg/kg	55	9	0.3	3.965636	8.3	10	N	2.7	Y	-	-	-	-	
Nickel	mg/kg	55	0	4	8.725636	17.09	20.3	N	8	Y	18	35.9	N	N	
Phosphorus	mg/kg	54	0	334	864.4444	1200	1300	N	850	Y	-	-	-	-	
Potassium	mg/kg	42	0	261	2177.833	5995	7200	N	-	-	-	-	-	-	
Selenium	mg/kg	42	14	0.1	3.312381	8	8	N	-	-	-	-	-	-	
Silicon	mg/kg	31	0	249	521.0323	826	878	N	344	Y	-	-	-	-	
Silver	mg/kg	55	15	0.055	1.295	2	2	N	2	N	-	-	-	-	
Sodium	mg/kg	54	0	100	397.6481	1456	1850	N	240	Y	-	-	-	-	
Strontium	mg/kg	54	0	13	42.90556	79	89.2	N	29.7	Y	-	-	-	-	
Sulphur	mg/kg	17	0	202	287.1765	418.6	501	N	-	-	-	-	-	-	

Table A.2-6 Selection of Chemicals of Concern in Sediments from Victoria Creek (Cont'd)

Chemical	Units	N	N<MDL	Min	Mean	95th Percentile	Max	Heavily Censored?	Reference Mean	Mean > Reference?	CCME Sediment Guideline ISQG	CCME Sediment Guideline PEL	Max/95th Percentile > CCME ISQG	Max/95th Percentile > CCME PEL	COPC?
Thallium	mg/kg	2	1	0.15	0.15	0.15	0.15	N	-	-	-	-	-	-	
Tin	mg/kg	55	9	0.3	5.273818	8	8	N	8	N	-	-	-	-	
Titanium	mg/kg	54	0	181	929.4815	1882	2028	N	709	Y	-	-	-	-	
Uranium	mg/kg	0	0	0	-	-	0	N	-	-	-	-	-	-	
Vanadium	mg/kg	55	0	22.6	63.59091	100	120	N	44	Y	-	-	-	-	
Zinc	mg/kg	55	0	26	77.93636	150.52	228	N	111	N	123	315	Y	N	
Zirconium	mg/kg	25	0	0.5	3.656	15.22	19.3	N	-	-	-	-	-	-	

A.3 TERRESTRIAL ENVIRONMENT

Measured concentrations were available for soil and vegetation in the terrestrial environment (at the Mill Site, Tailings Site, and Brown-McDade Pit). Reference concentrations were also available for soil and vegetation in the vicinity of the site, but outside of the potential for effects from the Mt. Nansen Mine. The reference sites were provided in the EDI 2007 document entitled "*Mount Nansen Terrestrial and Aquatic Effects Study 2005-2006*".

A.3.1 Soil Quality Data

The metals concentrations in soil measured at the Mt. Nansen Mine in 2005 were used in the assessment. Mill Site (transects G, H, I, J, K), Tailings Site (transects A, B, C, D, E, F and samples BVEG1, BVEG2, BVEG3), and Brown-McDade Pit (transects M, N, O, P, Q, R) were assessed separately. Measurements from mineralized control areas (Spud, Webber, and Flex zones) were used to determine the background concentrations. The reference locations were sampled in 2005. The reference sites were provided in the EDI 2007 document entitled "*Mount Nansen Terrestrial and Aquatic Effects Study 2005-2006*". Soil samples were collected from three soil horizons (A, B, and C). For the purposes of the screening assessment, only data from the top (A) soil horizon was considered.

Mill Site

The screening for the Mill Site considered 10 samples. A review of the dataset in Table A.3-1 indicates that beryllium, molybdenum, silver, and tin have more than 90% of the measured data below detection limits. Thus, these chemicals were not considered further.

Of the remaining chemicals, aluminum, chromium, magnesium, molybdenum, silver, tin, titanium, vanadium, and zirconium had measured concentrations that were below the reference concentrations (sites unaffected by the mine). These chemicals were not considered further.

The screening criteria used for soil was the CCME soil quality guidelines for agricultural land use (CCME 2007). This is a conservative approach to ensure that the maximum amount of chemicals are considered. Antimony, barium, beryllium, chromium, cobalt, copper, mercury, molybdenum, nickel, silver, tin, and vanadium were below the applicable CCME soil quality guidelines and were not considered further. Arsenic, boron, cadmium, lead, selenium, and zinc exceeded the applicable CCME soil quality guidelines and these were retained in the screening. There were no guideline values for calcium, iron, manganese, nickel, phosphorus, potassium, sodium, and strontium and therefore these were also retained in the screening. However, there are no appropriate terrestrial toxicity values for calcium, iron, phosphorus, potassium, and sodium and therefore these chemicals were dropped from the assessment. In addition, calcium, iron, phosphorus, potassium, and sodium are considered integral chemicals in the earth's crust. Overall, arsenic, boron, cadmium, lead, manganese, selenium, strontium, and zinc were selected as COPCs from the soil screening process at the Mill Site.

Tailings Site

The screening for the Tailings Site considered 6 samples. A review of the dataset in Table A.3-2 indicates that antimony, beryllium, molybdenum, and silver have more than 90% of the measured data below detection limits. Thus, these chemicals were not considered further.

Of the remaining chemicals, aluminum, cadmium, calcium, chromium, lead, magnesium, nickel, potassium, sodium, titanium, vanadium, zinc, and zirconium had measured concentrations that were below the reference concentrations (not influenced by the mine site). These chemicals were not considered further.

The screening criteria used for soil was the CCME soil quality guidelines for agricultural land use (CCME 2007). Barium, cobalt, mercury, and selenium were below the applicable CCME soil quality guidelines and were not considered further. Arsenic, boron, copper, and tin exceeded the applicable CCME soil quality guidelines and these were retained in the screening. There were no guideline values for iron, manganese, phosphorus, and strontium and therefore these were also retained in the screening. However, there are no appropriate terrestrial toxicity values for iron and phosphorus and therefore these chemicals were dropped from the assessment; however, calcium and phosphorus are considered a natural part of the earth's crust. Overall, arsenic, boron, copper, manganese, strontium, and tin were selected as COPCs from the soil screening process at the Tailings Site.

Brown-McDade Pit

The screening for the Brown-McDade Pit considered 6 samples. A review of the dataset in Table A.3-3 indicates that antimony, beryllium, lead, molybdenum, silver, and tin have more than 90% of the measured data below detection limits. Thus, these chemicals were not considered further.

Of the remaining chemicals, aluminum, arsenic, chromium, iron, magnesium, nickel, potassium, titanium, vanadium, zinc, and zirconium had measured concentrations that were below the reference concentrations (sites not affected by mine site). These chemicals were not considered further.

The screening criterion used for soil was the CCME soil quality guideline for agricultural land use (CCME 2007). Barium, cobalt, copper, mercury, and selenium were below the applicable CCME soil quality guidelines and were not considered further. Boron and cadmium exceeded the applicable CCME soil quality guidelines and these were retained in the screening. There were no guideline values for calcium, manganese, phosphorus, sodium, and strontium and therefore these were also retained in the screening. However, there are no appropriate terrestrial toxicity values for calcium, phosphorus, and sodium and therefore were dropped from the assessment; however, calcium, phosphorus, and sodium are considered a natural part of the earth's crust. Overall, boron, cadmium, manganese, and strontium were selected as COPCs from the soil screening process at the Brown-McDade Pit.

Table A.3-1 Selection of Chemicals of Concern in Soils from the Mill Site

Chemical	Units	N	N<MDL	Min	Mean	95th Percentile	Max	Heavily Censored?	Reference Mean	Mean > Reference?	CCME Soil Guideline (Agr)	Max/95th Percentile > CCME SG?	Toxicity Data Available?	COPC?
Aluminum	mg/kg	10	0	4180	8090	12910	13000	N	9067	N	-	-	Y	
Antimony	mg/kg	10	9	5.0	7.0	16.0	25	N	5	Y	20	N	Y	
Arsenic	mg/kg	10	3	5	110.5	397	485	N	42	Y	12	Y	Y	Y
Barium	mg/kg	10	0	162	285	465	528	N	101	Y	750	N	Y	
Beryllium	mg/kg	10	10	0.5	0.5	0.5	0.5	Y	0.5	N	4	N	Y	
Boron	mg/kg	10	7	0.5	1.5	4.75	7	N	0.6	Y	2	Y	Y	Y
Cadmium	mg/kg	10	1	0.25	1.6	3.9	4.6	N	1.3	Y	1.4	Y	Y	Y
Calcium	mg/kg	10	0	2640	11225	21865	22000	N	8712	Y	-	-		
Chromium	mg/kg	10	0	4	7.3	13	17	N	12.4	N	64	N	Y	
Cobalt	mg/kg	10	0	3	8.1	14	15	N	4.7	Y	40	N	Y	
Copper	mg/kg	10	0	19	35.3	50	54	N	18.7	Y	63	N	Y	
Iron	mg/kg	10	0	5810	13614	29825	32300	N	12267	Y	-	-		
Lead	mg/kg	10	5	2.5	20.0	84	129	N	16.0	Y	70	Y	Y	Y
Magnesium	mg/kg	10	0	666	2114	5326	6910	N	2135	N	-	-		
Manganese	mg/kg	10	0	121	1536	4103	5930	N	204	Y	-	-	Y	Y
Mercury	mg/kg	10	0	0.06	0.1	0.14	0.14	N	0.1	Y	6.6	N	Y	
Molybdenum	mg/kg	10	10	2	2.0	2	2	Y	2	N	5	N	Y	
Nickel	mg/kg	10	0	4	9.0	13.6	14	N	8.3	Y	50	N	Y	
Phosphorus	mg/kg	10	0	709	1137	1614	1880	N	559	Y	-	-		
Potassium	mg/kg	10	0	256	605	1455	2150	N	566	Y	-	-		
Selenium	mg/kg	10	1	0.1	0.6	1.5	2	N	0.1	Y	1	Y	Y	Y
Silver	mg/kg	10	10	1	1.0	1	1	Y	1	N	20	N	Y	
Sodium	mg/kg	10	0	52	103	127	127	N	102	Y	-	-		
Strontium	mg/kg	10	0	22	60.5	98	100	N	18.7	Y	-	-	Y	Y
Tin	mg/kg	10	10	2.5	2.5	2.5	2.5	Y	2.5	N	5	N	Y	
Titanium	mg/kg	10	0	63	174	389	482	N	236	N	-	-		
Vanadium	mg/kg	10	0	6	22.7	56	61	N	27	N	130	N	Y	
Zinc	mg/kg	10	0	12	76.5	200	253	N	68	Y	200	Y	Y	Y
Zirconium	mg/kg	10	4	0.5	1.0	2.0	2.0	N	1.0	N	-	-		

Table A.3-2 Selection of Chemicals of Concern in Soils from the Tailings Site

Chemical	Units	N	N<MDL	Min	Mean	95th Percentile	Max	Heavily Censored?	Reference Mean	Mean > Reference?	CCME Soil Guideline (Agr)	Max/95th Percentile > CCME SG?	Toxicity Data Available?	COPC?
Aluminum	mg/kg	6	0	2120	4203	7800	8850	N	9067	N	-	-	Y	
Antimony	mg/kg	6	6	5	5	5	5	Y	5	N	20	N	Y	
Arsenic	mg/kg	6	3	5	52	169.8	201	N	42	Y	12	Y	Y	Y
Barium	mg/kg	6	0	52	122	229.5	248	N	101	Y	750	N	Y	
Beryllium	mg/kg	6	6	0.5	0.5	0.5	0.5	Y	0.5	N	4	N	Y	
Boron	mg/kg	6	5	0.5	3.3	12.9	17	N	0.6	Y	2	Y	Y	Y
Cadmium	mg/kg	6	4	0.25	1.3	3.8	4.3	N	1.3	N	1.4	Y	Y	
Calcium	mg/kg	6	0	1340	4942	14630	18300	N	8712	N	-	-		
Chromium	mg/kg	6	0	3	6.3	10.75	11	N	12.4	N	64	N	Y	
Cobalt	mg/kg	6	0	1	7.0	20.75	25	N	4.7	Y	40	N	Y	
Copper	mg/kg	6	0	5	30	90.5	110	N	18.7	Y	63	Y	Y	Y
Iron	mg/kg	6	0	3790	15147	32725	37600	N	12267	Y	-	-		
Lead	mg/kg	6	3	2.5	5.1	9.25	10	N	16.0	N	70	N	Y	
Magnesium	mg/kg	6	0	376	1241	2327.5	2390	N	2135	N	-	-		
Manganese	mg/kg	6	0	66	1986	7770	9880	N	204	Y	-	-	Y	Y
Mercury	mg/kg	6	0	0.02	0.09	0.2	0.16	N	0.1	Y	6.6	N	Y	
Molybdenum	mg/kg	6	6	2	2.0	2	2	Y	2	N	5	N	Y	
Nickel	mg/kg	6	0	2	6.3	13.75	16	N	8.3	N	50	N	Y	
Phosphorus	mg/kg	6	0	389	750	942.25	948	N	559	Y	-	-		
Potassium	mg/kg	6	0	153	409	650.75	727	N	566	N	-	-		
Selenium	mg/kg	6	3	0.1	0.3	0.6	0.7	N	0.1	Y	1	N	Y	
Silver	mg/kg	6	6	1	1.0	1	1	Y	1	N	20	N	Y	
Sodium	mg/kg	6	0	53	85	112	113	N	102	N	-	-		
Strontium	mg/kg	6	0	12	29	57.25	66	N	18.7	Y	-	-	Y	Y
Tin	mg/kg	6	5	2.5	3	5.125	6	N	2.5	Y	5	Y	Y	Y
Titanium	mg/kg	6	0	56	143	261.5	283	N	236	N	-	-		
Vanadium	mg/kg	6	0	6	24	52.5	59	N	27	N	130	N	Y	
Zinc	mg/kg	6	0	14	53	140	159	N	68	N	200	N	Y	
Zirconium	mg/kg	6	4	0.5	0.8	1.75	2	N	1.0	N	-	-		

Table A.3-3 Selection of Chemicals of Concern in Soils from the Brown-McDade Pit

Chemical	Units	N	N<MDL	Min	Mean	95th Percentile	Max	Heavily Censored?	Reference Mean	Mean > Reference?	CCME Soil Guideline (Agr)	Max/95th Percentile > CCME SG?	Toxicity Data Available?	COPC?
Aluminum	mg/kg	6	0	1640	4660	7815	7850	N	9067	N	-	-	Y	
Antimony	mg/kg	6	6	5	5	5	5	Y	5	N	20	N	Y	
Arsenic	mg/kg	6	4	5	7.5	13.3	14	N	42	N	12	Y	Y	
Barium	mg/kg	6	0	82	256	428	442	N	101	Y	750	N	Y	
Beryllium	mg/kg	6	6	0.5	0.5	0.5	0.5	Y	0.5	N	4	N	Y	
Boron	mg/kg	6	4	0.5	1.17	2.75	3	N	0.6	Y	2	Y	Y	Y
Cadmium	mg/kg	6	0	1	3.8	6.1	6.5	N	1.3	Y	1.4	Y	Y	Y
Calcium	mg/kg	6	0	2110	10908	18675	19800	N	8712	Y	-	-		
Chromium	mg/kg	6	0	2	4.8	6.8	7	N	12.4	N	64	N	Y	
Cobalt	mg/kg	6	0	2	5.8	13.3	15	N	4.7	Y	40	N	Y	
Copper	mg/kg	6	0	7	23.7	39.8	42	N	18.7	Y	63	N	Y	
Iron	mg/kg	6	0	2160	8170	16540	19100	N	12267	N	-	-		
Lead	mg/kg	6	6	2.5	2.5	2.5	2.5	Y	16.0	N	70	N	Y	
Magnesium	mg/kg	6	0	373	1023	1305	1320	N	2135	N	-	-		
Manganese	mg/kg	6	0	66	937	2513	2840	N	204	Y	-	-	Y	Y
Mercury	mg/kg	6	0	0.05	0.08	0.11	0.11	N	0.1	Y	6.6	N	Y	
Molybdenum	mg/kg	6	6	2	2	2	2	Y	2	N	5	N	Y	
Nickel	mg/kg	6	0	4	7	9.75	10	N	8.3	N	50	N	Y	
Phosphorus	mg/kg	6	0	610	832	1140	1190	N	559	Y	-	-		
Potassium	mg/kg	6	0	94	308	527	567	N	566	N	-	-		
Selenium	mg/kg	6	2	0.1	0.35	0.58	0.6	N	0.1	Y	1	N	Y	
Silver	mg/kg	6	6	1.0	1.0	1.0	1.0	Y	1	N	20	N	Y	
Sodium	mg/kg	6	0	50	106	151	158	N	102	Y	-	-		
Strontium	mg/kg	6	0	23	78.2	136	150	N	18.7	Y	-	-	Y	Y
Tin	mg/kg	6	6	2.5	2.5	2.5	2.5	Y	2.5	N	5	N	Y	
Titanium	mg/kg	6	0	31	78	158	180	N	236	N	-	-		
Vanadium	mg/kg	6	0	3	8.3	12.3	13	N	27	N	130	N	Y	
Zinc	mg/kg	6	0	18	47.0	92.5	105	N	68	N	200	N	Y	
Zirconium	mg/kg	6	4	0.5	0.83	1.8	2	N	1.0	N	-	-		

A.3.2 Vegetation Quality Data

Extensive vegetation sampling was completed in 2005 and 2006 from around the Mt. Nansen Mine and metals concentrations in various types of vegetation are available. Mill Site (transects G, H, I, J, K, L and samples Dome-6, Dome-7), Tailings Site (transects A, B, C, D, E, F and samples FG, Dome-1, Dome-2, Dome-3, Dome-4, Dome-5), and Brown-McDade Pit (transects M, N, O, P, Q, R and samples EM3, V1, V2, V3, V4, Pony1, Pony2, Pony3, Dust1, Dust2, Dust3) were assessed separately. Measurements from a reference sampling location (CP-1, CP-2, CP-3, CP-4, CP-5, CP-6, CP-7, CP-8, CP-9) were used to determine the background concentrations. Vegetation samples from reference locations included cranberry, crowberry, Labrador tea, willow, blueberry, and wheatgrass. Lichens and sphagnum moss samples were not considered for the screening since these types of vegetation take up metals significantly from deposition from air, rather than from soil, and are not appropriate for this screening procedure.

<u>*Mill Site*</u>

As seen in Table A.3-4, a total of 58 samples were collected in the vegetation sampling. For screening purposes, bolete mushroom, cranberry, crowberry, Labrador tea, willow, blueberries, and spruce samples were considered.

Chemicals that had concentrations below the detection limits for more than 90% of the measurements include beryllium, mercury, selenium, tellurium, tin, uranium, vanadium, and zirconium. These eight chemicals were therefore not considered further.

Eleven of the chemicals which included antimony, arsenic, boron, calcium, iron, mercury, silver, sodium, vanadium, and zinc had concentrations that were above reference concentrations. The reference concentrations were measured at locations not influenced by mining activities.

Out of the 11 chemicals carried through from the previous selection step, only antimony, arsenic, mercury, vanadium, and zinc have available phytotoxic levels, and of these, only zinc had a 95th percentile concentrations that exceeded the phytotoxic level.

Overall, zinc was identified from the vegetation screening at the Mill Site. Zinc was also identified in the soil screening process.

<u>*Tailings Site*</u>

As seen in Table A.3-5, a total of 47 samples were collected in the vegetation sampling. For screening purposes, cranberry, crowberry, Labrador tea, willow, blueberries, and spruce samples were considered.

Chemicals that had concentrations below the detection limits for more than 90% of the measurements include antimony, beryllium, mercury, selenium, tellurium, tin, uranium, vanadium, and zirconium. These nine chemicals were therefore not considered further.

Fourteen of the chemicals which included antimony, arsenic, boron, copper, mercury, molybdenum, selenium, silver, sodium, tellurium, uranium, vanadium, zinc, and zirconium had concentrations that were above reference. The reference concentrations were measured at locations not influenced by mining activities.

Out of the 14 chemicals carried through from the previous selection step, only antimony, arsenic, mercury, molybdenum, selenium, vanadium, and zinc have available phytotoxic levels, and of these, only zinc had a 95^{th} percentile concentrations that exceeded the phytotoxic level.

Overall, zinc was identified from the vegetation screening at the Tailings Site. Zinc was identified in the soil screening process.

Brown-McDade Pit

As seen in Table A.3-6, a total of 61 samples were collected in the vegetation sampling. For screening purposes, bolete mushrooms, cranberry, crowberry, Labrador tea, willow, blueberries, rose, trembling aspen and spruce samples were considered.

Chemicals that had concentrations below the detection limits for more than 90% of the measurements include beryllium, mercury, selenium, tellurium, thallium, tin, uranium, vanadium, and zirconium. These nine chemicals were therefore not considered further.

Ten of the chemicals which included antimony, arsenic, boron, calcium, iron, silver, sodium, tin, vanadium, and zinc had concentrations that were above reference concentrations. The reference concentrations were measured at locations not influenced by mining activities.

Out of the 10 chemicals carried through from the previous selection step, only antimony, arsenic, and zinc have available phytotoxic levels, and of these, only zinc had a 95^{th} percentile concentrations that exceeded the phytotoxic level.

Overall, zinc was identified from the vegetation screening at the Brown-McDade Pit. Zinc was identified in the soil screening process.

Table A.3-4 Selection of Chemicals of Concern in Vegetation from the Mill Site

Chemical	Units	N	N<MDL	Min	Mean	95th Percentile	Max	Heavily Censored?	Reference Mean	Mean > Reference?	Phytotoxic Level	Max/95th Percentile > Phytotoxic Level?	COPC?
Aluminum	mg/kg dry	58	0	3	26	88.755	149	N	38	N	50 [a]	Y	
Antimony	mg/kg dry	58	47	0.05	0.09	0.215	0.9	N	0.05	Y	150 [a]	N	
Arsenic	mg/kg dry	58	10	0.05	0.62	1.8	3.6	N	0.09	Y	3 [b]	N	
Barium	mg/kg dry	58	0	1	36	78.32	141	N	48	N	400 [c]	N	
Beryllium	mg/kg dry	58	57	0.01	0.01	0.01	0.02	Y	0.01	N	-	-	
Boron	mg/kg dry	58	1	1	22	41.35	227	N	10	Y	-	-	
Cadmium	mg/kg dry	58	12	0.01	2.2	6.6915	55	N	2.6	N	5 [a,b]	Y	
Calcium	mg/kg dry	58	0	249	8051	21245	22700	N	6820	Y	-	-	
Chromium	mg/kg dry	58	48	0.05	0.07	0.2	0.3	N	0.10	N	5 [a,c]	N	
Cobalt	mg/kg dry	58	40	0.05	0.26	0.975	2.3	N	0.35	N	3 [c]	N	
Copper	mg/kg dry	58	0	0.4	3.7	4.745	11.4	N	3.8	N	-	-	
Iron	mg/kg dry	58	0	8	66	126.4	203	N	63	Y	-	-	
Lead	mg/kg dry	58	22	0.05	0.36	1.33	2.3	N	0.66	N	20 [c]	N	
Magnesium	mg/kg dry	58	0	34	1847	4245.5	5030	N	1840	Y	-	-	
Manganese	mg/kg dry	58	0	3.3	625	1641	2160	N	645	N	-	-	
Mercury	mg/kg dry	58	57	0.005	0.01	0.005	0.037	Y	0.01	Y	1 [a]	N	
Molybdenum	mg/kg dry	58	43	0.05	0.08	0.2	0.3	N	0.13	N	10 [a]	N	
Nickel	mg/kg dry	58	3	0.05	0.5	1.63	3.2	N	1.2	N	-	-	
Phosphorus	mg/kg dry	58	0	28.8	1256	2062.5	5870	N	1734	N	-	-	
Potassium	mg/kg dry	58	0	160	6442	9282	27400	N	7828	N	-	-	
Selenium	mg/kg dry	58	58	0.1	0.10	0.1	0.1	Y	0.10	N	5 [a]	N	
Silicon	mg/kg dry	58	0	46	102	150.6	200	N	133	N	-	-	
Silver	mg/kg dry	58	30	0.005	0.03	0.05	0.85	N	0.01	Y	-	-	
Sodium	mg/kg dry	58	1	0.5	17	80.4	176	N	6.4	Y	-	-	
Strontium	mg/kg dry	58	0	0.8	23	82.075	135	N	34	N	-	-	
Tellurium	mg/kg dry	58	58	0.05	0.05	0.05	0.05	Y	0.05	N	-	-	
Thallium	mg/kg dry	58	45	0.01	0.02	0.063	0.12	N	0.03	N	11 [c]	N	
Tin	mg/kg dry	58	58	0.05	0.05	0.05	0.05	Y	0.06	N	-	-	
Titanium	mg/kg dry	58	1	0.15	1.3	2.1	3	N	1.6	N	-	-	
Uranium	mg/kg dry	58	58	0.02	0.02	0.02	0.02	Y	0.02	N	-	-	
Vanadium	mg/kg dry	58	57	0.25	0.26	0.25	0.6	Y	0.25	Y	5 [a]	N	
Zinc	mg/kg dry	58	0	5.1	122	405.25	1480	N	65	Y	100 [a]	Y	Y
Zirconium	mg/kg dry	58	58	1.5	1.5	1.5	1.5	Y	1.5	N	-	-	

Notes: a - a- Leaf tissue concentration in plants that are neither sensitive or tolerant McBride, M.B. 1994 Environmental Chemistry of Soils. Oxford University Press Inc. New York, NY.
b - Phytotoxic conc. In plant foilage. Langmuir, D., P. Chrostowski, B. Vigneault and R. Chaney 2004. Issue Paper on the Environmental Chemistry of Metals. Submitted to U.S. Environmental Protection Agency, Risk Assessment Forum, Washington, DC. ERG, Lexington, MA.
c - Upper Critical Level in leaves and shoots of spring barley associated with reduced yield. Davis, R.D., P.H.T. Beckett and E. Wollan 1978. Critical Levels of Twenty Potentially Toxic Elements in Young Spring Barley. Plant Soil 49: 395-408.

Table A.3-5 Selection of Chemicals of Concern in Vegetation from the Tailings Site

Chemical	Units	N	N<MDL	Min	Mean	95th Percentile	Max	Heavily Censored?	Reference Mean	Mean > Reference?	Phytotoxic Level	Max/95th Percentile > Phytotoxic Level?	COPC?
Aluminum	mg/kg dry	47	0	2.9	24	52.05	102	N	38	N	50 [a]	Y	
Antimony	mg/kg dry	47	44	0.05	0.07	0.1	0.6	Y	0.05	Y	150 [a]	N	
Arsenic	mg/kg dry	47	28	0.05	0.38	1.25	4.7	N	0.09	Y	3 [b]	N	
Barium	mg/kg dry	47	0	2.6	32	80.47	94.4	N	48	N	400 [c]	N	
Beryllium	mg/kg dry	47	46	0.01	0.01	0.01	0.02	Y	0.01	N	-	-	
Boron	mg/kg dry	47	1	1	17	43.9	59	N	10	Y	-	-	
Cadmium	mg/kg dry	47	15	0.01	0.9	2.914	13.8	N	2.6	N	5 [a,b]	N	
Calcium	mg/kg dry	47	0	273	5471	15050	17700	N	6820	N	-	-	
Chromium	mg/kg dry	47	40	0.05	0.08	0.27	0.5	N	0.10	N	5 [a,c]	N	
Cobalt	mg/kg dry	47	35	0.05	0.22	0.94	1.5	N	0.35	N	3 [c]	N	
Copper	mg/kg dry	47	0	0.1	3.8	5.17	5.6	N	3.8	Y	-	-	
Iron	mg/kg dry	47	0	11	56	155.5	209	N	63	N	-	-	
Lead	mg/kg dry	47	35	0.05	0.31	0.91	5.9	N	0.66	N	20 [c]	N	
Magnesium	mg/kg dry	47	0	27.8	1439	3721	4120	N	1840	N	-	-	
Manganese	mg/kg dry	47	0	8.9	615	1511	2540	N	645	N	-	-	
Mercury	mg/kg dry	47	47	0.005	0.005	0.005	0.01	Y	0.01	Y	1 [a]	N	
Molybdenum	mg/kg dry	47	23	0.05	0.17	0.6	0.9	N	0.13	Y	10 [a]	N	
Nickel	mg/kg dry	47	4	0.05	0.6	2.03	3.2	N	1.2	N	-	-	
Phosphorus	mg/kg dry	47	0	17.1	1207	1821	3320	N	1734	N	-	-	
Potassium	mg/kg dry	47	0	74	6785	11310	11800	N	7828	N	-	-	
Selenium	mg/kg dry	47	46	0.1	0.10	0.1	0.2	Y	0.10	Y	5 [a]	N	
Silicon	mg/kg dry	47	0	50	111	155.5	390	N	133	N	-	-	
Silver	mg/kg dry	47	39	0.005	0.01	0.017	0.11	N	0.01	Y	-	-	
Sodium	mg/kg dry	47	1	0.5	22.4	63.6	260	N	6.4	Y	-	-	
Strontium	mg/kg dry	47	0	0.6	16	65.08	99.1	N	34	N	-	-	
Tellurium	mg/kg dry	47	47	0.05	0.05	0.05	0.1	Y	0.05	Y	-	-	
Thallium	mg/kg dry	47	38	0.01	0.02	0.07	0.11	N	0.03	N	11 [c]	N	
Tin	mg/kg dry	47	46	0.05	0.05	0.05	0.2	Y	0.06	N	-	-	
Titanium	mg/kg dry	47	1	0.3	1.1	2.18	2.8	N	1.6	N	-	-	
Uranium	mg/kg dry	47	47	0.02	0.02	0.02	0.04	Y	0.02	Y	-	-	
Vanadium	mg/kg dry	47	45	0.25	0.27	0.425	0.7	Y	0.25	Y	5 [a]	N	
Zinc	mg/kg dry	47	0	1.4	87	431.2	763	N	65	Y	100 [a]	Y	Y
Zirconium	mg/kg dry	47	47	1.5	1.5	1.5	3	Y	1.5	Y	-	-	

Notes: a - a- Leaf tissue concentration in plants that are neither sensitive or tolerant McBride, M.B. 1994 Environmental Chemistry of Soils. Oxford University Press Inc. New York, NY.
b - Phytotoxic conc. In plant foilage. Langmuir, D., P. Chrostowski, B. Vigneault and R. Chaney 2004. Issue Paper on the Environmental Chemistry of Metals. Submitted to U.S. Environmental Protection Agency, Risk Assessment Forum, Washington, DC. ERG, Lexington, MA.
c - Upper Critical Level in leaves and shoots of spring barley associated with reduced yield. Davis, R.D., P.H.T. Beckett and E. Wollan 1978. Critical Levels of Twenty Potentially Toxic Elements in Young Spring Barley. Plant Soil 49: 395-408.

Table A.3-6 Selection of Chemicals of Concern in Vegetation from the Brown-McDade Pit

Chemical	Units	N	N<MDL	Min	Mean	95th Percentile	Max	Heavily Censored?	Reference Mean	Mean > Reference?	Phytotoxic Level	Max/95th Percentile > Phytotoxic Level?	COPC?
Aluminum	mg/kg dry	61	0	2.6	24	66.9	91.6	N	38	N	50 [a]	Y	
Antimony	mg/kg dry	61	54	0.05	0.08	0.1	1.4	N	0.05	Y	150 [a]	N	
Arsenic	mg/kg dry	61	29	0.05	0.64	2.3	12.5	N	0.09	Y	3 [b]	N	
Barium	mg/kg dry	61	0	4.5	32	86.2	122	N	48	N	400 [c]	N	
Beryllium	mg/kg dry	61	61	0.01	0.01	0.01	0.01	Y	0.01	N	-	-	
Boron	mg/kg dry	61	3	1	15	32	53	N	10	Y	-	-	
Cadmium	mg/kg dry	61	14	0.01	2.2	11.8	17.4	N	2.6	N	5 [a,b]	Y	
Calcium	mg/kg dry	61	0	303	7208	16600	29500	N	6820	Y	-	-	
Chromium	mg/kg dry	61	50	0.05	0.09	0.3	0.4	N	0.10	N	5 [a,c]	N	
Cobalt	mg/kg dry	61	47	0.05	0.18	0.9	1.4	N	0.35	N	3 [c]	N	
Copper	mg/kg dry	61	0	0.2	3.5	5.1	5.2	N	3.8	N	-	-	
Iron	mg/kg dry	61	0	10	80	228	509	N	63	Y	-	-	
Lead	mg/kg dry	61	38	0.05	0.36	1.4	5.2	N	0.66	N	20 [c]	N	
Magnesium	mg/kg dry	61	0	34	1650	3960	4370	N	1840	N	-	-	
Manganese	mg/kg dry	61	0	5.9	429	1140	1740	N	645	N	-	-	
Mercury	mg/kg dry	61	61	0.005	0.01	0.005	0.005	Y	0.01	N	1 [a]	N	
Molybdenum	mg/kg dry	61	47	0.05	0.08	0.3	0.4	N	0.13	N	10 [a]	N	
Nickel	mg/kg dry	61	8	0.05	0.4	1.3	1.5	N	1.2	N	-	-	
Phosphorus	mg/kg dry	61	0	28.1	1130	2320	2760	N	1734	N	-	-	
Potassium	mg/kg dry	61	0	123	6960	13300	16600	N	7828	N	-	-	
Selenium	mg/kg dry	61	61	0.1	0.10	0.1	0.1	Y	0.10	N	5 [a]	N	
Silicon	mg/kg dry	61	0	59	110	156	207	N	133	N	-	-	
Silver	mg/kg dry	61	39	0.005	0.01	0.03	0.15	N	0.01	Y	-	-	
Sodium	mg/kg dry	61	8	0.5	17.9	82	286	N	6.4	Y	-	-	
Strontium	mg/kg dry	61	0	0.91	28	93.3	175	N	34	N	-	-	
Tellurium	mg/kg dry	61	61	0.05	0.05	0.05	0.05	Y	0.05	N	-	-	
Thallium	mg/kg dry	61	56	0.01	0.01	0.03	0.14	Y	0.03	N	11 [c]	N	
Tin	mg/kg dry	61	60	0.05	0.08	0.05	1.7	Y	0.06	Y	-	-	
Titanium	mg/kg dry	61	0	0.5	1.4	3.7	5.8	N	1.6	N	-	-	
Uranium	mg/kg dry	61	61	0.02	0.02	0.02	0.02	Y	0.02	N	-	-	
Vanadium	mg/kg dry	61	56	0.25	0.29	0.6	1.2	Y	0.25	Y	5 [a]	N	
Zinc	mg/kg dry	61	0	5.6	88	429	593	N	65	Y	100 [a]	Y	Y
Zirconium	mg/kg dry	61	61	1.5	1.5	1.5	1.5	Y	1.5	N	-	-	

Notes: a - a- Leaf tissue concentration in plants that are neither sensitive or tolerant McBride, M.B. 1994 Environmental Chemistry of Soils. Oxford University Press Inc. New York, NY.
b - Phytotoxic conc. In plant foilage. Langmuir, D., P. Chrostowski, B. Vigneault and R. Chaney 2004. Issue Paper on the Environmental Chemistry of Metals. Submitted to U.S. Environmental Protection Agency, Risk Assessment Forum, Washington, DC. ERG, Lexington, MA.
c - Upper Critical Level in leaves and shoots of spring barley associated with reduced yield. Davis, R.D., P.H.T. Beckett and E. Wollan 1978. Critical Levels of Twenty Potentially Toxic Elements in Young Spring Barley. Plant Soil 49: 395-408.

A.4 OVERALL LIST OF COPC CONSIDERED

A summary table with the selected COPC for the aquatic environment is provided in Table A.4-1 and includes chloride, sulphate, ammonia, cyanate, thiocyanate, antimony, arsenic, barium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, selenium, silver, strontium, vanadium, and zinc.

A summary table with the selected COPC for the terrestrial environment is provided in Table A.4-2 and includes arsenic, boron, cadmium, copper, lead, manganese, selenium, strontium, tin, and zinc.

Table A.4-1 Summary of Chemicals of Concern for the Mt. Nansen Mine Aquatic Environment Assessment

	Surface Water			Sediment			COPC
Routine/Nutrients	**Dome Creek**	**Pony Creek**	**Victoria Creek**	**Dome Creek**	**Pony Creek**	**Victoria Creek**	
Chloride	X	X					Chloride
Sulphate	X	X	X				Sulphate
Ammonia-N	X						Ammonia
Nitrate-N							
Cyanide Compounds							
Cyanide - T							
Cyanate	X						Cyanate
Thiocyanate	X						Thiocyanate
CN-WAD							
CN-SAD							
Total Metals							
Aluminum							
Antimony	X						Antimony
Arsenic	X	X	X	X	X		Arsenic
Barium	X	X	X				Barium
Beryllium							
Bismuth							
Boron	X		X				Boron
Cadmium	X	X	X	X	X		Cadmium
Calcium							
Chromium							Chromium*
Cobalt	X	X	X				Cobalt
Copper	X	X	X	X			Copper
Iron	X	X	X				Iron
Lead	X	X	X	X	X		Lead
Lithium							
Magnesium							
Manganese	X	X	X				Manganese
Molybdenum							
Nickel							
Potassium							
Selenium	X						Selenium
Silicon							
Silver	X						Silver
Sodium							
Strontium	X	X	X				Strontium
Sulphur							
Thallium							
Tin							
Titanium							
Uranium							
Vanadium	X	X	X				Vanadium
Zinc	X	X			X	X	Zinc

Note: * Chromium added as a COPC for water following COPC selection completed on a reduced dataset considering post-November 2007 data only.

Table A.4-2 Summary of Chemicals of Concern for the Mt. Nansen Mine Terrestrial Environment Assessment

Chemical	Soil			Vegetation			COPC
	Mill Site	Tailings Site	Brown-McDade Pit	Mill Site	Tailings Site	Brown-McDade Pit	
Aluminum							
Antimony							
Arsenic	X	X					Arsenic
Barium							
Beryllium							
Boron	X	X	X				Boron
Cadmium	X		X				Cadmium
Calcium							
Chromium							
Cobalt							
Copper		X					Copper
Iron							
Lead	X						Lead
Magnesium							
Manganese	X	X	X				Manganese
Mercury							
Molybdenum							
Nickel							
Phosphorus							
Potassium							
Selenium	X						Selenium
Silver							
Sodium							
Strontium	X	X	X				Strontium
Tin		X					Tin
Titanium							
Vanadium							
Zinc	X			X	X	X	Zinc
Zirconium							

A.5 REFERENCES

Canadian Council of Ministers of the Environment (CCME) 2007. *Canadian Environmental Quality Guidelines.* Prepared by the Task Force on Water Quality Guidelines of the Canadian Council of Ministers of the Environment. Includes updates to the Original 1999 Version.

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APPENDIX B

SUMMARY OF DATA

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APPENDIX B: SUMMARY OF DATA

This appendix summarizes the available monitoring data for the study area.

B.1 AQUATIC ENVIRONMENT

This section discusses surface water and sediment quality used in the risk assessment for the Mt. Nansen Mine site. Samples from slimy sculpin and burbot from a field investigation (EDI 2007) conducted in the between 2005 and 2006 are also summarized.

B.1.1 Surface Water Quality

From EDI (2008), water quality sampling at the Mt. Nansen mine site began in 1999 by the Department of Indian and Northern Affairs (DIAND), and in 2003 this sampling program was assumed by the Yukon Government Abandoned Mines Branch (AMB). Since 2005, EDI (under contract with AMB) has sampled the Mt. Nansen site at semi-regular frequencies. This frequency has been weekly, bi-weekly or monthly depending on activities at the mine site (i.e. discharge of water into Dome Creek) and water quality results. Some sites are not sampled in the winter when locations are frozen to substrate. Figure B.1.1-1 shows the sampling locations for water considered for the assessment.

The total metals concentrations in surface water measured at the Mt. Nansen Mine between January 1999 and November 2008 were used in the assessment, and Dome Creek, Pony Creek, Victoria Creek, Tailings Pond, and Brown-McDade Pit were assessed separately. Measurements from reference sampling locations Victoria Creek Reference and Dry Creek were used to determine the background concentrations. Reference locations were sampled in 2007 and 2008.

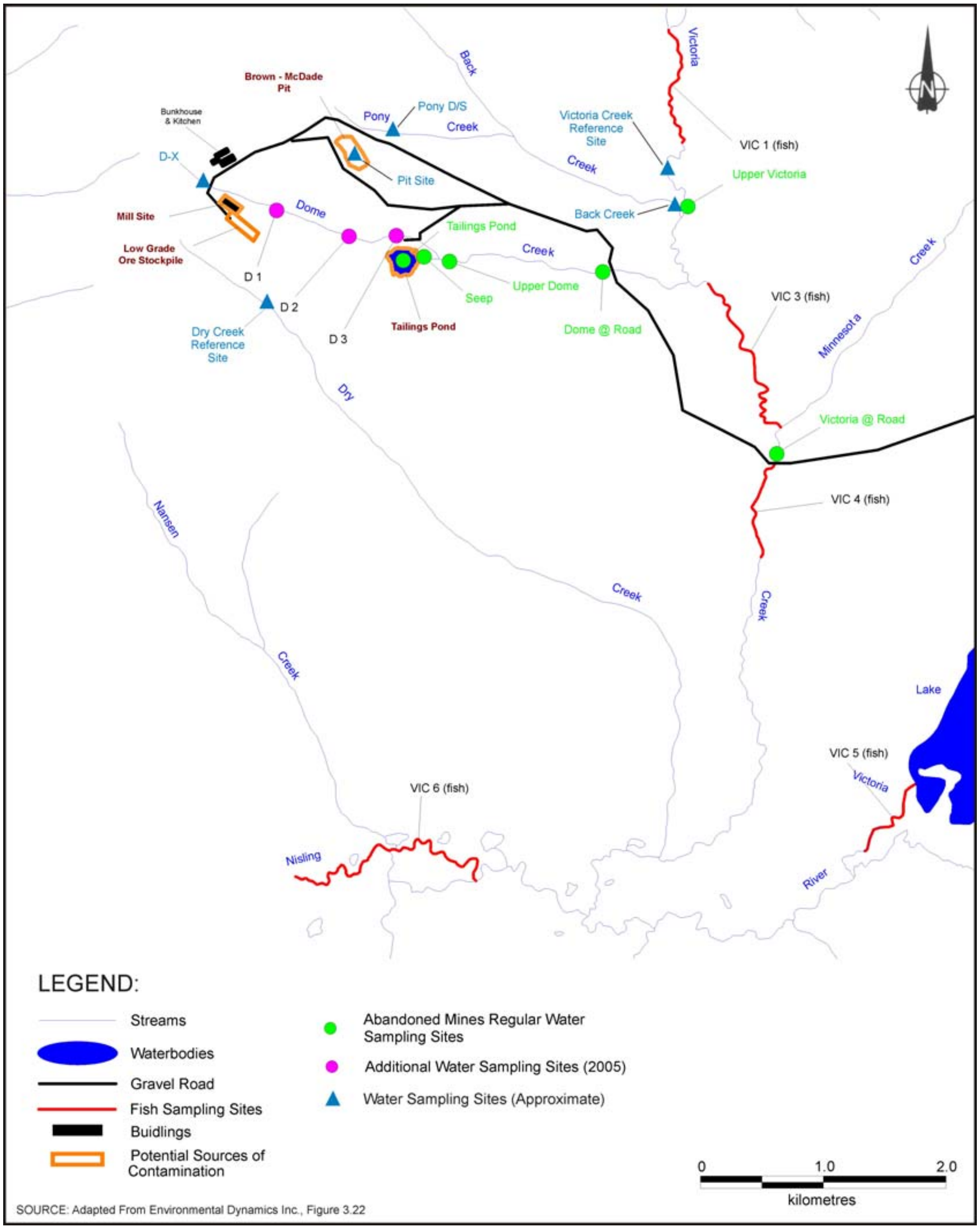
Surface water data prior to November 2007 has high detection limits. An analysis completed during the screening process and selection of COPC (Appendix A) found that more COPC were identified using the complete data set, and therefore, the concentrations in the full data set are considered in the assessment as a conservative assumption. For the purpose of calculating summary statistics for these data, concentrations measured as less than the detection limit (“<”) were considered as equal to ½ the detection limit.

Dome Creek

Surface water quality data were collected from different sampling locations in Dome Creek (sampling locations Dome-X, Dome 1, Dome 2, Dome 3, Upper Dome, Dome @ Road) and is summarized in Table B.1.1-1. Some general observations respecting the chemical levels measured in Dome Creek are noted as follows:

- At sampling locations in Dome Creek, mean concentrations of aluminum, arsenic, cadmium, copper, iron, lead, selenium, silver, thallium, and zinc exceed the CCME guidelines.
- Over 90% of the samples collected in Dome Creek were found to have concentrations below MDL for beryllium, bismuth, molybdenum, thallium, and tin.

Figure B.1.1-1 Locations Considered in Aquatic Assessment



Pony Creek

Surface water quality data were collected from different sampling locations in Pony Creek (Pony D/S, Back Creek) and are summarized in Table B.1.1-2. Some general observations respecting the chemical levels measured in Pony Creek are noted as follows:

- At sampling locations in Pony Creek, mean concentrations of aluminum, arsenic, cadmium, copper, iron, lead, silver, and zinc exceed the CCME guidelines. All samples collected in Pony Creek exceeded the CCME guideline for cadmium.
- Over 90% of the samples collected in Pony Creek were found to have concentrations below MDL for bismuth, molybdenum, and tin.

Victoria Creek

Surface water quality data were collected from different sampling locations in Victoria Creek (Upper Victoria Creek and Victoria Creek @ Road) and are summarized in Table B.1.1-3. Some general observations respecting the chemical levels measured in Victoria Creek are noted as follows:

- At sampling locations in Victoria Creek, mean concentrations of aluminum, arsenic, cadmium, copper, iron, lead, selenium, silver, and thallium exceed the CCME guidelines.
- Over 90% of the samples collected in Victoria Creek were found to have concentrations below MDL for cyanate, antimony, beryllium, bismuth, lithium, molybdenum, selenium, silver, thallium, and tin.

Reference Locations

Surface water quality data were collected from reference locations on Victoria Creek (upstream of impacts from the mine site) and Dry Creek and are summarized in Table B.1.1-4. Some general observations respecting the chemical levels measured in reference locations are noted as follows:

- At sampling locations from reference locations, mean concentrations of aluminum, arsenic, cadmium, iron, selenium, silver, and thallium exceed the CCME guidelines.
- Over 90% of the samples collected from reference locations were found to have concentrations below MDL for cyanate, beryllium, bismuth, molybdenum, selenium, thallium, and tin.

Tailings Pond

Surface water quality data were collected from the Tailings Pond and are summarized in Table B.1.1-5. Some general observations respecting the chemical levels measured in the Tailings Pond are noted as follows:

- Over 90% of the samples collected in Tailings Pond were found to have concentrations below MDL for beryllium, bismuth, and selenium.

A comparison with CCME criteria is not completed for the Tailings Pond since it is not an aquatic habitat.

Brown-McDade Pit

Surface water quality data were collected from the Brown-McDade Pit and the water quality from the “Top” samples are summarized in Table B.1.1-6. Some general observations respecting the chemical levels measured in the Brown-McDade Pit are noted as follows:

- Over 90% of the samples collected in the Brown-McDade Pit were found to have concentrations below MDL for beryllium, bismuth, chromium, molybdenum, and tin.

A comparison with CCME criteria is not completed for the Brown-McDade Pit since it is not an aquatic habitat.

Table B.1.1-1 Water Quality Summary for Dome Creek

Dome Creek **Routine Params/Nutrients**		**N**	**N<MDL**	**CCME WQ Guideline**	**N>CCME**	**Min**	**Mean**	**95th Percentile**	**Max**	**Heavily Censored?**
Chloride	mg/L	47	5	-	-	0.07	1.02	2.86	3.6	N
Sulphate	mg/L	254	0	-	-	16.2	449.3	996.5	3830	N
Ammonia-N	mg/L	256	21	2.2	58	0.005	2.06	**7.89**	**46.2**	N
Nitrate-N	mg/L	244	9	13	0	0.0025	0.87	2.84	8	N
Cyanide Compounds										
Cyanide - T	mg/L	135	5	-	-	0.0025	0.03	0.06	0.128	N
Cyanate	mg/L	241	154	-	-	0.005	2.1	4.6	143	N
Thiocyanate	mg/L	240	10	-	-	0.025	3.1	6.2	68.7	N
CN-WAD	mg/L	249	76	-	-	0.0005	0.04	0.06	6.23	N
CN-SAD	mg/L	113	11	-	-	0.001	1.1	6.1	24.6	N
Total Metals										
Aluminum	mg/L	258	97	0.1	135	0.005	**0.81**	**3.8**	**18.3**	N
Antimony	mg/L	254	200	-	-	0.000005	0.06	0.10	0.5	N
Arsenic	mg/L	257	138	0.005	249	0.0018	**0.08**	**0.18**	**0.5**	N
Barium	mg/L	258	1	-	-	0.01	0.07	0.17	0.317	N
Beryllium	mg/L	191	190	-	-	0.00005	0.002	0.003	0.015	Y
Bismuth	mg/L	217	216	-	-	0.00025	0.07	0.10	0.5	Y
Boron	mg/L	198	134	-	-	0.001	0.05	0.11	0.57	N
Cadmium	mg/L	258	184	0.000017	253	0.00001	**0.003**	**0.005**	**0.025**	N
Calcium	mg/L	258	0	-	-	12	142	276	1080	N
Chromium	mg/L	258	175	0.0089	11	0.00025	0.005	0.0080	**0.148**	N
Cobalt	mg/L	258	138	-	-	0.00005	0.01	0.03	0.073	N
Copper	mg/L	258	116	0.004	218	0.001	**0.04**	**0.27**	**1.1**	N
Iron	mg/L	258	3	0.3	236	0.04	**4.1**	**12.1**	**58.4**	N
Lead	mg/L	258	175	0.007	163	0.00005	**0.02**	**0.03**	**0.15**	N
Lithium	mg/L	217	154	-	-	0.0005	0.01	0.012	0.025	N
Magnesium	mg/L	258	0	-	-	3.1	36.6	54.3	176	N
Manganese	mg/L	258	2	-	-	0.0025	1.6	5.6	29.7	N
Molybdenum	mg/L	258	247	0.073	0	0.000226	0.01	0.02	0.055	Y
Nickel	mg/L	258	160	0.15	1	0.00025	0.02	0.025	**0.222**	N
Potassium	mg/L	257	19	-	-	0.15	4.3	9.9	40	N
Selenium	mg/L	254	221	0.001	196	0.000005	**0.06**	**0.10**	**0.5**	N
Silicon	mg/L	254	0	-	-	2.18	6.1	10.7	26.8	N
Silver	mg/L	258	218	0.0001	207	0.000005	**0.003**	**0.005**	**0.03**	N
Sodium	mg/L	258	0	-	-	0.9	39.7	150	582	N
Strontium	mg/L	258	2	-	-	0.01	0.41	0.80	3.06	N
Sulphur	mg/L	114	0	-	-	5.4	130	295	428	N
Thallium	mg/L	191	184	0.0008	135	0.000025	**0.08**	**0.10**	**0.5**	Y
Tin	mg/L	258	241	-	-	0.000005	0.01	0.02	0.079	Y
Titanium	mg/L	253	110	-	-	0.0005	0.03	0.16	1.17	N
Uranium	mg/L	50	14	0.02	0	0.00025	0.002	0.004	0.004	N
Vanadium	mg/L	254	154	-	-	0.000005	0.01	0.02	0.1	N
Zinc	mg/L	258	4	0.03	99	0.0025	**0.06**	**0.18**	**1.4**	N

Notes: CCME Guidelines = Canadian Council of Ministers of the Environment guidelines for protection of aquatic life (CCME 2003); Shading indicates values that exceed CCME guidelines.
No. of obs. > CCME = number of observations greater than the CCME guideline
Analytical results reported as less than method detection limit (MDL) were assumed to be equal to ½ method detection limit in the calculation of minimum, mean, 95th percentile and maximum values.

Table B.1.1-2 Water Quality Summary for Pony Creek

Pony Creek Routine Params/Nutrients		N	N<MDL	CCME WQ Guideline	N>CCME	Min	Mean	95th Percentile	Max	Heavily Censored?
Chloride	mg/L	21	3	-	-	0.09	0.68	2.40	2.6	N
Sulphate	mg/L	21	0	-	-	9.41	68.2	129.00	146	N
Ammonia-N	mg/L	21	15	2.2	0	0.005	0.02	0.03	0.039	N
Nitrate-N	mg/L	21	4	13	0	0.005	0.03	0.08	0.1	N
Cyanide Compounds										
Cyanide - T	mg/L	0	0	-	--	--	--	--	--	
Cyanate	mg/L	21	18	-	-	0.1	0.11	0.20	0.2	N
Thiocyanate	mg/L	21	0	-	-	0.4	0.86	1.40	2.1	N
CN-WAD	mg/L	21	2	-	-	0.001	0.002	0.00	0.004	N
CN-SAD	mg/L	21	11	-	-	0.001	0.0015	0.00	0.002	N
Total Metals										
Aluminum	mg/L	22	0	0.1	15	0.036	**2.22**	**3.21**	**41.1**	N
Antimony	mg/L	22	0	-	-	0.0002	0.0027	0.00	0.0242	N
Arsenic	mg/L	22	0	0.005	10	0.0024	**0.034**	**0.24**	**0.35**	N
Barium	mg/L	22	0	-	-	0.025	0.09	0.10	0.857	N
Beryllium	mg/L	22	19	-	-	0.00005	0.0001	0.00	0.002	N
Bismuth	mg/L	22	20	-	-	0.00025	0.0005	0.00	0.003	Y
Boron	mg/L	22	9	-	-	0.001	0.0023	0.00	0.01	N
Cadmium	mg/L	22	0	0.000017	22	**0.00006**	**0.0013**	**0.0061**	**0.0062**	N
Calcium	mg/L	22	0	-	-	10.4	37.4	53.42	55.4	N
Chromium	mg/L	22	10	0.0089	1	0.00025	0.003	0.0033	**0.049**	N
Cobalt	mg/L	22	4	-	-	0.00005	0.0017	0.00	0.029	N
Copper	mg/L	22	0	0.004	13	0.002	**0.018**	**0.09**	**0.14**	N
Iron	mg/L	22	1	0.3	14	0.05	**3.56**	**8.28**	**59.1**	N
Lead	mg/L	22	0	0.007	5	0.0002	**0.02**	**0.17**	**0.21**	N
Lithium	mg/L	22	7	-	-	0.0005	0.002	0.00	0.025	N
Magnesium	mg/L	22	0.00	-	-	2.4	8.89	12.00	12.9	N
Manganese	mg/L	22	0	-	-	0.011	0.35	0.77	3.03	N
Molybdenum	mg/L	22	20	0.073	0	0.0005	0.0007	0.0010	0.005	Y
Nickel	mg/L	22	4	0.15	0	0.00025	0.002	0.0020	0.032	N
Potassium	mg/L	22	3	-	-	0.2	0.92	1.76	7	N
Selenium	mg/L	22	18	0.001	0	0.0001	0.0002	0.0006	0.001	N
Silicon	mg/L	22	0.00	-	-	2.05	7.5	9.84	36.8	N
Silver	mg/L	22	4	0.0001	6	0.000005	**0.0003**	**0.0016**	**0.0029**	N
Sodium	mg/L	22	0	-	-	1.2	3.7	4.69	4.8	N
Strontium	mg/L	22	0	-	-	0.072	0.26	0.36	0.371	N
Sulphur	mg/L	22	0	-	-	3.7	22.6	41.75	43.3	N
Thallium	mg/L	22	19	0.0008	0	0.000025	6.48E-05	0.00011	0.00075	N
Tin	mg/L	22	22	-	-	0.0005	0.0005	0.00	0.001	Y
Titanium	mg/L	22	1	-	-	0.00025	0.07	0.10	1.33	N
Uranium	mg/L	22	11	0.02	0	0.00025	0.0009	0.00	0.0064	N
Vanadium	mg/L	22	0	-	-	0.0001	0.007	0.01	0.125	N
Zinc	mg/L	22	0	0.03	13	0.006	**0.11**	**0.42**	**0.51**	N

Notes: CCME Guidelines = Canadian Council of Ministers of the Environment guidelines for protection of aquatic life (CCME 2003); Shading indicates values that exceed CCME guidelines.
No. of obs. > CCME = number of observations greater than the CCME guideline.
Analytical results reported as less than method detection limit (MDL) were assumed to be equal to ½ method detection limit in the calculation of minimum, mean, 95th percentile and maximum values.

Table B.1.1-3 Water Quality Summary for Victoria Creek

Victoria Creek				**CCME WQ**				**95th**		**Heavily**
Routine Params/Nutrients		**N**	**N<MDL**	**Guideline**	**N>CCME**	**Min**	**Mean**	**Percentile**	**Max**	**Censored?**
Chloride	mg/L	28	4	-	-	0.1	0.50	1.2	2.6	N
Sulphate	mg/L	262	1	-	-	2.13	32.92	95.34	636	N
Ammonia-N	mg/L	259	111	2.2	3	0.0025	0.10	0.14	**8.3**	N
Nitrate-N	mg/L	251	14	13	0	0.001	0.15	0.47	7.5	N
Cyanide Compounds										
Cyanide - T	mg/L	156	73	-	-	0.0025	0.01	0.02	0.064	N
Cyanate	mg/L	259	235	-	-	0.0025	0.22	0.46	1.5	Y
Thiocyanate	mg/L	257	145	-	-	0.015	0.75	2.2	23.9	N
CN-WAD	mg/L	262	183	-	-	0.0005	0.01	0.01	0.25	N
CN-SAD	mg/L	106	35	-	-	0.0005	0.01	0.07	0.389	N
Total Metals							32.92			
Aluminum	mg/L	263	129	0.1	70	0.01	**0.31**	**1.1**	**10.2**	N
Antimony	mg/L	261	236	-	-	0.00005	0.06	0.10	0.2	Y
Arsenic	mg/L	263	193	0.005	198	0.0001	**0.06**	**0.10**	**0.2**	N
Barium	mg/L	263	0	-	-	0.035	0.08	0.12	0.581	N
Beryllium	mg/L	202	200	-	-	0.000025	0.002	0.003	0.005	Y
Bismuth	mg/L	232	232	-	-	0.000025	0.07	0.10	0.2	Y
Boron	mg/L	204	173	-	-	0.001	0.04	0.05	0.1	N
Cadmium	mg/L	263	215	0.000017	257	0.000005	**0.003**	**0.01**	**0.01**	N
Calcium	mg/L	263	0	-	-	7.3	27.9	40.5	241	N
Chromium	mg/L	263	226	0.0089	3	0.000025	0.003	0.005	**0.010**	N
Cobalt	mg/L	263	223	-	-	0.00005	0.003	0.01	0.012	N
Copper	mg/L	263	153	0.004	200	0.0005	**0.01**	**0.02**	**0.066**	N
Iron	mg/L	263	37	0.3	83	0.015	**0.49**	**1.84**	**12.1**	N
Lead	mg/L	263	219	0.007	160	0.000025	**0.02**	**0.03**	**0.055**	N
Lithium	mg/L	232	211	-	-	0.0005	0.004	0.01	0.023	Y
Magnesium	mg/L	263	0	-	-	2.2	9.0	13.1	76.6	N
Manganese	mg/L	263	9	-	-	0.0025	0.09	0.18	5.64	N
Molybdenum	mg/L	263	260	0.073	0	0.00031	0.01	0.02	0.03	Y
Nickel	mg/L	263	217	0.15	0	0.000025	0.02	0.03	0.05	N
Potassium	mg/L	263	155	-	-	0.1	1.2	2.0	13.3	N
Selenium	mg/L	261	243	0.001	212	0.0001	**0.06**	**0.10**	**0.2**	Y
Silicon	mg/L	261	0	-	-	2.39	6.3	8.1	44	N
Silver	mg/L	263	241	0.0001	217	0.000005	**0.003**	**0.01**	**0.011**	Y
Sodium	mg/L	263	29	-	-	0.9	4.2	9.0	92.7	N
Strontium	mg/L	263	0	-	-	0.079	0.26	0.37	2.28	N
Sulphur	mg/L	46	0	-	-	1	7.1	10.8	26.5	N
Thallium	mg/L	202	201	0.0008	154	0.000025	**0.08**	**0.10**	**0.2**	Y
Tin	mg/L	262	256	-	-	0.00005	0.01	0.02	0.03	Y
Titanium	mg/L	259	168	-	-	0.0005	0.01	0.03	0.307	N
Uranium	mg/L	37	21	0.02	0	0.000025	0.0004	0.001	0.0016	N
Vanadium	mg/L	260	175	-	-	0.0002	0.01	0.02	0.03	N
Zinc	mg/L	263	133	0.03	7	0.0005	0.01	0.02	**0.328**	N

Notes: CCME Guidelines = Canadian Council of Ministers of the Environment guidelines for protection of aquatic life (CCME 2003); Shading indicates values that exceed CCME guidelines.
No. of obs. > CCME = number of observations greater than the CCME guideline
Analytical results reported as less than method detection limit (MDL) were assumed to be equal to ½ method detection limit in the calculation of minimum, mean, 95th percentile and maximum values.

Table B.1.1-4 Water Quality Summary for Reference Locations

Reference				**CCME**				**95th**		**Heavily**
Routine Params/Nutrients		**N**	**N<MDL**	**WQ Guideline**	**N>CCME**	**Min**	**Mean**	**Percentile**	**Max**	**Censored?**
Chloride	mg/L	6	0	-	-	0.40	0.67	1.05	1.10	N
Sulphate	mg/L	8	0	-	-	0.70	1.84	2.50	2.60	N
Ammonia-N	mg/L	8	6	2.2	0	0.01	0.02	0.03	0.03	N
Nitrate-N	mg/L	8	5	13	0	0.003	0.03	0.09	0.09	N
Cyanide Compounds										
Cyanide - T	mg/L	2	0	-	-	0.007	0.009	0.010	0.011	N
Cyanate	mg/L	8	8	-	-	0.1	0.14	0.25	0.25	Y
Thiocyanate	mg/L	8	2	-	-	0.25	0.98	1.7	1.7	N
CN-WAD	mg/L	7	4	-	-	0.001	0.002	0.0025	0.0025	N
CN-SAD	mg/L	6	2	-	-	0.001	0.002	0.004	0.004	N
Total Metals										
Aluminum	mg/L	8	2	0.1	1	0.032	**0.22**	**0.88**	**1.3**	N
Antimony	mg/L	8	5	-	-	0.0001	0.025	0.1	0.1	N
Arsenic	mg/L	8	2	0.005	2	0.0002	**0.026**	**0.1**	**0.1**	N
Barium	mg/L	8	0	-	-	0.032	0.052	0.06	0.07	N
Beryllium	mg/L	8	8	-	-	0.00005	0.001	0.0025	0.0025	Y
Bismuth	mg/L	8	8	-	-	0.00025	0.025	0.1	0.1	Y
Boron	mg/L	8	5	-	-	0.001	0.014	0.05	0.05	N
Cadmium	mg/L	8	4	0.000017	5	0.000005	**0.001**	**0.005**	**0.005**	N
Calcium	mg/L	8	0	-	-	6.9	21.3	33.4	37.8	N
Chromium	mg/L	8	6	0.0089	0	0.00025	0.002	0.0057	0.0061	N
Cobalt	mg/L	8	6	-	-	0.00005	0.001	0.005	0.005	N
Copper	mg/L	8	2	0.004	3	0.001	0.003	**0.008**	**0.009**	N
Iron	mg/L	8	2	0.3	3	0.015	**0.39**	**1.3**	**1.7**	N
Lead	mg/L	8	5	0.007	2	0.00005	0.007	**0.025**	**0.025**	N
Lithium	mg/L	8	6	-	-	0.00005	0.002	0.005	0.005	N
Magnesium	mg/L	8	0	-	-	2	6.4	9.2	10.2	N
Manganese	mg/L	8	2	-	-	0.0025	0.019	0.05	0.072	N
Molybdenum	mg/L	8	8	0.073	0	0.00005	0.004	0.015	0.015	Y
Nickel	mg/L	8	4	0.15	0	0.00025	0.007	0.025	0.025	N
Potassium	mg/L	8	2	-	-	0.5	1.15	1.9	2.1	N
Selenium	mg/L	8	8	0.001	2	0.0001	**0.025**	**0.1**	**0.1**	Y
Silicon	mg/L	8	0	-	-	3.37	4.9	6.22	6.44	N
Silver	mg/L	8	6	0.0001	2	0.000005	**0.001**	**0.005**	**0.005**	N
Sodium	mg/L	8	0	-	-	0.8	2.0	2.8	2.9	N
Strontium	mg/L	8	0	-	-	0.066	0.15	0.26	0.27	N
Sulphur	mg/L	6	0	-	-	1	3.5	5.0	5.0	N
Thallium	mg/L	8	8	0.0008	2	0.000025	**0.025**	**0.1**	**0.1**	Y
Tin	mg/L	8	8	-	-	0.00005	0.004	0.015	0.015	Y
Titanium	mg/L	8	2	-	-	0.0014	0.008	0.03	0.04	N
Uranium	mg/L	6	5	0.02	0	0.00025	0.0003	0.0005	0.0006	N
Vanadium	mg/L	8	2	-	-	0.0004	0.005	0.015	0.015	N
Zinc	mg/L	8	2	0.03	0	0.0025	0.007	0.014	0.016	N

Notes: CCME Guidelines = Canadian Council of Ministers of the Environment guidelines for protection of aquatic life (CCME 2003); Shading indicates values that exceed CCME guidelines.
No. of obs. > CCME = number of observations greater than the CCME guideline
Analytical results reported as less than method detection limit (MDL) were assumed to be equal to ½ method detection limit in the calculation of minimum, mean, 95th percentile and maximum values.

Table B.1.1-5 Water Quality Summary for Tailings Pond

Tailings Pond								
Routine Params/Nutrients		**N**	**N<MDL**	**Min**	**Mean**	**95th Percentile**	**Max**	**Heavily Censored?**
Chloride	mg/L	13	0	1.2	2.12	3.13	3.81	N
Sulphate	mg/L	180	0	187	1380	2191	6000	N
Ammonia-N	mg/L	182	2	0.025	11.2	35.1	49	N
Nitrate-N	mg/L	171	4	0.01	1.75	4.3	8.1	N
Cyanide Compounds								
Cyanide - T	mg/L	71	0	0.0074	0.03	0.07	0.25	N
Cyanate	mg/L	171	56	0.015	12.5	87.6	168	N
Thiocyanate	mg/L	171	5	0.25	28.0	107	817	N
CN-WAD	mg/L	194	17	0.001	2.84	10	140	N
CN-SAD	mg/L	119	0	0.002	10.4	60	152	N
Total Metals								
Aluminum	mg/L	183	96	0.005	0.21	0.66	5.97	N
Antimony	mg/L	176	136	0.01	0.08	0.1	2.18	N
Arsenic	mg/L	180	107	0.01	0.09	0.20	1.86	N
Barium	mg/L	183	3	0.005	0.03	0.05	0.26	N
Beryllium	mg/L	87	87	0.00005	0.002	0.0025	0.005	Y
Bismuth	mg/L	125	118	0.00025	0.06	0.1	0.2	Y
Boron	mg/L	102	5	0.05	0.17	0.31	0.36	N
Cadmium	mg/L	183	113	0.00025	0.003	0.005	0.028	N
Calcium	mg/L	183	0	101	347	530	667	N
Chromium	mg/L	183	155	0.00025	0.003	0.005	0.013	N
Cobalt	mg/L	183	40	0.0012	0.05	0.143	0.174	N
Copper	mg/L	183	2	0.005	4.38	19.05	105	N
Iron	mg/L	183	2	0.0025	1.66	4.0	38.3	N
Lead	mg/L	183	112	0.0025	0.04	0.078	1.44	N
Lithium	mg/L	125	92	0.0025	0.01	0.0158	0.033	N
Magnesium	mg/L	183	1	0.01	35.5	75.6	106	N
Manganese	mg/L	183	0	0.123	4.45	10.18	26.6	N
Molybdenum	mg/L	183	124	0.0015	0.01	0.0169	0.151	N
Nickel	mg/L	183	77	0.0005	0.05	0.1208	0.869	N
Potassium	mg/L	183	0	5.5	17.5	31.7	48	N
Selenium	mg/L	176	163	0.0001	0.05	0.1	0.23	Y
Silicon	mg/L	176	0	0.41	3.2	5.6	11.1	N
Silver	mg/L	183	115	0.00011	0.02	0.06	0.24	N
Sodium	mg/L	183	0	27.2	214	464	709	N
Strontium	mg/L	183	0	0.08	0.86	1.49	1.73	N
Sulphur	mg/L	14	0	211	327	587	624	N
Thallium	mg/L	87	73	0.0002	0.08	0.1	0.2	N
Tin	mg/L	183	163	0.00025	0.01	0.025	0.12	N
Titanium	mg/L	179	149	0.0002	0.01	0.028	0.11	N
Uranium	mg/L	13	0	0.0012	0.002	0.005	0.006	N
Vanadium	mg/L	180	130	0.0002	0.01	0.029	0.054	N
Zinc	mg/L	183	0	0.004	0.14	0.25	5.01	N

Notes: CCME Guidelines are not included since the Tailings Pond is not an aquatic habitat.
Analytical results reported as less than method detection limit (MDL) were assumed to be equal to ½ method detection limit in the calculation of minimum, mean, 95th percentile and maximum values.

Table B.1.1-6 Water Quality Summary for Brown-McDade Pit

Brown-McDade Pit								
Routine Params/Nutrients		**N**	**N<MDL**	**Min**	**Mean**	**95th Percentile**	**Max**	**Heavily Censored?**
Chloride	mg/L	5	0	0.28	0.64	1.3	1.5	N
Sulphate	mg/L	18	0	111	675	1145.5	1290	N
Ammonia-N	mg/L	19	8	0.005	0.05	0.138	0.21	N
Nitrate-N	mg/L	18	2	0.0025	1.08	3.28	3.79	N
Cyanide Compounds								
Thiocyanate	mg/L	6	1	0.25	0.82	1.105	1.13	N
Total Metals								
Aluminum	mg/L	19	11	0.01	0.07	0.1	0.1	N
Antimony	mg/L	19	11	0.0046	0.06	0.1	0.1	N
Arsenic	mg/L	19	11	0.0081	0.06	0.1	0.1	N
Barium	mg/L	19	3	0.005	0.014	0.02	0.02	N
Beryllium	mg/L	19	19	0.00005	0.0015	0.0025	0.0025	Y
Bismuth	mg/L	19	19	0.000025	0.06	0.1	0.1	Y
Boron	mg/L	19	11	0.004	0.03	0.05	0.05	N
Cadmium	mg/L	19	11	0.00305	0.01	0.0145	0.0154	N
Calcium	mg/L	19	0	37.2	225	351	377	N
Chromium	mg/L	19	18	0.000025	0.003	0.005	0.005	Y
Cobalt	mg/L	19	12	0.00005	0.003	0.005	0.005	N
Copper	mg/L	19	6	0.005	0.02	0.0437	0.05	N
Iron	mg/L	19	7	0.015	0.07	0.137	0.2	N
Lead	mg/L	19	11	0.0007	0.02	0.025	0.025	N
Lithium	mg/L	19	7	0.005	0.01	0.0121	0.013	N
Magnesium	mg/L	19	0	9.8	66	109	116	N
Manganese	mg/L	19	0	0.0408	0.29	0.80	0.96	N
Molybdenum	mg/L	19	19	0.0005	0.01	0.015	0.015	Y
Nickel	mg/L	19	11	0.0016	0.02	0.025	0.025	N
Potassium	mg/L	19	3	1	2.3	3.2	3.5	N
Selenium	mg/L	19	15	0.0001	0.06	0.1	0.1	N
Silicon	mg/L	19	0	0.73	3.8	5.4	6.0	N
Silver	mg/L	19	12	0.00001	0.0032	0.0055	0.01	N
Sodium	mg/L	19	1	1.00	8.3	12.7	12.8	N
Strontium	mg/L	19	0	0.11	0.75	1.02	1.04	N
Sulphur	mg/L	8	0	172	219	263	273	N
Thallium	mg/L	19	11	0.00008	0.06	0.1	0.1	N
Tin	mg/L	19	19	0.0005	0.009	0.015	0.015	Y
Titanium	mg/L	19	11	0.0048	0.009	0.018	0.021	N
Uranium	mg/L	5	0	0.0023	0.003	0.0042	0.0045	N
Vanadium	mg/L	19	11	0.0002	0.01	0.015	0.015	N
Zinc	mg/L	19	0	0.16	0.73	1.33	1.38	N

Notes: CCME Guidelines are not included since the Tailings Pond is not an aquatic habitat.
Analytical results reported as less than method detection limit (MDL) were assumed to be equal to ½ method detection limit in the calculation of minimum, mean, 95th percentile and maximum values.

B.1.2 Sediment Quality

The total metals concentrations in sediment measured at the Mt. Nansen Mine between 1988 and 2006 from Dome Creek, Pony Creek, and Victoria Creek were used in the assessment. Measurements from a reference sampling location "upstream of mine development" were used to determine the background concentrations. The three samples from the reference location were collected in 1988. Sediment data were not available for the Tailings Pond and the Brown-McDade. For the purposes of calculating summary statistics, observations reported as less than MDL were assumed to be at half of the MDL.

Dome Creek

Sediment data were collected from different sampling locations in Dome Creek (sampling locations D1, D2, D3, D4, D5, D5_1, "at final discharge of tailings dam") and are summarized in Table B.1.2-1. The CCME Interim Sediment Quality Guidelines (ISQG) and Probable Effect Levels (PEL) are also provided in Table B.1.2-1. The guidelines provide scientific benchmarks for evaluating the potential for observing adverse biological effects on benthic invertebrates in aquatic systems. The ISQG values represent the concentrations below which adverse biological erects are expected occur rarely. The PEL values represent the concentrations above which adverse effects are expected to occur frequently.

Bold shaded cells in Table B.1.2-1 indicate values that exceed ISQG. CCME ISQG levels were exceeded for arsenic, cadmium, chromium, copper, lead, mercury and zinc at Dome Creek. ISQG levels were also exceeded for arsenic and cadmium at the reference location.

Pony Creek

Sediment data were collected from different sampling locations in Pony Creek (B1, B1_1, P1, P2, P3) and are summarized in Table B.1.2-2. The CCME Interim Sediment Quality Guidelines (ISQG) and Probable Effect Levels (PEL) are also provided in Table B.1.2-2. The guidelines provide scientific benchmarks for evaluating the potential for observing adverse biological effects on benthic invertebrates in aquatic systems. The ISQG values represent the concentrations below which adverse biological erects are expected occur rarely. The PEL values represent the concentrations above which adverse effects are expected to occur frequently.

Bold shaded cells in Table B.1.2-2 indicate values that exceed ISQG. CCME ISQG levels were exceeded for arsenic, cadmium, copper, lead, and zinc at Pony Creek. ISQG levels were also exceeded for arsenic and cadmium at the reference location.

Victoria Creek

Sediment data were collected from different sampling locations in Victoria Creek (V1, V2, V3, V4, V5) and are summarized in Table B.1.2-3. The CCME Interim Sediment Quality Guidelines (ISQG) and Probable Effect Levels (PEL) are also provided in Table B.1.2-3. The guidelines provide scientific benchmarks for evaluating the potential for observing adverse biological effects on benthic invertebrates in aquatic systems. The ISQG values represent the concentrations below which adverse biological erects are expected occur rarely. The PEL values represent the concentrations above which adverse effects are expected to occur frequently.

Bold shaded cells in Table B.1.2-3 indicate values that exceed ISQG. CCME ISQG levels were exceeded for arsenic, cadmium, chromium, copper, lead, and zinc at Victoria Creek. ISQG levels were also exceeded for arsenic and cadmium at the reference location.

Reference Location

Sediment data were collected from a reference location ("upstream of mine development") are summarized in Table B.1.2-4. The CCME Interim Sediment Quality Guidelines (ISQG) and Probable Effect Levels (PEL) are also provided in Table B.1.2-4. The guidelines provide scientific benchmarks for evaluating the potential for observing adverse biological effects on benthic invertebrates in aquatic systems. The ISQG values represent the concentrations below which adverse biological erects are expected occur rarely. The PEL values represent the concentrations above which adverse effects are expected to occur frequently.

Bold shaded cells in Table B.1.2-4 indicate values that exceed ISQG. CCME ISQG levels were exceeded for arsenic and cadmium at the reference location.

Table B.1.2-1 Sediment Quality at Dome Creek

				CCME					
	Units	**N**	**N<MDL**	**ISQG**	**PEL**	**Min**	**Mean**	**95th Percentile**	**Max**
Aluminum	mg/kg (dw)	40	0			4680	12437	28231	31540
Antimony	mg/kg (dw)	31	11			0.25	19	70	99.6
Arsenic	mg/kg (dw)	41	0	5.9	17	**11**	**570**	**2500**	**2760**
Barium	mg/kg (dw)	40	0			42	154	412	444
Beryllium	mg/kg (dw)	40	9			0.14	0.41	0.81	1
Bismuth	mg/kg (dw)	1	1			0.25	0.25	0.25	0.25
Boron	mg/kg (dw)	10	9			0.5	7	35	63
Cadmium	mg/kg (dw)	41	8	0.6	3.5	0.025	**6**	**26.4**	**48**
Calcium	mg/kg (dw)	40	0			2520	7591	13900	16300
Chromium	mg/kg (dw)	40	0	37.3	90	8	23	**54**	**60.4**
Cobalt	mg/kg (dw)	41	0			1.9	11	20	29.9
Copper	mg/kg (dw)	41	0	35.7	197	5.43	**50**	**157**	**683**
Iron	mg/kg (dw)	40	0			7380	27296	52390	88500
Lead	mg/kg (dw)	41	2	35	91.3	2.5	**152**	**530**	**1030**
Lithium	mg/kg (dw)	1	0			6.1	6.1	6.1	6.1
Magnesium	mg/kg (dw)	40	0			1860	4056	7817	9260
Manganese	mg/kg (dw)	41	0			88	1952	14100	20400
Mercury	mg/kg (dw)	17	8	0.17	0.486	0.005	0.022	0.08	**0.21**
Molybdenum	mg/kg (dw)	41	9			0.1	3	9	10
Nickel	mg/kg (dw)	41	0			5	13	32	35
Phosphorus	mg/kg (dw)	40	0			420	800	1200	1400
Potassium	mg/kg (dw)	31	0			324	1902	5169	5538
Selenium	mg/kg (dw)	31	14			0.1	2	8	8
Silicon	mg/kg (dw)	12	0			240	785	1361	1410
Silver	mg/kg (dw)	41	15			0.055	2	7	15.7
Sodium	mg/kg (dw)	40	0			100	370	735	2780
Strontium	mg/kg (dw)	40	0			12	39	77	77.4
Sulphur	mg/kg (dw)	5	0			213	354	456	465
Thallium	mg/kg (dw)	1	1			0.15	0.15	0.15	0.15
Tin	mg/kg (dw)	41	9			0.3	5	10	32
Titanium	mg/kg (dw)	40	0			172	766	2231	2310
Uranium	mg/kg (dw)	0	0			-	-	-	-
Vanadium	mg/kg (dw)	41	0			15	55	110	140
Zinc	mg/kg (dw)	41	0	123	315	27	**601**	**3030**	**4680**
Zirconium	mg/kg (dw)	22	0			1	3	9.2	15.8

Notes: Shading indicates values that exceed CCME ISQG levels.
Observations reported as less than method detection limit (MDL) were assumed to be at half of the MDL

Table B.1.2-2 Sediment Quality at Pony Creek

	Units	N	N<MDL	CCME ISQG	CCME PEL	Min	Mean	95th Percentile	Max
Aluminum	mg/kg (dw)	8	0			6570	17558	51425	57900
Antimony	mg/kg (dw)	8	1			0.8	62	234	310
Arsenic	mg/kg (dw)	8	0	5.9	17	**21.5**	**838**	**3269**	**4480**
Barium	mg/kg (dw)	8	0			85.4	233	577	669
Beryllium	mg/kg (dw)	8	0			0.19	0.4	0.7	0.7
Bismuth	mg/kg (dw)	8	5			0.25	10	40	54
Boron	mg/kg (dw)	0	0			-	-	-	-
Cadmium	mg/kg (dw)	8	0	0.6	3.5	0.3	**8**	**28**	**31.5**
Calcium	mg/kg (dw)	8	0			3560	4881	8780	10600
Chromium	mg/kg (dw)	8	0	37.3	90	10.4	15	23	26.7
Cobalt	mg/kg (dw)	8	0			3	6	11	11.3
Copper	mg/kg (dw)	8	0	35.7	197	7.44	**203**	**822**	**1150**
Iron	mg/kg (dw)	8	0			14200	37638	88360	106000
Lead	mg/kg (dw)	8	0	35	91.3	12.7	**628**	**2802**	**4090**
Lithium	mg/kg (dw)	8	0			5.5	10	21	23.6
Magnesium	mg/kg (dw)	8	0			2370	3061	5150	6420
Manganese	mg/kg (dw)	8	0			153	1257	2877	3360
Mercury	mg/kg (dw)	6	0	0.17	0.486	0.012	0.05	0.12	0.14
Molybdenum	mg/kg (dw)	8	2			0.025	0.8	2.3	3.0
Nickel	mg/kg (dw)	8	0			5.97	9	14	16.2
Phosphorus	mg/kg (dw)	8	0			694	842	988	990
Potassium	mg/kg (dw)	8	0			527	3235	12841	17300
Selenium	mg/kg (dw)	8	8			0.15	0.36	1.00	1.00
Silicon	mg/kg (dw)	8	0			274	712	2123	2990
Silver	mg/kg (dw)	8	0			0.2	15	69	98.9
Sodium	mg/kg (dw)	8	0			134	395	1193	1360
Strontium	mg/kg (dw)	8	0			22.1	44	84	93
Sulphur	mg/kg (dw)	2	0			940	11970	21897	23000
Thallium	mg/kg (dw)	8	7			0.15	0.5	1.5	2.0
Tin	mg/kg (dw)	8	1			0.4	0.6	0.9	1.0
Titanium	mg/kg (dw)	8	0			176	369	845	1140
Uranium	mg/kg (dw)	2	2			2.5	2.5	2.5	2.5
Vanadium	mg/kg (dw)	8	0			28.1	44	59	61
Zinc	mg/kg (dw)	8	0	123	315	69.3	**521**	**1677**	**2070**
Zirconium	mg/kg (dw)	8	0			1.4	5	12	13.2

Notes: Shading indicates values that exceed CCME ISQG levels.
Observations reported as less than method detection limit (MDL) were assumed to be at half of the MDL

Table B.1.2-3 Sediment Quality at Victoria Creek

				CCME				**95th**	
	Units	**N**	**N<MDL**	**ISQG**	**PEL**	**Min**	**Mean**	**Percentile**	**Max**
Aluminum	mg/kg (dw)	54	0			4070	13771	32090	35000
Antimony	mg/kg (dw)	42	11			0.25	6	20	21
Arsenic	mg/kg (dw)	55	0	5.9	17	2.5	**29**	**63**	**97**
Barium	mg/kg (dw)	54	0			54.6	167	375	434
Beryllium	mg/kg (dw)	54	9			0.15	0.5	0.8	0.9
Bismuth	mg/kg (dw)	2	1			0.25	0.25	0.25	0.25
Boron	mg/kg (dw)	12	9			0.5	4.7	23	51
Cadmium	mg/kg (dw)	55	8	0.6	3.5	0.1	0.5	**0.92**	**2.3**
Calcium	mg/kg (dw)	54	0			2070	5810	9897	12800
Chromium	mg/kg (dw)	54	0	37.3	90	7.7	22	35	**69**
Cobalt	mg/kg (dw)	55	0			2.5	12	20.3	23.5
Copper	mg/kg (dw)	55	0	35.7	197	4	29	**77**	**127**
Iron	mg/kg (dw)	54	0			9580	25242	40471	49620
Lead	mg/kg (dw)	55	2	35	91.3	1	34	**80**	**387**
Lithium	mg/kg (dw)	2	0			5.2	6	6.2	6.3
Magnesium	mg/kg (dw)	54	0			1490	4036	7527.5	9170
Manganese	mg/kg (dw)	55	0			113	567	1372	3560
Mercury	mg/kg (dw)	18	8	0.17	0.486	0.005	0.011	0.020	0.052
Molybdenum	mg/kg (dw)	55	9			0.3	4.0	8.3	10
Nickel	mg/kg (dw)	55	0			4	9	17.1	20.3
Phosphorus	mg/kg (dw)	54	0			334	864	1200	1300
Potassium	mg/kg (dw)	42	0			261	2178	5995	7200
Selenium	mg/kg (dw)	42	14			0.1	3.3	8	8
Silicon	mg/kg (dw)	31	0			249	521	826	878
Silver	mg/kg (dw)	55	15			0.055	1.3	2	2
Sodium	mg/kg (dw)	54	0			100	398	1456	1850
Strontium	mg/kg (dw)	54	0			13	43	79	89
Sulphur	mg/kg (dw)	17	0			202	287	419	501
Thallium	mg/kg (dw)	2	1			0.15	0.15	0.15	0.15
Tin	mg/kg (dw)	55	9			0.3	5	8	8
Titanium	mg/kg (dw)	54	0			181	929	1882	2028
Uranium	mg/kg (dw)	0	0			-	-	-	-
Vanadium	mg/kg (dw)	55	0			22.6	64	100	120
Zinc	mg/kg (dw)	55	0	123	315	26	78	**151**	**228**
Zirconium	mg/kg (dw)	25	0			0.5	4	15	19

Notes: Shading indicates values that exceed CCME ISQG levels.
Observations reported as less than method detection limit (MDL) were assumed to be at half of the MDL

Table B.1.2-4 Sediment Quality at Reference Location

	Units	N	CCME ISQG	CCME PEL	Min	Mean	95th Percentile	Max
Aluminum	mg/kg (dw)	3			12100	12300	12560	12600
Antimony	mg/kg (dw)	0			-	-	-	-
Arsenic	mg/kg (dw)	3	5.9	17	**87**	**101**	**118**	**120**
Barium	mg/kg (dw)	3			125	127	129	129
Beryllium	mg/kg (dw)	3			0.2	0.2	0.3	0.3
Bismuth	mg/kg (dw)	0			-	-	-	-
Boron	mg/kg (dw)	0			-	-	-	-
Cadmium	mg/kg (dw)	3	0.6	3.5	**0.63**	**0.72**	**0.86**	**0.89**
Calcium	mg/kg (dw)	3			5680	5850	5963	5970
Chromium	mg/kg (dw)	3	37.3	90	12.0	13.0	13.9	14.0
Cobalt	mg/kg (dw)	3			20	20	20	20
Copper	mg/kg (dw)	3	35.7	197	11.0	11.3	11.9	12.0
Iron	mg/kg (dw)	3			13700	14133	14790	14900
Lead	mg/kg (dw)	3	35	91.3	22.4	25	28.4	28.8
Lithium	mg/kg (dw)	0			-	-	-	-
Magnesium	mg/kg (dw)	3			2580	2610	2637	2640
Manganese	mg/kg (dw)	3			297	331	370	376
Mercury	mg/kg (dw)	0	0.17	0.486	-	-	-	-
Molybdenum	mg/kg (dw)	3			2.0	2.7	3.0	3.0
Nickel	mg/kg (dw)	3			7.0	8.0	8.9	9.0
Phosphorus	mg/kg (dw)	3			840	850	859	860
Potassium	mg/kg (dw)	0			-	-	-	-
Selenium	mg/kg (dw)	0			-	-	-	-
Silicon	mg/kg (dw)	3			336	344	352	353
Silver	mg/kg (dw)	3			2.0	2.0	2.0	2.0
Sodium	mg/kg (dw)	3			230	240	249	250
Strontium	mg/kg (dw)	3			29.0	29.7	30.1	30.1
Sulphur	mg/kg (dw)	0			-	-	-	-
Thallium	mg/kg (dw)	0			-	-	-	-
Tin	mg/kg (dw)	3			8.0	8.0	8.0	8.0
Titanium	mg/kg (dw)	3			669	709	739	741
Uranium	mg/kg (dw)	0			-	-	-	-
Vanadium	mg/kg (dw)	3			43	44	45	45
Zinc	mg/kg (dw)	3	123	315	108	111	115	116
Zirconium	mg/kg (dw)	0			-	-	-	-

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B.1.3 Fish Surveys

Fish samples from slimy sculpin and burbot were collected and analyzed for metals concentrations during the field investigation conducted in 2005 and 2006 by EDI (2007). Fish caught in Victoria Creek sampling locations Vic3 (downstream from Dome Creek) and Vic4 (downstream of the road crossing) were selected for use in this assessment. Fish collected from Vic5 (outlet of Victoria Lake) and Rowlinson Creek (reference location) were considered to represent background concentrations outside the influence of the site for the purposes of this assessment.

Slimy sculpin were analyzed on a whole body basis due to the small size of the species, and this data is summarized in Table B.1.3-1. Only burbot fish flesh (muscle) concentrations were considered in the assessment are included in Table B.1.3-1. Dry weight concentrations reported by the laboratory are converted to fresh weight based on the reported sample moisture content.

From Table B.1.3-1, concentrations of antimony, beryllium, boron, and tellurium in fish are below the laboratory MDL for both mine areas and reference locations. Chemical concentrations in fish sampled in the mine area are not consistently higher or lower than the concentrations in fish sampled from the reference location, although there is a noticeable difference in arsenic concentrations in fish from the two areas.

Table B.1.3-1 Summary of Concentrations in Fish

(mg/kg fw)	Mine Area						Reference Locations					
	N	**N < MDL**	**Min**	**Mean**	**95th Percentile**	**Max**	**N**	**N < MDL**	**Min**	**Mean**	**95th Percentile**	**Max**
Aluminum	19	0	1.3	27	62	156	24	0	0.4	16.6	33.6	93.0
Antimony	19	19	0.010	0.013	0.016	0.02	24	24	0.01	0.02	0.02	0.06
Arsenic	19	0	0.20	0.4	0.6	0.7	24	0	0.06	0.15	0.26	0.27
Barium	19	0	0.13	2.5	4.3	5.7	24	0	0.05	2.7	5.5	6.3
Beryllium	19	19	0.002	0.003	0.003	0.004	24	24	0.002	0.003	0.003	0.012
Boron	19	19	0.21	0.26	0.32	0.40	24	24	0.2	0.3	0.3	1.2
Cadmium	19	4	0.002	0.04	0.09	0.10	24	10	0.00	0.02	0.07	0.08
Calcium	19	0	260	7849	13827	14145	24	0	203	8804	16724	20096
Chromium	19	4	0.01	0.06	0.11	0.22	24	12	0.01	0.05	0.19	0.29
Cobalt	19	4	0.01	0.07	0.11	0.15	24	4	0.01	0.06	0.15	0.23
Copper	19	0	0.55	0.92	1.25	1.30	24	0	0.4	1.0	1.6	1.7
Iron	19	0	5	88	188	312	24	0	4.5	70	118	254
Lead	19	6	0.01	0.05	0.12	0.22	24	13	0.01	0.02	0.06	0.10
Magnesium	19	0	296	372	450	470	24	0	303	401	499	518
Manganese	19	0	0.73	14.3	28.0	35.2	24	0	0.5	12.0	24.1	31.7
Mercury	19	0	0.008	0.02	0.05	0.06	24	0	0.01	0.04	0.06	0.22
Molybdenum	19	15	0.010	0.02	0.03	0.05	24	16	0.01	0.03	0.06	0.06
Nickel	19	3	0.010	0.06	0.14	0.19	24	5	0.01	0.11	0.20	1.17
Phosphorus	19	0	2300	5985	9060	9350	24	0	2255	6476	10849	12529
Potassium	19	0	2899	3502	4439	4507	24	0	2916	3612	4516	5085
Selenium	19	0	0.16	0.89	1.84	2.44	24	0	0.1	0.5	1.5	1.7
Silicon	19	0	17	35	55	78	24	0	14	43	85	86
Silver	19	9	0.001	0.003	0.006	0.008	24	14	0.001	0.002	0.003	0.006
Sodium	19	0	772	1193	1487	1690	24	0	500	1146	1513	1721
Strontium	19	0	0.38	15.83	28.54	29.03	24	0	0.4	19.7	38.9	50.2
Tellurium	19	19	0.010	0.013	0.016	0.020	24	24	0.010	0.015	0.016	0.059
Thallium	19	12	0.002	0.004	0.007	0.008	24	23	0.002	0.003	0.004	0.012
Tin	19	15	0.010	0.020	0.049	0.093	24	21	0.010	0.027	0.084	0.164
Titanium	19	0	0.94	3.48	6.09	9.08	24	0	0.86	3.2	5.2	5.9
Uranium	19	14	0.004	0.008	0.015	0.022	24	23	0.004	0.006	0.009	0.017
Vanadium	19	4	0.05	0.32	0.69	0.74	24	5	0.05	0.27	0.45	0.55
Zinc	19	0	5.7	18.3	25.2	25.3	24	0	5.2	19.2	27.3	28.4
Zirconium	4	4	0.31	0.40	0.56	0.60	4	4	0.30	0.32	0.34	0.34

Notes: N = total number of fish samples

Analytical results reported as less than method detection limit (MDL) were assumed to be equal to ½ method detection limit in the calculation of minimum, mean, 95th percentile, and maximum.

Concentrations are on a fresh weight (fw) basis calculated using the reported moisture content and dry weight concentrations.

B.2 TERRESTRIAL ENVIRONMENT

The Mt. Nansen Terrestrial and Aquatic Effects Study 2005-2006 (EDI 2007) presents the results from extensive soil, vegetation, and small animal sampling completed around the Mt. Nansen Mine site, as well as from upland (reference) areas. Ungulate (caribou and moose) sample concentrations were also presented in EDI (2007). Figure B.2.1-1 presents the site locations considered in the terrestrial environment.

B.2.1 Soil Data

Soil data were provided by EDI (2007). Soil samples were collected from three soil horizons (A, B, and C). The A Horizon was mineral soil above the ash layer; the B Horizon was the ash layer; and the C Horizon was the mineral soil below the ash layer. For the purposes of the assessment, only data from the top (A) soil horizon was considered.

Table B.2.1-1 summarizes chemical concentrations in surface soil samples from the mine areas and Table B.2.1-2 summarizes the soil samples from the reference/background location. The reference samples were collected from a mineralized control area, approximately 1 to 2 km from the mine site. The CCME soil guidelines for agricultural land uses are also included in Tables B.2.1-1 and B.2.1-2 (CCME 2003).

Mean arsenic concentrations in soil exceed the CCME guidelines in the affected mine areas. The mean arsenic concentration in soil at the reference site also exceeds the CCME guidelines, indicating that the observed high concentrations of arsenic in soil might, in some part, be due to natural levels in the area and are not a direct result of the mining activities.

Mean cadmium concentrations in soil exceed the CCME guidelines in affected area, but not the reference site. In general, the soil concentrations in affected area are higher than the reference sites for most metals.

Table B.2.1-1 Soil Data Summary – Mine Areas

	Units	N	N<MDL	CCME Soil Guideline (Agr)	Min	Mean	95th Percentile	Max	Heavily Censored?
Mill Site									
Aluminum	mg/kg	26	0	-	1000	7863	13750	16000	N
Antimony	mg/kg	26	25	20	5.0	5.8	5.0	**25**	Y
Arsenic	mg/kg	26	8	12	5	**75.3**	**279**	**485**	N
Barium	mg/kg	26	0	750	10	210	493	**1310**	N
Beryllium	mg/kg	26	26	4	0.5	0.5	0.5	0.5	Y
Boron	mg/kg	26	23	2	0.5	0.9	2	**7**	N
Cadmium	mg/kg	26	12	1.4	0.25	1.1	**4.2**	**7**	N
Calcium	mg/kg	26	0	-	1050	6407	19300	22000	N
Chromium	mg/kg	26	1	64	1	8.5	18	20	N
Cobalt	mg/kg	26	0	40	2	8.6	14	**59**	N
Copper	mg/kg	26	0	63	1	22.5	43	54	N
Iron	mg/kg	26	0	-	4520	15628	30925	37400	N
Lead	mg/kg	26	11	70	2.5	13.3	33	**129**	N
Magnesium	mg/kg	26	0	-	434	2605	6495	8360	N
Manganese	mg/kg	26	0	-	60	1552	4915	21200	N
Mercury	mg/kg	26	5	6.6	0.005	0.1	0.14	0.14	N
Molybdenum	mg/kg	26	26	5	2	2.0	2	2	Y
Nickel	mg/kg	26	5	50	1	6.6	13.8	14	N
Phosphorus	mg/kg	26	0	-	331	860	1280	1880	N
Potassium	mg/kg	26	0	-	53	684	2150	2200	N
Selenium	mg/kg	26	13	1	0.1	0.4	1.3	**2**	N
Silver	mg/kg	26	26	20	1	1.0	1	1	Y
Sodium	mg/kg	26	0	-	52	121	211	218	N
Strontium	mg/kg	26	0	-	7	34.4	90	100	N
Tin	mg/kg	26	26	5	2.5	2.5	2.5	2.5	Y
Titanium	mg/kg	26	0	-	63	373	719	783	N
Vanadium	mg/kg	26	0	130	6	34.5	60	65	N
Zinc	mg/kg	26	0	200	7	61.8	**201**	**253**	N
Zirconium	mg/kg	26	9	-	0.5	1.2	2.0	2.0	N
Tailings Site									
Aluminum	mg/kg	20	0	-	634	7145	24465	37100	N
Antimony	mg/kg	20	19	20	5	5.3	5.3	10	Y
Arsenic	mg/kg	20	11	12	5	69	352	400	N
Barium	mg/kg	20	0	750	6	111	342	388	N
Beryllium	mg/kg	20	20	4	0.5	0.5	0.5	0.5	Y
Boron	mg/kg	20	19	2	0.5	1.3	1.3	**17**	Y
Cadmium	mg/kg	20	14	1.4	0.25	1.2	**4.4**	**6.1**	N
Calcium	mg/kg	20	0	-	419	3094	7907	18300	N

Table B.2.1-1 Soil Data Summary – Mine Areas (Cont'd)

	Units	N	N<MDL	CCME Soil Guideline (Agr)	Min	Mean	95th Percentile	Max	Heavily Censored?
Tailings Site (cont'd)									
Chromium	mg/kg	20	2	64	1	8.4	23.1	24	N
Cobalt	mg/kg	20	0	40	1	8.0	31.1	32	N
Copper	mg/kg	20	1	63	0.5	41.8	**122**	**340**	N
Iron	mg/kg	20	0	-	3510	22202	91425	99500	N
Lead	mg/kg	20	13	70	2.5	7.2	28.2	31	N
Magnesium	mg/kg	20	0	-	179	1402	2629	3170	N
Manganese	mg/kg	20	0	-	24	1568	9082	9880	N
Mercury	mg/kg	20	7	6.6	0.005	0.05	0.16	0.17	N
Molybdenum	mg/kg	20	18	5	2	2.3	4.1	5	N
Nickel	mg/kg	20	5	50	1	6.5	18.4	25	N
Phosphorus	mg/kg	20	0	-	87	596	979	1090	N
Potassium	mg/kg	20	0	-	96	365	609	727	N
Selenium	mg/kg	20	13	1	0.1	0.3	0.9	0.9	N
Silver	mg/kg	20	19	20	1	1.3	1.3	6	Y
Sodium	mg/kg	20	0	-	53	124	235	264	N
Strontium	mg/kg	20	0	-	5	21	54	66	N
Tin	mg/kg	20	16	5	2.5	3.3	7.1	8	N
Titanium	mg/kg	20	0	-	54	242	428	443	N
Vanadium	mg/kg	20	0	130	6	31	78	104	N
Zinc	mg/kg	20	0	200	5	46	161	195	N
Zirconium	mg/kg	20	12	-	0.5	1.4	6.1	7	N
Brown-McDade Pit									
Aluminum	mg/kg	15	0	-	853	6672	16730	19600	N
Antimony	mg/kg	15	15	20	5	5	5	5	Y
Arsenic	mg/kg	15	7	12	5	**13.9**	**34**	**62**	N
Barium	mg/kg	15	0	750	5	177	445.3	453	N
Beryllium	mg/kg	15	15	4	0.5	0.5	0.5	0.5	Y
Boron	mg/kg	15	13	2	0.5	0.77	**2.3**	**3**	N
Cadmium	mg/kg	15	7	1.4	0.25	**1.8**	**5.45**	**6.5**	N
Calcium	mg/kg	15	0	-	377	6182	16650	19800	N
Chromium	mg/kg	15	1	64	1	8.4	20.2	23	N
Cobalt	mg/kg	15	0	40	2	5.5	15	15	N
Copper	mg/kg	15	0	63	1	19.7	56.4	**90**	N
Iron	mg/kg	15	0	-	2160	10851	19760	21300	N
Lead	mg/kg	15	9	70	2.5	8.1	26.6	35	N
Magnesium	mg/kg	15	0	-	212	1497	3034	3090	N
Manganese	mg/kg	15	0	-	30	578	1923	2840	N
Mercury	mg/kg	15	4	6.6	0.005	0.04	0.11	0.11	N

Table B.2.1-1 Soil Data Summary – Mine Areas (Cont'd)

	Units	N	N<MDL	CCME Soil Guideline (Agr)	Min	Mean	95th Percentile	Max	Heavily Censored?
Brown-McDade Pit (cont'd)									
Molybdenum	mg/kg	15	15	5	2	2	2	2	Y
Nickel	mg/kg	15	3	50	1	6.2	11.8	16	N
Phosphorus	mg/kg	15	0	-	55	630	1048.6	1190	N
Potassium	mg/kg	15	0	-	94	311	542.5	567	N
Selenium	mg/kg	15	10	1	0.1	0.21	0.53	0.6	N
Silver	mg/kg	15	15	20	1	1	1	1	Y
Sodium	mg/kg	15	0	-	50	134	234.1	246	N
Strontium	mg/kg	15	0	-	6	44	109.4	150	N
Tin	mg/kg	15	15	5	2.5	2.5	2.5	2.5	Y
Titanium	mg/kg	15	0	-	31	226	365.8	398	N
Vanadium	mg/kg	15	0	130	3	22.9	46.3	54	N
Zinc	mg/kg	15	0	200	9	44.3	105.6	107	N
Zirconium	mg/kg	15	7	-	0.5	0.83	1.3	2	N

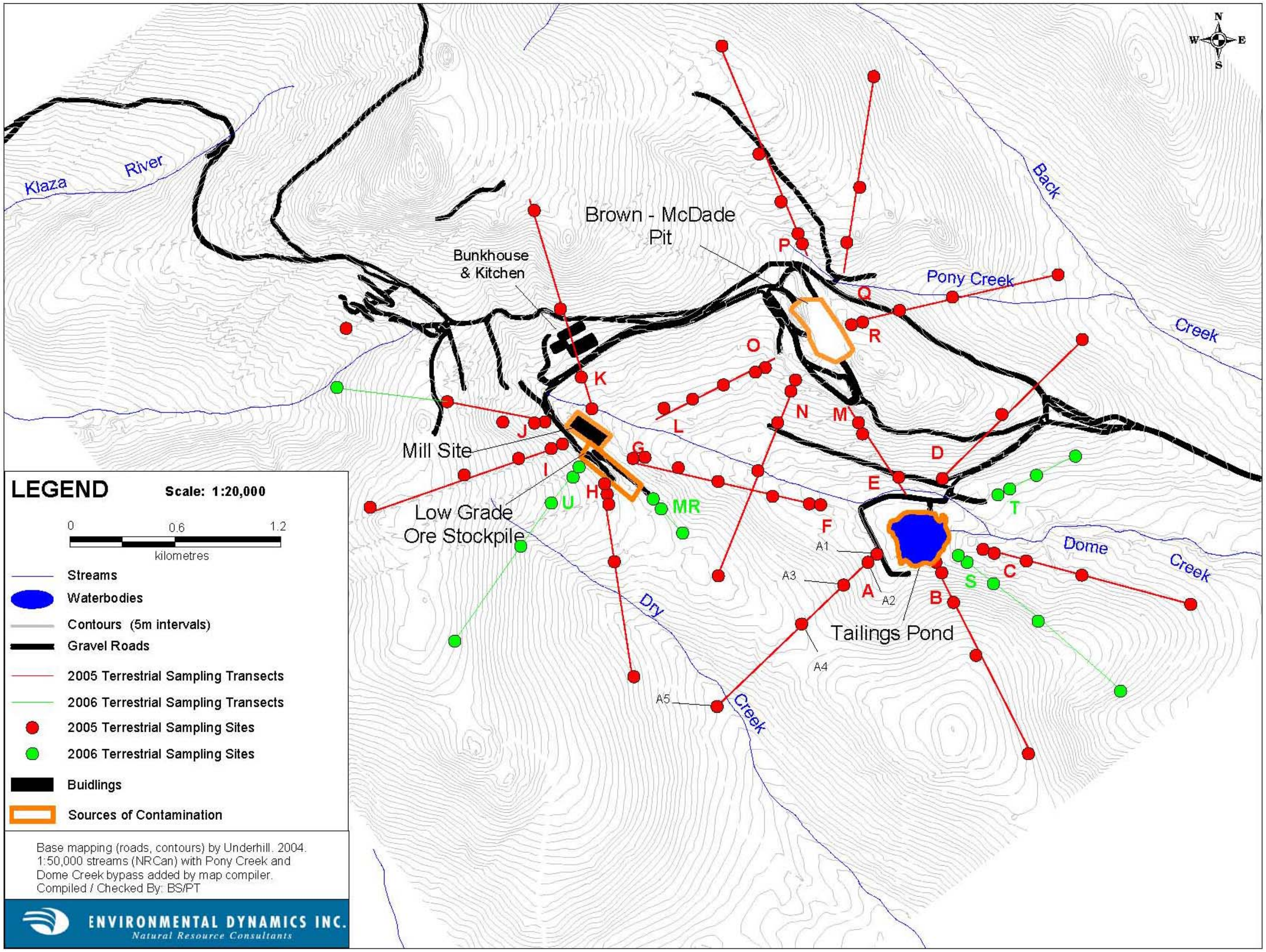
Notes: CCME Guidelines = Canadian Council of Ministers of the Environment guidelines for soil (agricultural land uses) (CCME 2003)
Shading indicates values that exceed CCME guidelines.
Analytical results reported as less than method detection limit (MDL) were assumed to be equal to ½ method detection limit in the calculation of minimum, mean, and 95th percentile and maximum.

Table B.2.1-2 Soil Data Summary – Reference Area

	Units	N	CCME Soil Guideline (Agr)	Min	Mean	95th Percentile	Max
Aluminum	mg/kg	3	-	4200	9067	15996	17120
Antimony	mg/kg	3	20	5	5	5	5
Arsenic	mg/kg	3	12	11	**42**	**80**	**85**
Barium	mg/kg	3	750	46	101	132	133
Beryllium	mg/kg	3	4	0.5	0.5	0.5	0.5
Boron	mg/kg	3	2	0.5	0.6	0.86	0.9
Cadmium	mg/kg	3	1.4	0.3	1.3	**2.1**	**2.2**
Calcium	mg/kg	3	-	997	8712	20239	22156
Chromium	mg/kg	3	64	8	12.4	19.7	21
Cobalt	mg/kg	3	40	2.8	4.7	7.7	8.2
Copper	mg/kg	3	63	12.0	18.7	28.4	30.0
Iron	mg/kg	3	-	7932	12267	18871	19980
Lead	mg/kg	3	70	8.9	16.0	26.3	28.0
Magnesium	mg/kg	3	-	1223	2135	3683	3956
Manganese	mg/kg	3	-	121	204	334	356
Mercury	mg/kg	3	6.6	0.02	0.1	0.1	0.1
Molybdenum	mg/kg	3	5	2	2	2	2
Nickel	mg/kg	3	50	5.4	8.3	11.6	12
Phosphorus	mg/kg	3	-	245	559	928	981
Potassium	mg/kg	3	-	344	566	688	691
Selenium	mg/kg	3	1	0.1	0.1	0.1	0.1
Silver	mg/kg	3	20	1	1	1	1
Sodium	mg/kg	3	-	83	102	128	132
Strontium	mg/kg	3	-	8.0	18.7	28.8	30.0
Tin	mg/kg	3	5	2.5	2.5	2.5	2.5
Titanium	mg/kg	3	-	108	236	338	347
Vanadium	mg/kg	3	130	15	27	41	43
Zinc	mg/kg	3	200	31	68	106	111
Zirconium	mg/kg	3	-	0.6	1.0	1.7	1.8

Notes: CCME Guidelines = Canadian Council of Ministers of the Environment guidelines for soil (agricultural land uses) (CCME 2003)
Shading indicates values that exceed CCME guidelines.
Analytical results reported as less than method detection limit (MDL) were assumed to be equal to ½ method detection limit in the calculation of minimum, mean and maximum.

Figure B.2.1-1 Locations Considered in Terrestrial Assessment



B.2.2 Terrestrial Vegetation Data

Extensive vegetation sampling was completed in 2005 and 2006 from around the Mt. Nansen Mine and metals concentrations in various types of vegetation are available (EDI 2007). Vegetation types sampled include: trembling aspen, blueberry, cranberry, foxtail barley, lichen, sphagnum moss, bolete mushroom, rose hip, spruce, Labrador tea, willow, and wheatgrass.

Mill Site (transects G, H, I, J, K, L and samples Dome-6, Dome-7), Tailings Site (transects A, B, C, D, E, F and samples FG, Dome-1, Dome-2, Dome-3, Dome-4, Dome-5), and Brown-McDade Pit (transects M, N, O, P, Q, R and samples EM3, V1, V2, V3, V4, Pony1, Pony2, Pony3, Dust1, Dust2, Dust3) were assessed separately. Measurements from a reference sampling location (CP-1, CP-2, CP-3, CP-4, CP-5, CP-6, CP-7, CP-8, CP-9) were used to determine the background concentrations.

Tables B.2.2-1 to B.2.2-5 summarize COPC concentrations for each vegetation type in both the background and mine areas. Forage (Table B.2.2-1), browse (Table B.2.2-2), berries (Table B.2.2-3), lichen (Table B.2.2-4), fungi (Table B.2.2-5), and evergreen (Table B.2.2-6) are consumed by wildlife in the area. In the ecological risk assessment, wheatgrass, foxtail barley, and Labrador tea were grouped as forage and cranberry (foliage), willow and trembling aspen as browse and their concentrations are summarized for each mine area as defined in Section B.2.1. Berries were characterized by blueberry, cranberry, and crowberry and are also summarized. Fungi were characterized by bolete mushroom and evergreen were represented by spruce. Dry weight concentrations reported by the laboratory are converted to fresh weight based on the reported sample moisture content.

Labrador tea was brewed following the traditional procedure and analyzed for metals content, as summarized in Table B.2.2-7. This data was used for the human health risk assessment.

Table B.2.2-1 Summary of Concentrations in Forage

COPC	Units	N	N <MDL	Min	Mean	95th Percentile	Max
Background							
Aluminum	mg/kg ww	13	0	3.1	15.6	24.7	25.9
Antimony	mg/kg ww	13	13	0.019	0.022	0.025	0.025
Arsenic	mg/kg ww	13	7	0.02	0.04	0.12	0.15
Barium	mg/kg ww	13	0	5.6	23.5	30.9	32.6
Beryllium	mg/kg ww	13	13	0.004	0.004	0.005	0.005
Boron	mg/kg ww	13	0	1.1	5.5	9.3	10.5
Cadmium	mg/kg ww	13	6	0.004	0.02	0.07	0.09
Calcium	mg/kg ww	13	0	783	2239	3306	3365
Chromium	mg/kg ww	13	9	0.02	0.07	0.26	0.46
Cobalt	mg/kg ww	13	13	0.019	0.022	0.025	0.025
Copper	mg/kg ww	13	0	1.2	1.6	1.9	2.0
Iron	mg/kg ww	13	0	17.8	26.9	36.9	40.6
Lead	mg/kg ww	13	8	0.02	0.68	3.8	5.9
Magnesium	mg/kg ww	13	0	258	532	702	753
Manganese	mg/kg ww	13	0	10	439	937	964
Mercury	mg/kg ww	13	13	0.002	0.002	0.002	0.003
Molybdenum	mg/kg ww	13	7	0.02	0.07	0.22	0.27
Nickel	mg/kg ww	13	0	0.09	0.20	0.44	0.59
Phosphorus	mg/kg ww	13	0	452	645	832	953
Potassium	mg/kg ww	13	0	1746	2726	4660	4674
Selenium	mg/kg ww	13	13	0.04	0.04	0.05	0.05
Silicon	mg/kg ww	13	0	37	84	162	206
Silver	mg/kg ww	13	11	0.002	0.003	0.007	0.011
Sodium	mg/kg ww	13	0	0.44	1.9	4.1	6.4
Strontium	mg/kg ww	13	0	2.6	3.6	5.3	5.8
Tellurium	mg/kg ww	13	13	0.019	0.022	0.025	0.025
Thallium	mg/kg ww	13	3	0.004	0.027	0.063	0.065
Tin	mg/kg ww	13	12	0.02	0.03	0.05	0.08
Titanium	mg/kg ww	13	0	0.40	0.69	1.1	1.3
Uranium	mg/kg ww	13	13	0.008	0.009	0.010	0.010
Vanadium	mg/kg ww	13	13	0.09	0.11	0.12	0.13
Zinc	mg/kg ww	13	0	6.5	11.4	14.1	15.3
Zirconium	mg/kg ww	13	13	0.57	0.67	0.75	0.75

Table B.2.2-1 Summary of Concentrations in Forage (Cont'd)

COPC	Units	N	N <MDL	Min	Mean	95th Percentile	Max
Mill Site							
Aluminum	mg/kg ww	24	0	3.6	11	21	37
Antimony	mg/kg ww	24	16	0.02	0.05	0.1	0.4
Arsenic	mg/kg ww	24	2	0.02	0.6	2	5
Barium	mg/kg ww	24	0	1.6	21	36	39
Beryllium	mg/kg ww	24	24	0.004	0.005	0.005	0.005
Boron	mg/kg ww	24	0	2.0	9.0	18	22
Cadmium	mg/kg ww	24	7	0.0	0.1	0.2	0.6
Calcium	mg/kg ww	24	0	1178	2842	4164	4916
Chromium	mg/kg ww	24	17	0.02	0.07	0.23	0.46
Cobalt	mg/kg ww	24	23	0.02	0.04	0.03	0.41
Copper	mg/kg ww	24	0	1.0	1.7	2.1	2.2
Iron	mg/kg ww	24	0	16.7	35	66	93
Lead	mg/kg ww	24	5	0.02	0.4	2.0	3.0
Magnesium	mg/kg ww	24	0	395	635	1063	1651
Manganese	mg/kg ww	24	0	29	349	767	938
Mercury	mg/kg ww	24	24	0.002	0.002	0.002	0.003
Molybdenum	mg/kg ww	24	18	0.02	0.08	0.25	0.72
Nickel	mg/kg ww	24	0	0.0	0.1	0.4	0.4
Phosphorus	mg/kg ww	24	0	403	606	689	1388
Potassium	mg/kg ww	24	0	1484	2283	3699	3917
Selenium	mg/kg ww	24	24	0.040	0.045	0.047	0.051
Silicon	mg/kg ww	24	0	31	77	231	269
Silver	mg/kg ww	24	11	0.002	0.01	0.04	0.05
Sodium	mg/kg ww	24	0	0.4	3.2	10	14
Strontium	mg/kg ww	24	0	2.0	3.9	6	9
Tellurium	mg/kg ww	24	24	0.020	0.023	0.024	0.026
Thallium	mg/kg ww	24	13	0.004	0.013	0.048	0.054
Tin	mg/kg ww	24	23	0.02	0.04	0.03	0.33
Titanium	mg/kg ww	24	0	0.4	0.6	0.8	1.2
Uranium	mg/kg ww	24	24	0.008	0.009	0.009	0.010
Vanadium	mg/kg ww	24	24	0.10	0.11	0.12	0.13
Zinc	mg/kg ww	24	0	9	19	42	91
Zirconium	mg/kg ww	24	24	0.60	0.68	0.71	0.77

Table B.2.2-1 Summary of Concentrations in Forage (Cont'd)

COPC	Units	N	N <MDL	Min	Mean	95th Percentile	Max
Tailings Site							
Aluminum	mg/kg ww	14	0	5.7	19.2	39.2	65.2
Antimony	mg/kg ww	14	10	0.02	0.26	1.2	2.3
Arsenic	mg/kg ww	14	6	0.02	2.5	12.1	24.4
Barium	mg/kg ww	14	0	2.4	24	37	37
Beryllium	mg/kg ww	14	14	0.004	0.005	0.005	0.005
Boron	mg/kg ww	14	0	3.4	6.7	10.5	15.9
Cadmium	mg/kg ww	14	4	0.0	0.1	0.4	0.8
Calcium	mg/kg ww	14	0	1548	2543	3379	3640
Chromium	mg/kg ww	14	9	0.02	0.08	0.26	0.39
Cobalt	mg/kg ww	14	13	0.02	0.03	0.03	0.05
Copper	mg/kg ww	14	0	1.2	3.5	11.5	26.2
Iron	mg/kg ww	14	0	13.9	67	222	449
Lead	mg/kg ww	14	5	0.02	2.3	11.4	24.2
Magnesium	mg/kg ww	14	0	190	532	880	1125
Manganese	mg/kg ww	14	0	25	476	916	1226
Mercury	mg/kg ww	14	14	0.002	0.002	0.003	0.003
Molybdenum	mg/kg ww	14	8	0.02	0.09	0.26	0.29
Nickel	mg/kg ww	14	0	0.1	0.2	0.3	0.3
Phosphorus	mg/kg ww	14	0	410	575	681	686
Potassium	mg/kg ww	14	0	1625	2811	6561	8883
Selenium	mg/kg ww	14	14	0.039	0.048	0.052	0.052
Silicon	mg/kg ww	14	0	31	59	106	131
Silver	mg/kg ww	14	9	0.002	0.02	0.11	0.20
Sodium	mg/kg ww	14	1	0.2	15.4	79	117
Strontium	mg/kg ww	14	0	1.6	4.3	8.8	9.9
Tellurium	mg/kg ww	14	14	0.019	0.024	0.026	0.026
Thallium	mg/kg ww	14	4	0.004	0.022	0.054	0.057
Tin	mg/kg ww	14	14	0.019	0.024	0.026	0.026
Titanium	mg/kg ww	14	0	0.3	0.5	0.8	0.8
Uranium	mg/kg ww	14	14	0.008	0.010	0.010	0.010
Vanadium	mg/kg ww	14	13	0.10	0.13	0.19	0.29
Zinc	mg/kg ww	14	0	7	20	70	99
Zirconium	mg/kg ww	14	14	0.6	0.7	0.8	0.8

Table B.2.2-1 Summary of Concentrations in Forage (Cont'd)

COPC	Units	N	N <MDL	Min	Mean	95th Percentile	Max
Brown-McDade Pit							
Aluminum	mg/kg ww	21	0	4.7	16.4	42.6	77.7
Antimony	mg/kg ww	21	17	0.02	0.08	0.28	0.65
Arsenic	mg/kg ww	21	1	0.02	0.94	5.8	7.4
Barium	mg/kg ww	21	0	0.49	18.9	40.1	48.4
Beryllium	mg/kg ww	21	21	0.0041	0.0047	0.0049	0.0050
Boron	mg/kg ww	21	0	1.9	7.4	14.0	15.8
Cadmium	mg/kg ww	21	3	0.005	0.09	0.31	0.41
Calcium	mg/kg ww	21	0	847	2400	3964	4034
Chromium	mg/kg ww	21	11	0.02	0.09	0.28	0.28
Cobalt	mg/kg ww	21	19	0.02	0.03	0.05	0.14
Copper	mg/kg ww	21	0	1.2	2.0	4.1	5.3
Iron	mg/kg ww	21	0	18	65	237	343
Lead	mg/kg ww	21	4	0.02	0.64	2.42	6.09
Magnesium	mg/kg ww	21	0	248	577	861	1225
Manganese	mg/kg ww	21	0	18	300	772	810
Mercury	mg/kg ww	21	21	0.0021	0.0023	0.0025	0.0025
Molybdenum	mg/kg ww	21	12	0.02	0.09	0.25	0.47
Nickel	mg/kg ww	21	0	0.05	0.20	0.64	0.69
Phosphorus	mg/kg ww	21	0	406	622	948	1151
Potassium	mg/kg ww	21	0	1182	3008	5118	6467
Selenium	mg/kg ww	21	21	0.04	0.05	0.05	0.05
Silicon	mg/kg ww	21	0	46	96	201	245
Silver	mg/kg ww	21	6	0.002	0.02	0.05	0.07
Sodium	mg/kg ww	21	2	0.23	2.5	6.0	6.5
Strontium	mg/kg ww	21	0	2.0	4.8	6.5	10.6
Tellurium	mg/kg ww	21	21	0.021	0.023	0.025	0.025
Thallium	mg/kg ww	21	15	0.004	0.010	0.014	0.07
Tin	mg/kg ww	21	21	0.021	0.023	0.025	0.025
Titanium	mg/kg ww	21	0	0.33	0.84	1.7	2.7
Uranium	mg/kg ww	21	20	0.008	0.010	0.010	0.028
Vanadium	mg/kg ww	21	19	0.10	0.14	0.28	0.42
Zinc	mg/kg ww	21	0	8.6	35.5	117	125
Zirconium	mg/kg ww	21	21	0.62	0.70	0.74	0.74

Notes: Analytical results reported as less than method detection limit (MDL) were assumed to be equal to ½ method detection limit in the calculation of minimum, mean and maximum.
Forage: wheatgrass, foxtail barley, and Labrador tea
Moisture content reported by laboratory or assumed to be equal to the average moisture content of other forage samples.

Table B.2.2-2 Summary of Concentrations in Browse

COPC	Units	N	N <MDL	Min	Mean	95th Percentile	Max
Background							
Aluminum	mg/kg ww	11	0	8.0	21.2	45.9	46.7
Antimony	mg/kg ww	11	11	0.019	0.021	0.023	0.024
Arsenic	mg/kg ww	11	5	0.02	0.04	0.08	0.12
Barium	mg/kg ww	11	0	10.4	33.0	50.8	53.7
Beryllium	mg/kg ww	11	7	0.004	0.006	0.012	0.012
Boron	mg/kg ww	11	0	2.1	3.3	4.6	5.0
Cadmium	mg/kg ww	11	0	0.82	3.3	8.7	11.4
Calcium	mg/kg ww	11	0	3643	5733	9131	9420
Chromium	mg/kg ww	11	8	0.02	0.04	0.10	0.12
Cobalt	mg/kg ww	11	0	0.21	0.43	0.66	0.66
Copper	mg/kg ww	11	0	1.0	1.5	1.8	1.9
Iron	mg/kg ww	11	0	31.8	44.2	55.2	57.3
Lead	mg/kg ww	11	2	0.02	0.13	0.49	0.89
Magnesium	mg/kg ww	11	0	781	1514	2268	2628
Manganese	mg/kg ww	11	0	78	232	569	768
Mercury	mg/kg ww	11	11	0.0019	0.0021	0.0023	0.0024
Molybdenum	mg/kg ww	11	5	0.02	0.03	0.04	0.04
Nickel	mg/kg ww	11	0	0.29	1.2	1.6	1.7
Phosphorus	mg/kg ww	11	0	450	1004	1610	1629
Potassium	mg/kg ww	11	0	1863	3706	4618	4838
Selenium	mg/kg ww	11	11	0.038	0.041	0.046	0.049
Silicon	mg/kg ww	11	0	23	40	60	65
Silver	mg/kg ww	11	4	0.002	0.005	0.012	0.015
Sodium	mg/kg ww	11	0	1.9	4.2	10.7	13.2
Strontium	mg/kg ww	11	0	22	39	60	60
Tellurium	mg/kg ww	11	11	0.019	0.021	0.023	0.024
Thallium	mg/kg ww	11	11	0.004	0.004	0.005	0.005
Tin	mg/kg ww	11	10	0.019	0.023	0.033	0.042
Titanium	mg/kg ww	11	0	0.50	0.98	1.6	2.1
Uranium	mg/kg ww	11	11	0.008	0.008	0.009	0.010
Vanadium	mg/kg ww	11	11	0.09	0.10	0.11	0.12
Zinc	mg/kg ww	11	0	34	69	168	272
Zirconium	mg/kg ww	11	11	0.56	0.62	0.69	0.73

Table B.2.2-2 Summary of Concentrations in Browse (Cont'd)

COPC	Units	N	N <MDL	Min	Mean	95th Percentile	Max
Mill Site							
Aluminum	mg/kg ww	22	0	3.3	25	144	194
Antimony	mg/kg ww	22	12	0.02	0.29	2.1	2.5
Arsenic	mg/kg ww	22	1	0.02	4.2	24	55
Barium	mg/kg ww	22	0	0.4	12	29	53
Beryllium	mg/kg ww	22	20	0.004	0.004	0.007	0.008
Boron	mg/kg ww	22	0	1.5	9.9	34	85
Cadmium	mg/kg ww	22	0	0.4	3.2	11.1	20.7
Calcium	mg/kg ww	22	0	3293	5628	8513	8535
Chromium	mg/kg ww	22	15	0.02	0.09	0.57	0.76
Cobalt	mg/kg ww	22	1	0.02	0.25	0.53	0.86
Copper	mg/kg ww	22	0	0.8	1.7	3.4	4.0
Iron	mg/kg ww	22	0	24.1	111	602	837
Lead	mg/kg ww	22	1	0.02	2.3	14.9	25.0
Magnesium	mg/kg ww	22	0	632	1339	1886	3221
Manganese	mg/kg ww	22	0	31	165	316	609
Mercury	mg/kg ww	22	22	0.002	0.002	0.002	0.002
Molybdenum	mg/kg ww	22	7	0.02	0.06	0.11	0.18
Nickel	mg/kg ww	22	0	0.1	0.5	1.0	1.2
Phosphorus	mg/kg ww	22	0	286	586	1431	1500
Potassium	mg/kg ww	22	0	1169	2948	4581	4750
Selenium	mg/kg ww	22	22	0.036	0.038	0.038	0.039
Silicon	mg/kg ww	22	0	28	48	109	172
Silver	mg/kg ww	22	5	0.002	0.04	0.25	0.31
Sodium	mg/kg ww	22	0	0.8	9.2	35	49
Strontium	mg/kg ww	22	0	5.1	19.7	33	51
Tellurium	mg/kg ww	22	22	0.018	0.019	0.019	0.020
Thallium	mg/kg ww	22	16	0.004	0.007	0.016	0.040
Tin	mg/kg ww	22	19	0.019	0.025	0.071	0.075
Titanium	mg/kg ww	22	0	0.4	1.4	8.4	8.8
Uranium	mg/kg ww	22	22	0.007	0.008	0.008	0.008
Vanadium	mg/kg ww	22	19	0.09	0.18	0.91	1.1
Zinc	mg/kg ww	22	0	39	142	389	556
Zirconium	mg/kg ww	22	22	0.55	0.56	0.57	0.59

Table B.2.2-2 Summary of Concentrations in Browse (Cont'd)

COPC	Units	N	N <MDL	Min	Mean	95th Percentile	Max
Tailings Site							
Aluminum	mg/kg ww	13	0	4.4	13.0	37.9	43.0
Antimony	mg/kg ww	13	9	0.02	0.08	0.27	0.30
Arsenic	mg/kg ww	13	2	0.02	0.7	2.6	3.5
Barium	mg/kg ww	13	0	1.6	17	41	50
Beryllium	mg/kg ww	13	12	0.004	0.005	0.006	0.008
Boron	mg/kg ww	13	0	3.0	11.8	25.0	33.3
Cadmium	mg/kg ww	13	0	0.3	2.4	7.5	10.0
Calcium	mg/kg ww	13	0	2659	5913	8651	9790
Chromium	mg/kg ww	13	12	0.02	0.04	0.10	0.21
Cobalt	mg/kg ww	13	0	0.1	0.4	0.7	0.8
Copper	mg/kg ww	13	0	1.2	2.0	3.3	4.7
Iron	mg/kg ww	13	0	30.0	52	91	94
Lead	mg/kg ww	13	7	0.02	0.7	2.6	2.7
Magnesium	mg/kg ww	13	0	477	1242	1616	1680
Manganese	mg/kg ww	13	0	70	260	509	557
Mercury	mg/kg ww	13	13	0.002	0.002	0.002	0.002
Molybdenum	mg/kg ww	13	2	0.02	0.19	0.38	0.38
Nickel	mg/kg ww	13	0	0.1	0.6	1.2	1.4
Phosphorus	mg/kg ww	13	0	324	709	1353	1401
Potassium	mg/kg ww	13	0	2291	3660	4895	4895
Selenium	mg/kg ww	13	12	0.04	0.05	0.06	0.08
Silicon	mg/kg ww	13	0	21	38	57	70
Silver	mg/kg ww	13	8	0.002	0.01	0.04	0.05
Sodium	mg/kg ww	13	0	0.8	21.0	83	110
Strontium	mg/kg ww	13	0	9.5	22.5	42.1	42.6
Tellurium	mg/kg ww	13	13	0.021	0.021	0.021	0.021
Thallium	mg/kg ww	13	13	0.004	0.004	0.004	0.004
Tin	mg/kg ww	13	13	0.021	0.021	0.021	0.021
Titanium	mg/kg ww	13	0	0.3	0.7	1.2	1.2
Uranium	mg/kg ww	13	13	0.008	0.008	0.008	0.008
Vanadium	mg/kg ww	13	13	0.11	0.11	0.11	0.11
Zinc	mg/kg ww	13	0	51	141	261	322
Zirconium	mg/kg ww	13	13	0.6	0.6	0.6	0.6

Table B.2.2-2 Summary of Concentrations in Browse (Cont'd)

COPC	Units	N	N <MDL	Min	Mean	95^{th} Percentile	Max
Brown-McDade Pit							
Aluminum	mg/kg ww	19	0	3.5	11.3	24.8	26.9
Antimony	mg/kg ww	19	14	0.02	0.04	0.06	0.27
Arsenic	mg/kg ww	19	3	0.02	0.45	1.5	2.0
Barium	mg/kg ww	19	0	0.35	12	44	50
Beryllium	mg/kg ww	19	18	0.004	0.004	0.005	0.008
Boron	mg/kg ww	19	0	1.6	6.3	12.7	13.4
Cadmium	mg/kg ww	19	0	0.72	5.1	12.4	15.0
Calcium	mg/kg ww	19	0	3121	5705	9390	11987
Chromium	mg/kg ww	19	10	0.02	0.05	0.13	0.16
Cobalt	mg/kg ww	19	0	0.08	0.25	0.50	0.57
Copper	mg/kg ww	19	0	0.93	1.8	2.9	4.0
Iron	mg/kg ww	19	0	28	57	102	106
Lead	mg/kg ww	19	4	0.02	0.32	0.83	1.77
Magnesium	mg/kg ww	19	0	589	1261	1841	2431
Manganese	mg/kg ww	19	0	40	198	346	495
Mercury	mg/kg ww	19	19	0.0019	0.0020	0.0021	0.0021
Molybdenum	mg/kg ww	19	8	0.02	0.08	0.18	0.33
Nickel	mg/kg ww	19	0	0.04	0.35	0.65	1.1
Phosphorus	mg/kg ww	19	0	346	643	1141	1276
Potassium	mg/kg ww	19	0	1451	3112	4441	4917
Selenium	mg/kg ww	19	19	0.038	0.041	0.041	0.042
Silicon	mg/kg ww	19	0	24.0	41.3	56.1	57.2
Silver	mg/kg ww	19	3	0.002	0.01	0.02	0.04
Sodium	mg/kg ww	19	1	0.20	19	77	116
Strontium	mg/kg ww	19	0	10	28	52	71
Tellurium	mg/kg ww	19	19	0.019	0.020	0.021	0.021
Thallium	mg/kg ww	19	19	0.004	0.004	0.004	0.004
Tin	mg/kg ww	19	18	0.02	0.03	0.03	0.13
Titanium	mg/kg ww	19	0	0.41	0.79	1.2	1.5
Uranium	mg/kg ww	19	19	0.008	0.008	0.008	0.008
Vanadium	mg/kg ww	19	18	0.10	0.11	0.12	0.24
Zinc	mg/kg ww	19	0	33	171	473	518
Zirconium	mg/kg ww	19	19	0.58	0.61	0.62	0.64

Notes: Analytical results reported as less than method detection limit (MDL) were assumed to be equal to ½ method detection limit in the calculation of minimum, mean and maximum.
Browse: cranberry (foliage), willow and trembling aspen
Moisture content reported by laboratory or assumed to be equal to the average moisture content of other browse samples.

Table B.2.2-3 Summary of Concentrations in Berries

COPC	Units	N	N <MDL	Min	Mean	95th Percentile	Max
Background							
Aluminum	mg/kg ww	12	0	1.1	4.5	15.6	30.1
Antimony	mg/kg ww	12	12	0.01	0.01	0.01	0.01
Arsenic	mg/kg ww	12	11	0.01	0.01	0.02	0.03
Barium	mg/kg ww	12	0	0.7	2.1	4.2	5.9
Beryllium	mg/kg ww	12	12	0.001	0.002	0.002	0.002
Boron	mg/kg ww	12	0	0.7	1.5	2.4	2.4
Cadmium	mg/kg ww	12	2	0.001	0.05	0.21	0.30
Calcium	mg/kg ww	12	0	98	348	946	1666
Chromium	mg/kg ww	12	12	0.007	0.008	0.008	0.008
Cobalt	mg/kg ww	12	12	0.007	0.008	0.008	0.008
Copper	mg/kg ww	12	0	0.44	0.64	0.83	0.87
Iron	mg/kg ww	12	0	1.9	3.7	8.4	14.2
Lead	mg/kg ww	12	12	0.007	0.008	0.008	0.008
Magnesium	mg/kg ww	12	0	56.9	133	299	501
Manganese	mg/kg ww	12	0	4.1	56	165	275
Mercury	mg/kg ww	12	12	0.0007	0.0008	0.0008	0.0008
Molybdenum	mg/kg ww	12	6	0.01	0.02	0.04	0.05
Nickel	mg/kg ww	12	0	0.03	0.06	0.11	0.11
Phosphorus	mg/kg ww	12	0	117	211	296	300
Potassium	mg/kg ww	12	0	730	1293	1647	1675
Selenium	mg/kg ww	12	12	0.01	0.02	0.02	0.02
Silicon	mg/kg ww	12	0	11.4	15.8	19.9	20.3
Silver	mg/kg ww	12	12	0.0007	0.0008	0.0008	0.0008
Sodium	mg/kg ww	12	0	0.17	0.78	1.6	1.8
Strontium	mg/kg ww	12	0	0.22	0.65	1.7	3.0
Tellurium	mg/kg ww	12	12	0.007	0.008	0.008	0.008
Thallium	mg/kg ww	12	12	0.001	0.002	0.002	0.002
Tin	mg/kg ww	12	12	0.007	0.008	0.008	0.008
Titanium	mg/kg ww	12	0	0.08	0.15	0.26	0.37
Uranium	mg/kg ww	12	12	0.003	0.003	0.003	0.003
Vanadium	mg/kg ww	12	12	0.03	0.04	0.04	0.04
Zinc	mg/kg ww	12	0	0.69	2.3	4.6	6.6
Zirconium	mg/kg ww	12	12	0.21	0.23	0.25	0.25

Table B.2.2-3 Summary of Concentrations in Berries (Cont'd)

COPC	Units	N	N <MDL	Min	Mean	95th Percentile	Max
Mill Site							
Aluminum	mg/kg ww	18	0	0.5	4.9	22.0	24.6
Antimony	mg/kg ww	18	18	0.01	0.01	0.01	0.01
Arsenic	mg/kg ww	18	7	0.01	0.03	0.10	0.13
Barium	mg/kg ww	18	0	0.5	3	10	11
Beryllium	mg/kg ww	18	18	0.001	0.002	0.002	0.002
Boron	mg/kg ww	18	0	0.5	2.5	6.0	6.7
Cadmium	mg/kg ww	18	4	0.00	0.05	0.15	0.24
Calcium	mg/kg ww	18	0	64	530	1376	1404
Chromium	mg/kg ww	18	16	0.01	0.01	0.03	0.03
Cobalt	mg/kg ww	18	18	0.01	0.01	0.01	0.01
Copper	mg/kg ww	18	0	0.4	0.6	0.8	0.9
Iron	mg/kg ww	18	0	1.4	5	10	11
Lead	mg/kg ww	18	16	0.005	0.010	0.019	0.033
Magnesium	mg/kg ww	18	0	43	156	377	384
Manganese	mg/kg ww	18	0	5	85	265	356
Mercury	mg/kg ww	18	18	0.001	0.001	0.001	0.001
Molybdenum	mg/kg ww	18	17	0.005	0.009	0.013	0.016
Nickel	mg/kg ww	18	2	0.006	0.050	0.087	0.115
Phosphorus	mg/kg ww	18	0	86	179	303	386
Potassium	mg/kg ww	18	0	443	1160	1934	2128
Selenium	mg/kg ww	18	18	0.010	0.016	0.024	0.025
Silicon	mg/kg ww	18	0	8	18	35	46
Silver	mg/kg ww	18	14	0.0005	0.0012	0.0033	0.0035
Sodium	mg/kg ww	18	1	0.1	1.1	3	3
Strontium	mg/kg ww	18	0	0.1	1.1	3.7	4.8
Tellurium	mg/kg ww	18	18	0.005	0.008	0.012	0.012
Thallium	mg/kg ww	18	18	0.001	0.002	0.002	0.002
Tin	mg/kg ww	18	18	0.005	0.008	0.012	0.012
Titanium	mg/kg ww	18	1	0.04	0.1	0.2	0.3
Uranium	mg/kg ww	18	18	0.002	0.003	0.005	0.005
Vanadium	mg/kg ww	18	18	0.03	0.04	0.06	0.06
Zinc	mg/kg ww	18	0	1	3	8	10
Zirconium	mg/kg ww	18	18	0.2	0.2	0.4	0.4

Table B.2.2-3 Summary of Concentrations in Berries (Cont'd)

COPC	Units	N	N <MDL	Min	Mean	95th Percentile	Max
Tailings Site							
Aluminum	mg/kg ww	24	0	0.40	2.7	6.7	8.1
Antimony	mg/kg ww	24	24	0.006	0.008	0.010	0.016
Arsenic	mg/kg ww	24	19	0.01	0.02	0.04	0.08
Barium	mg/kg ww	24	0	0.77	3.1	13.6	14.9
Beryllium	mg/kg ww	24	24	0.001	0.002	0.002	0.003
Boron	mg/kg ww	24	0	0.72	2.2	3.8	9.3
Cadmium	mg/kg ww	24	10	0.001	0.02	0.07	0.19
Calcium	mg/kg ww	24	0	83	375	1246	1780
Chromium	mg/kg ww	24	21	0.006	0.012	0.03	0.05
Cobalt	mg/kg ww	24	23	0.006	0.009	0.02	0.03
Copper	mg/kg ww	24	0	0.46	0.64	0.80	0.97
Iron	mg/kg ww	24	0	1.4	4.2	10.1	15.4
Lead	mg/kg ww	24	22	0.006	0.009	0.016	0.016
Magnesium	mg/kg ww	24	0	57	139	308	649
Manganese	mg/kg ww	24	0	11	56	205	244
Mercury	mg/kg ww	24	24	0.0006	0.0008	0.0010	0.0016
Molybdenum	mg/kg ww	24	12	0.01	0.02	0.03	0.05
Nickel	mg/kg ww	24	3	0.01	0.06	0.11	0.19
Phosphorus	mg/kg ww	24	0	61	162	231	261
Potassium	mg/kg ww	24	0	466	1182	1805	1922
Selenium	mg/kg ww	24	24	0.01	0.02	0.02	0.03
Silicon	mg/kg ww	24	0	10	20	54	61
Silver	mg/kg ww	24	21	0.001	0.001	0.002	0.002
Sodium	mg/kg ww	24	0	0.14	2.1	7.2	7.9
Strontium	mg/kg ww	24	0	0.08	0.94	3.8	6.0
Tellurium	mg/kg ww	24	24	0.006	0.008	0.010	0.016
Thallium	mg/kg ww	24	24	0.001	0.002	0.002	0.003
Tin	mg/kg ww	24	23	0.006	0.009	0.015	0.032
Titanium	mg/kg ww	24	1	0.05	0.13	0.27	0.30
Uranium	mg/kg ww	24	24	0.002	0.003	0.004	0.006
Vanadium	mg/kg ww	24	23	0.03	0.04	0.08	0.09
Zinc	mg/kg ww	24	0	0.71	2.5	6.6	11.2
Zirconium	mg/kg ww	24	24	0.18	0.25	0.31	0.48

Table B.2.2-3 Summary of Concentrations in Berries (Cont'd)

COPC	Units	N	N <MDL	Min	Mean	95th Percentile	Max
Brown-McDade Pit							
Aluminum	mg/kg ww	31	0	0.45	2.8	8.3	12.1
Antimony	mg/kg ww	31	31	0.005	0.009	0.016	0.017
Arsenic	mg/kg ww	31	25	0.005	0.02	0.06	0.18
Barium	mg/kg ww	31	0	0.44	4.4	14.1	15.3
Beryllium	mg/kg ww	31	31	0.001	0.002	0.003	0.003
Boron	mg/kg ww	31	0	0.94	2.7	6.8	9.6
Cadmium	mg/kg ww	31	10	0.001	0.06	0.30	0.46
Calcium	mg/kg ww	31	0	77	994	3220	4760
Chromium	mg/kg ww	31	30	0.005	0.01	0.02	0.03
Cobalt	mg/kg ww	31	31	0.005	0.01	0.02	0.02
Copper	mg/kg ww	31	0	0.41	0.67	1.0	1.2
Iron	mg/kg ww	31	0	1.4	6.3	18.1	27.6
Lead	mg/kg ww	31	30	0.005	0.01	0.02	0.02
Magnesium	mg/kg ww	31	0	45	276	770	894
Manganese	mg/kg ww	31	0	1.6	56	112	207
Mercury	mg/kg ww	31	31	0.0005	0.001	0.002	0.002
Molybdenum	mg/kg ww	31	26	0.005	0.01	0.03	0.07
Nickel	mg/kg ww	31	5	0.005	0.07	0.26	0.51
Phosphorus	mg/kg ww	31	0	75	229	744	877
Potassium	mg/kg ww	31	0	574	1657	4389	5644
Selenium	mg/kg ww	31	31	0.01	0.02	0.03	0.03
Silicon	mg/kg ww	31	0	10.5	19.6	37.1	47.9
Silver	mg/kg ww	31	29	0.0005	0.001	0.002	0.003
Sodium	mg/kg ww	31	5	0.08	1.2	4.2	8.5
Strontium	mg/kg ww	31	0	0.11	3.6	15.2	16.8
Tellurium	mg/kg ww	31	31	0.005	0.009	0.016	0.017
Thallium	mg/kg ww	31	31	0.001	0.002	0.003	0.003
Tin	mg/kg ww	31	30	0.005	0.017	0.016	0.255
Titanium	mg/kg ww	31	0	0.07	0.16	0.37	0.61
Uranium	mg/kg ww	31	31	0.002	0.004	0.006	0.007
Vanadium	mg/kg ww	31	31	0.02	0.05	0.08	0.09
Zinc	mg/kg ww	31	0	0.53	4.2	13.2	24.9
Zirconium	mg/kg ww	31	31	0.14	0.27	0.47	0.51

Notes: Analytical results reported as less than method detection limit (MDL) were assumed to be equal to ½ method detection limit in the calculation of minimum, mean and maximum.
Berries: blueberry, cranberry, and crowberry
Moisture content reported by laboratory or assumed to be equal to the average moisture content of other berry samples.

Table B.2.2-4 Summary of Concentrations in Lichen

COPC	Units	N	N <MDL	Min	Mean	95th Percentile	Max
Mine Site							
Aluminum	mg/kg ww	114	0	21.6	113	200	593
Antimony	mg/kg ww	114	32	0.02	0.30	1.0	1.9
Arsenic	mg/kg ww	114	0	0.1	3.1	10	20
Barium	mg/kg ww	114	0	1.6	5	8	9
Beryllium	mg/kg ww	114	107	0.003	0.006	0.010	0.023
Boron	mg/kg ww	114	69	0.4	1.6	6	8
Cadmium	mg/kg ww	114	0	0.01	0.2	0.5	0.6
Calcium	mg/kg ww	114	0	294	874	1445	2944
Chromium	mg/kg ww	114	1	0.03	0.31	0.51	1.2
Cobalt	mg/kg ww	114	16	0.02	0.10	0.19	0.36
Copper	mg/kg ww	114	0	0.4	1.3	2.5	5.8
Iron	mg/kg ww	114	0	39	229	509	857
Lead	mg/kg ww	114	0	0.11	2.7	8.3	21.5
Magnesium	mg/kg ww	114	0	87	278	423	859
Manganese	mg/kg ww	114	0	17	101	198	231
Mercury	mg/kg ww	114	88	0.002	0.007	0.018	0.024
Molybdenum	mg/kg ww	114	59	0.02	0.19	0.45	0.59
Nickel	mg/kg ww	114	0	0.1	0.3	0.5	2.7
Phosphorus	mg/kg ww	114	0	163	1050	1804	2349
Potassium	mg/kg ww	114	0	404	1104	1618	2148
Selenium	mg/kg ww	114	113	0.03	0.05	0.08	0.18
Silicon	mg/kg ww	114	0	29	194	312	512
Silver	mg/kg ww	114	0	0.01	0.22	0.64	1.43
Sodium	mg/kg ww	114	0	3.7	15.0	36	45
Strontium	mg/kg ww	114	0	0.7	2.6	5	8
Tellurium	mg/kg ww	114	53	0.019	0.09	0.19	0.27
Thallium	mg/kg ww	114	101	0.003	0.006	0.015	0.026
Tin	mg/kg ww	113	53	0.02	0.11	0.28	1.96
Titanium	mg/kg ww	114	0	1.2	6.6	14.1	44.4
Uranium	mg/kg ww	114	97	0.007	0.014	0.031	0.048
Vanadium	mg/kg ww	114	30	0.11	0.47	0.93	2.23
Zinc	mg/kg ww	114	0	5	17	30	40
Zirconium	mg/kg ww	114	114	0.50	0.79	1.26	1.35

Notes: Analytical results reported as less than method detection limit (MDL) were assumed to be equal to ½ method detection limit in the calculation of minimum, mean and maximum.
Moisture content reported by laboratory or assumed to be equal to the average moisture content of other lichen samples.

Table B.2.2-5 Summary of Concentrations in Fungi

COPC	Units	N	N <MDL	Min	Mean	95th Percentile	Max
Background						**no data**	
Mill Site							
Aluminum	mg/kg ww	1	0	39.6	39.6	39.6	39.6
Antimony	mg/kg ww	1	0	0.09	0.09	0.09	0.09
Arsenic	mg/kg ww	1	0	1.1	1.1	1.1	1.1
Barium	mg/kg ww	1	0	0.4	0.4	0.4	0.4
Beryllium	mg/kg ww	1	1	0.003	0.003	0.003	0.003
Boron	mg/kg ww	1	0	0.6	0.6	0.6	0.6
Cadmium	mg/kg ww	1	0	0.1	0.1	0.1	0.1
Calcium	mg/kg ww	1	0	75	75	75	75
Chromium	mg/kg ww	1	0	0.06	0.06	0.06	0.06
Cobalt	mg/kg ww	1	1	0.02	0.02	0.02	0.02
Copper	mg/kg ww	1	0	3.4	3.4	3.4	3.4
Iron	mg/kg ww	1	0	21	21	21	21
Lead	mg/kg ww	1	0	0.7	0.7	0.7	0.7
Magnesium	mg/kg ww	1	0	263	263	263	263
Manganese	mg/kg ww	1	0	11	11	11	11
Mercury	mg/kg ww	1	0	0.01	0.01	0.01	0.01
Molybdenum	mg/kg ww	1	0	0.06	0.06	0.06	0.06
Nickel	mg/kg ww	1	0	0.1	0.1	0.1	0.1
Phosphorus	mg/kg ww	1	0	1761	1761	1761	1761
Potassium	mg/kg ww	1	0	8220	8220	8220	8220
Selenium	mg/kg ww	1	1	0.03	0.03	0.03	0.03
Silicon	mg/kg ww	1	0	17	17	17	17
Silver	mg/kg ww	1	0	0.26	0.26	0.26	0.26
Sodium	mg/kg ww	1	0	53	53	53	53
Strontium	mg/kg ww	1	0	0.3	0.3	0.3	0.3
Tellurium	mg/kg ww	1	1	0.015	0.015	0.015	0.015
Thallium	mg/kg ww	1	1	0.003	0.003	0.003	0.003
Tin	mg/kg ww	1	1	0.015	0.015	0.015	0.015
Titanium	mg/kg ww	1	0	0.9	0.9	0.9	0.9
Uranium	mg/kg ww	1	1	0.006	0.006	0.006	0.006
Vanadium	mg/kg ww	1	1	0.08	0.08	0.08	0.08
Zinc	mg/kg ww	1	0	31	31	31	31
Zirconium	mg/kg ww	1	1	0.5	0.5	0.5	0.5
Tailings Site						**no data**	
Brown-McDade Pit						**no data**	

Notes: Analytical results reported as less than method detection limit (MDL) were assumed to be equal to ½ method detection limit in the calculation of minimum, mean and maximum.
Fungi: bolete mushroom
Moisture content assumed to be 70%

Table B.2.2-6 Summary of Concentrations in Evergreen

COPC	Units	N	N <MDL	Min	Mean	95th Percentile	Max
Background						**no data**	
Mill Site							
Aluminum	mg/kg ww	1	0	8	8	8	8
Antimony	mg/kg ww	1	1	0.02	0.02	0.02	0.02
Arsenic	mg/kg ww	1	0	0.09	0.09	0.09	0.09
Barium	mg/kg ww	1	0	2.5	2.5	2.5	2.5
Beryllium	mg/kg ww	1	1	0.003	0.003	0.003	0.003
Boron	mg/kg ww	1	1	0.3	0.3	0.3	0.3
Cadmium	mg/kg ww	1	1	0.003	0.003	0.003	0.003
Calcium	mg/kg ww	1	0	197	197	197	197
Chromium	mg/kg ww	1	0	0.06	0.06	0.06	0.06
Cobalt	mg/kg ww	1	1	0.02	0.02	0.02	0.02
Copper	mg/kg ww	1	0	0.1	0.1	0.1	0.1
Iron	mg/kg ww	1	0	11	11	11	11
Lead	mg/kg ww	1	0	0.1	0.1	0.1	0.1
Magnesium	mg/kg ww	1	0	10	10	10	10
Manganese	mg/kg ww	1	0	1	1	1	1
Mercury	mg/kg ww	1	1	0.002	0.002	0.002	0.002
Molybdenum	mg/kg ww	1	1	0.02	0.02	0.02	0.02
Nickel	mg/kg ww	1	1	0.02	0.02	0.02	0.02
Phosphorus	mg/kg ww	1	0	9	9	9	9
Potassium	mg/kg ww	1	0	48	48	48	48
Selenium	mg/kg ww	1	1	0.03	0.03	0.03	0.03
Silicon	mg/kg ww	1	0	46	46	46	46
Silver	mg/kg ww	1	0	0.003	0.003	0.003	0.003
Sodium	mg/kg ww	1	0	1.5	1.5	1.5	1.5
Strontium	mg/kg ww	1	0	0.6	0.6	0.6	0.6
Tellurium	mg/kg ww	1	1	0.015	0.015	0.015	0.015
Thallium	mg/kg ww	1	1	0.003	0.003	0.003	0.003
Tin	mg/kg ww	1	1	0.02	0.02	0.02	0.02
Titanium	mg/kg ww	1	0	0.5	0.5	0.5	0.5
Uranium	mg/kg ww	1	1	0.006	0.006	0.006	0.006
Vanadium	mg/kg ww	1	0	0.18	0.18	0.18	0.18
Zinc	mg/kg ww	1	0	1.6	1.6	1.6	1.6
Zirconium	mg/kg ww	1	1	0.45	0.45	0.45	0.45

Table B.2.2-6 Summary of Concentrations in Evergreen (Cont'd)

COPC	Units	N	N <MDL	Min	Mean	95th Percentile	Max
Tailings Site							
Aluminum	mg/kg ww	1	0	4.8	4.8	4.8	4.8
Antimony	mg/kg ww	1	1	0.015	0.015	0.015	0.015
Arsenic	mg/kg ww	1	1	0.015	0.015	0.015	0.015
Barium	mg/kg ww	1	0	0.8	0.8	0.8	0.8
Beryllium	mg/kg ww	1	1	0.003	0.003	0.003	0.003
Boron	mg/kg ww	1	1	0.3	0.3	0.3	0.3
Cadmium	mg/kg ww	1	1	0.0	0.0	0.0	0.0
Calcium	mg/kg ww	1	0	82	82	82	82
Chromium	mg/kg ww	1	0	0.06	0.06	0.06	0.06
Cobalt	mg/kg ww	1	1	0.02	0.02	0.02	0.02
Copper	mg/kg ww	1	0	0.0	0.0	0.0	0.0
Iron	mg/kg ww	1	0	7.2	7.2	7.2	7.2
Lead	mg/kg ww	1	1	0.02	0.02	0.02	0.02
Magnesium	mg/kg ww	1	0	8	8	8	8
Manganese	mg/kg ww	1	0	3	3	3	3
Mercury	mg/kg ww	1	1	0.002	0.002	0.002	0.002
Molybdenum	mg/kg ww	1	1	0.02	0.02	0.02	0.02
Nickel	mg/kg ww	1	1	0.02	0.02	0.02	0.02
Phosphorus	mg/kg ww	1	0	5	5	5	5
Potassium	mg/kg ww	1	0	22	22	22	22
Selenium	mg/kg ww	1	1	0.030	0.030	0.030	0.030
Silicon	mg/kg ww	1	0	36	36	36	36
Silver	mg/kg ww	1	1	0.002	0.002	0.002	0.002
Sodium	mg/kg ww	1	0	0.6	0.6	0.6	0.6
Strontium	mg/kg ww	1	0	0.2	0.2	0.2	0.2
Tellurium	mg/kg ww	1	1	0.015	0.015	0.015	0.015
Thallium	mg/kg ww	1	1	0.003	0.003	0.003	0.003
Tin	mg/kg ww	1	1	0.015	0.015	0.015	0.015
Titanium	mg/kg ww	1	0	0.2	0.2	0.2	0.2
Uranium	mg/kg ww	1	1	0.006	0.006	0.006	0.006
Vanadium	mg/kg ww	1	0	0.21	0.21	0.21	0.21
Zinc	mg/kg ww	1	0	0.4	0.4	0.4	0.4
Zirconium	mg/kg ww	1	1	0.5	0.5	0.5	0.5

Table B.2.2-6 Summary of Concentrations in Evergreen (Cont'd)

COPC	Units	N	N <MDL	Min	Mean	95th Percentile	Max
Brown-McDade Pit							
Aluminum	mg/kg ww	3	0	7.4	13.7	20.6	21.5
Antimony	mg/kg ww	3	1	0.02	0.06	0.09	0.09
Arsenic	mg/kg ww	3	0	0.15	0.60	1.05	1.11
Barium	mg/kg ww	3	0	1.6	3.0	4.5	4.7
Beryllium	mg/kg ww	3	3	0.003	0.003	0.003	0.003
Boron	mg/kg ww	3	3	0.300	0.300	0.300	0.300
Cadmium	mg/kg ww	3	1	0.003	0.021	0.032	0.033
Calcium	mg/kg ww	3	0	91	196	306	321
Chromium	mg/kg ww	3	1	0.02	0.07	0.09	0.09
Cobalt	mg/kg ww	3	3	0.015	0.015	0.015	0.015
Copper	mg/kg ww	3	0	0.06	0.20	0.29	0.30
Iron	mg/kg ww	3	0	12	40	66	69
Lead	mg/kg ww	3	0	0.12	0.65	1.1	1.2
Magnesium	mg/kg ww	3	0	10.2	11.2	11.7	11.7
Manganese	mg/kg ww	3	0	1.8	3.5	4.4	4.4
Mercury	mg/kg ww	3	3	0.0015	0.0015	0.0015	0.0015
Molybdenum	mg/kg ww	3	3	0.015	0.015	0.015	0.015
Nickel	mg/kg ww	3	3	0.015	0.015	0.015	0.015
Phosphorus	mg/kg ww	3	0	8.4	8.7	8.9	9.0
Potassium	mg/kg ww	3	0	36.9	48.9	57.1	57.6
Selenium	mg/kg ww	3	3	0.03	0.03	0.03	0.03
Silicon	mg/kg ww	3	0	43.5	53.4	61.4	62.1
Silver	mg/kg ww	3	1	0.002	0.01	0.02	0.02
Sodium	mg/kg ww	3	0	0.60	1.10	1.47	1.50
Strontium	mg/kg ww	3	0	0.34	0.74	1.11	1.16
Tellurium	mg/kg ww	3	3	0.015	0.015	0.015	0.015
Thallium	mg/kg ww	3	3	0.003	0.003	0.003	0.003
Tin	mg/kg ww	3	3	0.015	0.015	0.015	0.015
Titanium	mg/kg ww	3	0	0.39	0.74	1.17	1.23
Uranium	mg/kg ww	3	3	0.006	0.006	0.006	0.006
Vanadium	mg/kg ww	3	0	0.21	0.27	0.35	0.36
Zinc	mg/kg ww	3	0	1.9	2.6	3.1	3.2
Zirconium	mg/kg ww	3	3	0.45	0.45	0.45	0.45

Notes: Analytical results reported as less than method detection limit (MDL) were assumed to be equal to ½ method detection limit in the calculation of minimum, mean and maximum.
Evergreen: spruce
Moisture content assumed to be 70%

Table B.2.2-7 Summary of Concentrations in Labrador Tea

COPC	Units	N	N <MDL	Min	Mean	95th Percentile	Max
Background							
Aluminum	mg/L	1	0	0.12	0.12	0.12	0.12
Antimony	mg/L	1	0	0.005	0.005	0.005	0.005
Arsenic	mg/L	1	1	0.002	0.002	0.002	0.002
Barium	mg/L	1	0	0.20	0.20	0.20	0.20
Beryllium	mg/L	1	0	0.00002	0.00002	0.00002	0.00002
Bismuth	mg/L	1	0	0.005	0.005	0.005	0.005
Boron	mg/L	1	0	0.414	0.414	0.414	0.414
Cadmium	mg/L	1	0	0.0005	0.0005	0.0005	0.0005
Calcium	mg/L	1	0	54.30	54.30	54.30	54.30
Chromium	mg/L	1	0	0.0045	0.0045	0.0045	0.0045
Cobalt	mg/L	1	0	0.0005	0.0005	0.0005	0.0005
Copper	mg/L	1	0	0.08	0.08	0.08	0.08
Iron	mg/L	1	0	0.10	0.10	0.10	0.10
Lead	mg/L	1	0	0.0025	0.0025	0.0025	0.0025
Lithium	mg/L	1	0	0.008	0.008	0.008	0.008
Magnesium	mg/L	1	0	21.10	21.10	21.10	21.10
Manganese	mg/L	1	0	1.23	1.23	1.23	1.23
Molybdenum	mg/L	1	0	0.001	0.001	0.001	0.001
Nickel	mg/L	1	0	0.030	0.030	0.030	0.030
Phosphorus	mg/L	1	0	10.70	10.70	10.70	10.70
Potassium	mg/L	1	0	106.0	106.0	106.0	106.0
Selenium	mg/L	1	0	0.0025	0.0025	0.0025	0.0025
Silicon	mg/L	1	0	12.50	12.50	12.50	12.50
Silver	mg/L	1	0	0.0015	0.0015	0.0015	0.0015
Sodium	mg/L	1	0	6.58	6.58	6.58	6.58
Strontium	mg/L	1	0	0.23	0.23	0.23	0.23
Sulfur	mg/L	1	0	14.80	14.80	14.80	14.80
Thallium	mg/L	1	0	0.009	0.009	0.009	0.009
Tin	mg/L	1	1	0.002	0.002	0.002	0.002
Titanium	mg/L	1	0	0.001	0.001	0.001	0.001
Uranium	mg/L	1	0	0.03	0.03	0.03	0.03
Vanadium	mg/L	1	0	0.0015	0.0015	0.0015	0.0015
Zinc	mg/L	1	0	0.12	0.12	0.12	0.12
Zirconium	mg/L	1	0	0.0005	0.0005	0.0005	0.0005

Table B.2.2-7 Summary of Concentrations in Labrador Tea (Cont'd)

COPC	Units	N	N <MDL	Min	Mean	95th Percentile	Max
Mine Site							
Aluminum	mg/L	3	0	0.17	0.22	0.24	0.24
Antimony	mg/L	3	0	0.005	0.005	0.005	0.005
Arsenic	mg/L	3	0	0.02	0.03	0.03	0.03
Barium	mg/L	3	0	0.03	0.09	0.12	0.12
Beryllium	mg/L	3	0	0.00002	0.00021	0.00054	0.00060
Bismuth	mg/L	3	0	0.005	0.005	0.005	0.005
Boron	mg/L	3	0	0.005	0.081	0.120	0.120
Cadmium	mg/L	3	0	0.0005	0.0005	0.0005	0.0005
Calcium	mg/L	3	0	11.10	29.60	39.29	39.40
Chromium	mg/L	3	0	0.0014	0.0018	0.0022	0.0023
Cobalt	mg/L	3	0	0.0005	0.0005	0.0005	0.0005
Copper	mg/L	3	0	0.08	0.10	0.11	0.11
Iron	mg/L	3	0	0.38	0.47	0.52	0.52
Lead	mg/L	3	0	0.0025	0.0037	0.0057	0.0060
Lithium	mg/L	3	0	0.006	0.007	0.008	0.008
Magnesium	mg/L	3	0	3.14	9.68	13.15	13.20
Manganese	mg/L	3	0	0.53	0.54	0.55	0.55
Molybdenum	mg/L	3	0	0.003	0.003	0.004	0.004
Nickel	mg/L	3	0	0.008	0.014	0.018	0.018
Phosphorus	mg/L	3	0	1.32	1.81	2.10	2.11
Potassium	mg/L	3	0	15.4	29.5	37.1	37.2
Selenium	mg/L	3	0	0.0025	0.0025	0.0025	0.0025
Silicon	mg/L	3	0	5.39	7.02	7.97	8.00
Silver	mg/L	3	0	0.0015	0.0015	0.0015	0.0015
Sodium	mg/L	3	0	2.75	3.25	3.50	3.50
Strontium	mg/L	3	0	0.05	0.14	0.19	0.19
Sulfur	mg/L	3	0	6.50	7.70	8.46	8.50
Thallium	mg/L	3	0	0.003	0.011	0.017	0.017
Tin	mg/L	3	0	0.18	0.58	1.25	1.37
Titanium	mg/L	3	0	0.002	0.003	0.004	0.004
Uranium	mg/L	3	0	0.03	0.03	0.03	0.03
Vanadium	mg/L	3	0	0.0015	0.0035	0.0049	0.0050
Zinc	mg/L	3	0	0.05	0.07	0.09	0.09
Zirconium	mg/L	3	0	0.0005	0.0005	0.0005	0.0005

Notes: Analytical results reported as less than method detection limit (MDL) were assumed to be equal to ½ method detection limit in the calculation of minimum, mean and maximum.

B.2.3 Measured Small Animal Concentrations

As described in EDI (2007), a trapping program was completed for small animals within 500 m of the three main areas of concern on site (i.e., the mill site, tailings pond, Brown-McDade Pit). Small animals were also trapped at the reference location of Rowlinson Creek, approximately 20 km from the Mt Nansen Mine Site. Small animals generally have a small home range and therefore make good indicators for contamination accumulation.

Measured concentrations in small animals were used in the ecological risk assessment for the assessment of food chain effects. Gray jay and squirrel captured from the mine site and gray jay captured from the reference location were analyzed for COPC concentrations in liver and kidney; both liver and kidney concentrations were considered in the risk assessment. Hare and grouse were analyzed for COPC concentrations in liver, kidney, and muscle tissue; muscle tissue concentrations only were considered in the risk assessment. The whole body of shrews from the mine site and reference location were analyzed for COPC concentrations due to their small size; the whole body concentrations were considered in the risk assessment.

Table B.2.3-1 summarizes the concentrations in small animals from the mine site and the reference (Rowlinson Creek) site. Dry weight concentrations were reported by the laboratory and are converted to fresh weight based on the reported sample moisture content.

B.2.4 Measured Moose and Caribou Concentrations

EDI (2007) summarized eight caribou and two moose samples provided by the community and the Northern Contaminants Program. Of these samples, two each of caribou and moose were muscle samples, and these were used in the risk assessment to represent impacts from the mine and are summarized in Table B.2.4-1. EDI (2007) also provided background concentrations for select COPCs to characterize Yukon background concentrations, and these are also summarized in Table B.2.4-1, as available. Dry weight concentrations were reported by the laboratory and are converted to fresh weight based on the reported sample moisture content. The average moisture content from the site moose samples (78%) and caribou samples (73.8%) were used to convert the Yukon background concentrations from dry weight to wet weight.

Table B.2.3-1 Summary of Concentrations in Small Animals

COPC	Units	Mine Area						Reference Location					
		N	N <MDL	Min	Mean	95th Per.	Max	N	N <MDL	Min	Mean	95th Per.	Max
Gray Jay													
Aluminum	µg/g (ww)	3	0	0.40	0.59	0.59	0.59	3	0	0.28	0.40	0.54	0.56
Antimony	µg/g (ww)	3	3	0.015	0.038	0.037	0.038	3	3	0.014	0.022	0.034	0.036
Arsenic	µg/g (ww)	3	1	0.04	0.24	0.23	0.24	3	3	0.014	0.022	0.034	0.036
Barium	µg/g (ww)	3	0	0.09	0.14	0.14	0.14	3	1	0.04	0.05	0.06	0.06
Beryllium	µg/g (ww)	3	3	0.003	0.008	0.007	0.008	3	3	0.003	0.004	0.007	0.007
Boron	µg/g (ww)	3	3	0.30	0.77	0.75	0.77	3	3	0.28	0.43	0.68	0.73
Cadmium	µg/g (ww)	3	0	0.89	3.51	3.45	3.51	3	0	0.49	1.30	1.77	1.79
Calcium	µg/g (ww)	3	0	85.0	91.9	91.7	91.9	3	0	58.5	64.9	71.7	72.7
Chromium	µg/g (ww)	3	2	0.01	0.15	0.14	0.15	3	2	0.01	0.05	0.11	0.12
Cobalt	µg/g (ww)	3	3	0.015	0.038	0.037	0.038	3	3	0.01	0.02	0.03	0.04
Copper	µg/g (ww)	3	0	3.83	4.59	4.57	4.59	3	0	4.3	4.6	4.9	4.9
Iron	µg/g (ww)	3	0	126	2717	2642	2717	3	0	97	1440	2232	2262
Lead	µg/g (ww)	3	1	0.04	0.09	0.08	0.09	3	3	0.01	0.02	0.03	0.04
Magnesium	µg/g (ww)	3	0	185	208	206	208	3	0	167	181	194	195
Manganese	µg/g (ww)	3	0	2.52	3.17	3.16	3.17	3	0	1.30	1.84	2.54	2.65
Mercury	µg/g (ww)	3	1	0.004	0.022	0.022	0.022	3	0	0.02	0.03	0.03	0.03
Molybdenum	µg/g (ww)	3	0	0.46	1.15	1.13	1.15	3	0	0.46	0.96	1.25	1.26
Nickel	µg/g (ww)	3	3	0.015	0.038	0.037	0.038	3	3	0.01	0.02	0.03	0.04
Phosphorus	µg/g (ww)	3	0	2917	3167	3142	3167	3	0	2810	2909	3051	3074
Potassium	µg/g (ww)	3	0	1939	2324	2296	2324	3	0	1599	1867	2209	2262
Selenium	µg/g (ww)	3	0	0.29	0.59	0.57	0.59	3	0	0.39	0.44	0.52	0.53
Silicon	µg/g (ww)	3	0	17.2	19.4	19.4	19.4	3	0	13.3	15.6	18.1	18.4
Silver	µg/g (ww)	3	1	0.004	0.033	0.030	0.033	3	3	0.0014	0.0022	0.0034	0.0036
Sodium	µg/g (ww)	3	0	844	1068	1052	1068	3	0	970	1069	1151	1159
Strontium	µg/g (ww)	3	0	0.047	0.097	0.097	0.097	3	0	0.04	0.05	0.06	0.06
Tellurium	µg/g (ww)	3	3	0.015	0.038	0.037	0.038	3	3	0.01	0.02	0.03	0.04
Thallium	µg/g (ww)	3	3	0.003	0.008	0.007	0.008	3	3	0.003	0.004	0.007	0.007
Tin	µg/g (ww)	3	3	0.015	0.038	0.037	0.038	3	3	0.014	0.022	0.034	0.036
Titanium	µg/g (ww)	3	0	0.92	1.02	1.02	1.02	3	0	0.86	0.89	0.93	0.93
Uranium	µg/g (ww)	3	3	0.006	0.013	0.013	0.013	3	3	0.006	0.008	0.012	0.013
Vanadium	µg/g (ww)	3	3	0.074	0.192	0.187	0.192	3	3	0.07	0.11	0.17	0.18
Zinc	µg/g (ww)	3	0	22.76	27.02	26.62	27.02	3	0	20.7	23.4	25.6	25.8
Zirconium	µg/g (ww)	3	3	0.44	1.15	1.12	1.15	3	3	0.42	0.65	1.03	1.09

Table B.2.3-1 Summary of Concentrations in Small Animals (Cont'd)

COPC	Units	Mine Area						Reference Location					
		N	N <MDL	Min	Mean	95th Per.	Max	N	N <MDL	Min	Mean	95th Per.	Max
Grouse													
Aluminum	µg/g (ww)	6	0	1.3	3.1	6.2	6.7	3	0	1.0	2.6	4.5	4.7
Antimony	µg/g (ww)	6	6	0.013	0.013	0.015	0.015	3	3	0.013	0.014	0.014	0.014
Arsenic	µg/g (ww)	6	0	0.01	0.09	0.27	0.33	3	0	0.01	0.08	0.19	0.21
Barium	µg/g (ww)	6	0	0.03	0.07	0.16	0.18	3	0	0.03	0.09	0.17	0.18
Beryllium	µg/g (ww)	6	6	0.0025	0.0027	0.0029	0.0030	3	3	0.0026	0.0027	0.0028	0.0029
Boron	µg/g (ww)	6	6	0.25	0.27	0.29	0.30	3	3	0.26	0.27	0.28	0.29
Cadmium	µg/g (ww)	6	0	0.003	0.009	0.027	0.033	3	0	0.003	0.004	0.005	0.005
Calcium	µg/g (ww)	6	0	50	73	137	163	3	0	49.4	55.0	57.9	57.9
Chromium	µg/g (ww)	6	0	0.03	0.04	0.06	0.06	3	0	0.03	0.04	0.05	0.06
Cobalt	µg/g (ww)	6	6	0.013	0.013	0.015	0.015	3	3	0.013	0.014	0.014	0.014
Copper	µg/g (ww)	6	0	1.12	1.29	1.50	1.54	3	0	1.20	1.27	1.31	1.32
Iron	µg/g (ww)	6	0	20.5	27.7	34.7	35.8	3	0	21.6	24.4	26.2	26.3
Lead	µg/g (ww)	6	0	0.01	0.20	0.77	0.98	3	0	0.01	0.10	0.16	0.16
Magnesium	µg/g (ww)	6	0	274	296	319	321	3	0	274	294	308	309
Manganese	µg/g (ww)	6	0	0.29	0.49	0.80	0.82	3	0	0.3	1.1	2.3	2.4
Mercury	µg/g (ww)	6	6	0.0013	0.0013	0.0015	0.0015	3	3	0.001	0.001	0.001	0.001
Molybdenum	µg/g (ww)	6	0	0.013	0.016	0.023	0.025	3	0	0.013	0.028	0.053	0.057
Nickel	µg/g (ww)	6	6	0.013	0.013	0.015	0.015	3	3	0.013	0.014	0.014	0.014
Phosphorus	µg/g (ww)	6	0	2245	2386	2527	2540	3	0	2233	2333	2424	2434
Potassium	µg/g (ww)	6	0	3606	3796	4007	4013	3	0	3498	3879	4214	4250
Selenium	µg/g (ww)	6	0	0.03	0.04	0.06	0.06	3	3	0.026	0.027	0.028	0.029
Silicon	µg/g (ww)	6	0	24.5	28.5	34.2	35.2	3	0	22.6	28.2	34.9	35.9
Silver	µg/g (ww)	6	6	0.0013	0.0013	0.0015	0.0015	3	0	0.001	0.003	0.005	0.005
Sodium	µg/g (ww)	6	0	862	995	1186	1193	3	0	818	886	937	941
Strontium	µg/g (ww)	6	0	0.04	0.08	0.17	0.21	3	0	0.066	0.075	0.083	0.084
Tellurium	µg/g (ww)	6	6	0.013	0.013	0.015	0.015	3	3	0.013	0.014	0.014	0.014
Thallium	µg/g (ww)	6	6	0.0025	0.0027	0.0029	0.0030	3	3	0.0026	0.0027	0.0028	0.0029
Tin	µg/g (ww)	6	0	0.01	0.03	0.07	0.08	3	3	0.013	0.014	0.014	0.014
Titanium	µg/g (ww)	6	0	0.80	0.89	0.99	1.01	3	0	0.801	0.829	0.863	0.868
Uranium	µg/g (ww)	6	6	0.005	0.005	0.006	0.006	3	3	0.0053	0.0054	0.0057	0.0057
Vanadium	µg/g (ww)	6	6	0.06	0.07	0.07	0.08	3	3	0.066	0.068	0.071	0.072
Zinc	µg/g (ww)	6	0	14.8	18.0	21.4	21.7	3	0	14.7	18.8	24.1	24.9
Zirconium	µg/g (ww)	6	6	0.38	0.40	0.44	0.45	3	3	0.39	0.41	0.43	0.43

Table B.2.3-1 Summary of Concentrations in Small Animals (Cont'd)

COPC	Units	Mine Area						Reference Location					
		N	N <MDL	Min	Mean	95th Per.	Max	N	N <MDL	Min	Mean	95th Per.	Max
Hare													
Aluminum	µg/g (ww)	3	0	0.32	0.69	1.06	1.10	3	0	0.40	0.50	0.58	0.59
Antimony	µg/g (ww)	3	3	0.012	0.013	0.013	0.013	3	3	0.012	0.013	0.014	0.014
Arsenic	µg/g (ww)	3	1	0.01	0.06	0.10	0.10	3	3	0.012	0.013	0.014	0.014
Barium	µg/g (ww)	3	0	0.02	0.04	0.05	0.05	3	0	0.02	0.05	0.08	0.08
Beryllium	µg/g (ww)	3	3	0.002	0.003	0.003	0.003	3	3	0.0024	0.0026	0.0028	0.0028
Boron	µg/g (ww)	3	3	0.24	0.25	0.26	0.26	3	3	0.24	0.26	0.28	0.28
Cadmium	µg/g (ww)	3	0	0.02	0.06	0.14	0.15	3	1	0.003	0.03	0.05	0.06
Calcium	µg/g (ww)	3	0	57.8	63.4	66.4	66.5	3	0	61	67	73	73
Chromium	µg/g (ww)	3	2	0.012	0.017	0.025	0.026	3	1	0.012	0.021	0.028	0.028
Cobalt	µg/g (ww)	3	3	0.012	0.013	0.013	0.013	3	3	0.012	0.013	0.014	0.014
Copper	µg/g (ww)	3	0	1.94	2.32	2.73	2.79	3	0	2.0	2.3	2.5	2.5
Iron	µg/g (ww)	3	0	26.8	30.4	35.7	36.6	3	0	30.3	32.9	35.0	35.2
Lead	µg/g (ww)	3	3	0.012	0.013	0.013	0.013	3	1	0.01	0.05	0.09	0.10
Magnesium	µg/g (ww)	3	0	206	229	250	253	3	0	231	242	256	258
Manganese	µg/g (ww)	3	0	0.20	0.28	0.36	0.37	3	0	0.27	0.34	0.41	0.42
Mercury	µg/g (ww)	3	2	0.001	0.003	0.007	0.008	3	3	0.0012	0.0013	0.0014	0.0014
Molybdenum	µg/g (ww)	3	2	0.012	0.017	0.025	0.026	3	1	0.012	0.022	0.028	0.028
Nickel	µg/g (ww)	3	3	0.012	0.013	0.013	0.013	3	3	0.012	0.013	0.014	0.014
Phosphorus	µg/g (ww)	3	0	1729	1902	2083	2107	3	0	1855	1963	2129	2157
Potassium	µg/g (ww)	3	0	3447	3715	4010	4050	3	0	3133	3657	4176	4241
Selenium	µg/g (ww)	3	1	0.02	0.05	0.07	0.07	3	3	0.024	0.026	0.028	0.028
Silicon	µg/g (ww)	3	0	6.7	8.1	9.7	10.0	3	0	7.3	7.8	8.4	8.4
Silver	µg/g (ww)	3	3	0.0012	0.0013	0.0013	0.0013	3	3	0.0012	0.0013	0.0014	0.0014
Sodium	µg/g (ww)	3	0	423	482	557	568	3	0	483	524	556	559
Strontium	µg/g (ww)	3	0	0.062	0.070	0.080	0.082	3	0	0.09	0.11	0.14	0.14
Tellurium	µg/g (ww)	3	3	0.012	0.013	0.013	0.013	3	3	0.012	0.013	0.014	0.014
Thallium	µg/g (ww)	3	3	0.002	0.003	0.003	0.003	3	2	0.002	0.003	0.005	0.005
Tin	µg/g (ww)	3	2	0.012	0.025	0.046	0.050	3	2	0.012	0.027	0.051	0.056
Titanium	µg/g (ww)	3	0	0.50	0.66	0.84	0.87	3	0	0.53	0.68	0.82	0.84
Uranium	µg/g (ww)	3	3	0.005	0.005	0.005	0.005	3	3	0.005	0.005	0.006	0.006
Vanadium	µg/g (ww)	3	3	0.060	0.063	0.065	0.066	3	3	0.060	0.064	0.069	0.070
Zinc	µg/g (ww)	3	0	19.9	25.6	31.3	32.1	3	0	26.3	27.4	29.0	29.3
Zirconium	µg/g (ww)	3	3	0.36	0.38	0.39	0.39	3	3	0.36	0.38	0.41	0.42

Table B.2.3-1 Summary of Concentrations in Small Animals (Cont'd)

COPC	Units	Mine Area						Reference Location					
		N	N <MDL	Min	Mean	95th Per.	Max	N	N <MDL	Min	Mean	95th Per.	Max
Shrew													
Aluminum	µg/g (ww)	7	0	2.0	2.8	4.0	4.0	1	0	3.61	3.61	3.61	3.61
Antimony	µg/g (ww)	7	7	0.01	0.02	0.02	0.02	1	1	0.013	0.013	0.013	0.013
Arsenic	µg/g (ww)	7	0	0.03	0.14	0.49	0.68	1	1	0.013	0.013	0.013	0.013
Barium	µg/g (ww)	7	0	1.0	2.2	3.9	4.1	1	0	1.88	1.88	1.88	1.88
Beryllium	µg/g (ww)	7	7	0.003	0.003	0.003	0.004	1	1	0.003	0.003	0.003	0.003
Boron	µg/g (ww)	7	6	0.3	0.4	0.8	1.0	1	1	0.25	0.25	0.25	0.25
Cadmium	µg/g (ww)	7	0	0.1	0.3	0.6	0.6	1	0	0.04	0.04	0.04	0.04
Calcium	µg/g (ww)	7	0	6111	8738	10937	11250	1	0	7544	7544	7544	7544
Chromium	µg/g (ww)	7	5	0.01	0.02	0.03	0.04	1	1	0.013	0.013	0.013	0.013
Cobalt	µg/g (ww)	7	5	0.01	0.02	0.03	0.04	1	1	0.013	0.013	0.013	0.013
Copper	µg/g (ww)	7	0	2.9	3.5	4.4	4.7	1	0	3.71	3.71	3.71	3.71
Iron	µg/g (ww)	7	0	75	120	157	162	1	0	79	79	79	79
Lead	µg/g (ww)	7	2	0.01	0.06	0.15	0.18	1	0	0.05	0.05	0.05	0.05
Magnesium	µg/g (ww)	7	0	317	407	516	530	1	0	363	363	363	363
Manganese	µg/g (ww)	7	0	1.5	6.3	12.4	14.5	1	0	2.79	2.79	2.79	2.79
Mercury	µg/g (ww)	7	0	0.01	0.02	0.05	0.06	1	0	0.01	0.01	0.01	0.01
Molybdenum	µg/g (ww)	7	0	0.08	0.12	0.20	0.21	1	0	0.10	0.10	0.10	0.10
Nickel	µg/g (ww)	7	2	0.01	0.05	0.09	0.10	1	0	0.03	0.03	0.03	0.03
Phosphorus	µg/g (ww)	7	0	5005	6104	7022	7084	1	0	5664	5664	5664	5664
Potassium	µg/g (ww)	7	0	2373	3110	3423	3432	1	0	2482	2482	2482	2482
Selenium	µg/g (ww)	7	0	0.3	0.4	0.7	0.7	1	0	0.25	0.25	0.25	0.25
Silicon	µg/g (ww)	7	0	16.0	20.1	23.1	23.1	1	0	27	27	27	27
Silver	µg/g (ww)	7	0	0.003	0.008	0.012	0.013	1	0	0.008	0.008	0.008	0.008
Sodium	µg/g (ww)	7	0	1013	1390	1650	1698	1	0	975	975	975	975
Strontium	µg/g (ww)	7	0	1.9	3.6	7.4	8.9	1	0	3.86	3.86	3.86	3.86
Tellurium	µg/g (ww)	7	7	0.013	0.015	0.017	0.018	1	1	0.013	0.013	0.013	0.013
Thallium	µg/g (ww)	7	7	0.003	0.003	0.003	0.004	1	1	0.003	0.003	0.003	0.003
Tin	µg/g (ww)	7	7	0.013	0.015	0.017	0.018	1	0	0.025	0.025	0.025	0.025
Titanium	µg/g (ww)	7	0	2.0	2.5	3.0	3.1	1	0	2.24	2.24	2.24	2.24
Uranium	µg/g (ww)	7	7	0.005	0.006	0.007	0.007	1	1	0.005	0.005	0.005	0.005
Vanadium	µg/g (ww)	7	7	0.063	0.076	0.087	0.089	1	1	0.06	0.06	0.06	0.06
Zinc	µg/g (ww)	7	0	23.8	28.8	34.4	36.0	1	0	26.7	26.7	26.7	26.7
Zirconium	µg/g (ww)	7	7	0.4	0.5	0.5	0.5	1	1	0.38	0.38	0.38	0.38

Table B.2.3-1 Summary of Concentrations in Small Animals (Cont'd)

COPC	Units	Mine Area						Reference Location					
		N	N <MDL	Min	Mean	95^{th} Per.	Max	N	N <MDL	Min	Mean	95^{th} Per.	Max
Squirrel													
Aluminum	µg/g (ww)	2	0	0.66	0.69	0.71	0.71	No squirrel samples available from the reference location					
Antimony	µg/g (ww)	2	2	0.02	0.02	0.03	0.03						
Arsenic	µg/g (ww)	2	0	1.6	2.1	2.5	2.6						
Barium	µg/g (ww)	2	1	0.03	0.06	0.09	0.09						
Beryllium	µg/g (ww)	2	2	0.003	0.004	0.005	0.005						
Boron	µg/g (ww)	2	2	0.30	0.41	0.51	0.52						
Cadmium	µg/g (ww)	2	0	3.7	7.7	11.3	11.7						
Calcium	µg/g (ww)	2	0	60.1	86.8	110.8	113.4						
Chromium	µg/g (ww)	2	0	0.06	0.11	0.15	0.16						
Cobalt	µg/g (ww)	2	2	0.015	0.021	0.026	0.026						
Copper	µg/g (ww)	2	0	3.2	4.4	5.5	5.6						
Iron	µg/g (ww)	2	0	32.5	33.0	33.5	33.5						
Lead	µg/g (ww)	2	0	0.30	0.61	0.89	0.92						
Magnesium	µg/g (ww)	2	0	125.5	152.7	177.3	180.0						
Manganese	µg/g (ww)	2	0	0.9	1.6	2.2	2.3						
Mercury	µg/g (ww)	2	0	0.03	0.11	0.17	0.18						
Molybdenum	µg/g (ww)	2	0	0.26	0.64	0.99	1.03						
Nickel	µg/g (ww)	2	2	0.015	0.021	0.026	0.026						
Phosphorus	µg/g (ww)	2	0	2230	2450	2648	2670						
Potassium	µg/g (ww)	2	0	1273	1781	2238	2289						
Selenium	µg/g (ww)	2	0	0.48	0.78	1.04	1.07						
Silicon	µg/g (ww)	2	0	17.2	18.8	20.3	20.4						
Silver	µg/g (ww)	2	1	0.00	0.01	0.01	0.02						
Sodium	µg/g (ww)	2	0	535	622	701	710						
Strontium	µg/g (ww)	2	0	0.052	0.061	0.069	0.069						
Tellurium	µg/g (ww)	2	2	0.015	0.021	0.026	0.026						
Thallium	µg/g (ww)	2	2	0.003	0.004	0.005	0.005						
Tin	µg/g (ww)	2	2	0.015	0.021	0.026	0.026						
Titanium	µg/g (ww)	2	0	0.76	0.80	0.84	0.85						
Uranium	µg/g (ww)	2	2	0.006	0.008	0.010	0.010						
Vanadium	µg/g (ww)	2	2	0.08	0.10	0.13	0.13						
Zinc	µg/g (ww)	2	0	21.0	24.6	27.9	28.2						
Zirconium	µg/g (ww)	2	2	0.45	0.62	0.77	0.79						

Note: concentrations have been converted from dry weight to wet weight basis using reported moisture contents.

Table B.2.4-1 Summary of Concentrations in Large Mammals

µg/g (ww)	Mine Site						Yukon Background
Caribou	**Num**	**Num < MDL**	**Min**	**Mean**	**95th Percentile**	**Max**	**Mean**
Aluminum	2	0	0.013	0.043	0.070	0.073	
Antimony	2	0	0.00025	0.00026	0.00027	0.00027	0.001
Arsenic	2	0	0.001	0.002	0.003	0.003	0.065
Barium	2	0	0.005	0.007	0.009	0.009	
Beryllium	2	1	0.00001	0.00014	0.00026	0.00027	
Boron	No data						
Cadmium	2	0	0.006	0.008	0.010	0.010	0.026
Calcium	No data						
Chromium	2	0	0.026	0.031	0.036	0.037	0.013
Cobalt	2	0	0.0008	0.0010	0.0012	0.0012	
Copper	2	0	0.9	0.9	1.0	1.0	2.72
Iron	2	0	9.5	10.4	11.3	11.4	
Lead	2	0	0.0005	0.0005	0.0005	0.0005	0.014
Magnesium	No data						
Manganese	2	0	0.10	0.11	0.11	0.12	0.288
Mercury	2	0	0.0008	0.0010	0.0012	0.0013	0.0005
Molybdenum	2	0	0.006	0.008	0.010	0.010	
Nickel	2	0	0.015	0.018	0.020	0.020	0.0039
Phosphorus	No data						
Potassium	2	0	836	919	993	1001	
Selenium	2	0	0.011	0.014	0.017	0.018	0.0406
Silicon	No data						
Silver	2	2	0.00001	0.00001	0.00001	0.00001	0.00018
Sodium	No data						
Strontium	2	0	0.008	0.011	0.013	0.014	
Tellurium	No data						
Thallium	2	0	0.00014	0.00014	0.00015	0.00015	
Tin	No data						
Titanium	No data						
Uranium	2	2	0.00001	0.00001	0.00001	0.00001	
Vanadium	2	1	0.00013	0.00020	0.00026	0.00027	
Zinc	2	0	6.64	6.87	7.08	7.10	42.99
Zirconium	No data						

Table B.2.4-1 Summary of Concentrations in Large Mammals (Cont'd)

μg/g (ww)	Mine Site						Yukon Background
Moose	**Num**	**Num < MDL**	**Min**	**Mean**	**95th Percentile**	**Max**	**Mean**
Aluminum	2	0	0.012	0.028	0.042	0.044	
Antimony	2	0	0.00021	0.00022	0.00023	0.00023	0.001
Arsenic	2	0	0.0021	0.0022	0.0023	0.0023	0.02
Barium	2	0	0.002	0.006	0.009	0.010	
Beryllium	2	1	0.00001	0.00009	0.00016	0.00017	
Boron	No data						
Cadmium	2	0	0.0015	0.0015	0.0016	0.0016	0.022
Calcium	No data						
Chromium	2	0	0.006	0.009	0.011	0.012	0.022
Cobalt	2	0	0.0006	0.0009	0.0011	0.0012	
Copper	2	0	0.086	0.209	0.321	0.333	1.28
Iron	2	0	4.0	6.0	7.8	8.0	
Lead	2	0	0.0005	0.0007	0.0008	0.0008	1.11
Magnesium	No data						
Manganese	2	0	0.020	0.027	0.034	0.034	0.176
Mercury	2	2	0.00021	0.00022	0.00023	0.00023	0.0015
Molybdenum	2	0	0.0016	0.0020	0.0023	0.0023	
Nickel	2	1	0.0006	0.0022	0.0036	0.0038	0.002
Phosphorus	No data						
Potassium	2	0	670	742	807	814	
Selenium	2	0	0.012	0.017	0.022	0.023	0.02
Silicon	No data						
Silver	2	2	0.00001	0.00001	0.00001	0.00001	0.002
Sodium	No data						
Strontium	2	0	0.0052	0.0055	0.0058	0.0059	
Tellurium	No data						
Thallium	2	0	0.000021	0.000022	0.000023	0.000023	
Tin	No data						
Titanium	No data						
Uranium	2	2	0.00001	0.00001	0.00001	0.00001	
Vanadium	2	1	0.00012	0.00016	0.00020	0.00021	
Zinc	2	0	9.4	10.7	11.8	11.9	45.96
Zirconium	No data						

Note: concentrations have been converted from dry weight to wet weight basis using reported moisture contents.

B.3 REFERENCES

Canadian Council of Ministers of the Environment (CCME) 2003. *Canadian Environmental Quality Guidelines*.

EDI Environmental Dynamics Inc. 2008. *Mt. Nansen Site-Specific Water Quality Investigation.* Prepared for Government of Yukon. February.

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APPENDIX C

SAMPLE CALCULATION FOR TERRESTRIAL ECOLOGICAL RECEPTORS

SAMPLE CALCULATION **ARSENIC - Mill Site**

Notes:
fw indicates fresh weight
dw indicates dry weight

Parameter	Units	Symbol	Value	Reference or Equation
Water-to-aquatic vegetation transfer factor	L/kg (FW)	TFav	5.0	CSA1987, Bird and Schwartx 1996 (geomean)
Water-to-benthic invertebrates transfer factor	L/kg (FW)	Tfbi	1700	U.S. EPA 1979, COGEMA 1997
Water concentration	mg/L	Watc	0.18	95th percentile at Dome Creek
Sediment concentration	mg/kg dw	Sedc	2500	95th percentile at Dome Creek
Soil concentration	mg/kg dw	Soilc	485	Maximum measured at Mill Site
Berry concentration	mg/kg (FW)	Berryc	0.1	Maximum measured at Mill Site
Forage concentration	mg/kg (FW)	Foragec	2.1	Maximum measured at Mill Site
Browse concentration	mg/kg (FW)	Browsec	24.4	95th percentile at Mill Site
Fungi concentration	mg/kg (FW)	Fungic	1.08	Maximum measured at Mill Site
Spruce concentration	mg/kg (FW)	Sprucec	0.09	Maximum measured at Mill Site
Aquatic Vegetation concentration	mg/kg (FW)	Aqvegc	0.90	=Watc*Tfav
Benthic invertebrate concentration	mg/kg (FW)	Benthicc	306	=Watc*Tfbi
Fish concentration	mg/kg (FW)	Fishc	0.7	Maximum measured in Victoria Creek
Shrew concentration	mg/kg (FW)	Shrewc	0.68	Maximum measured at the Site
Grouse				
Body weight	kg	BWgro	0.475	U.S. EPA, 1993
Water ingestion rate	g/d	WIRgro	358	U.S. EPA, 1993
Soil ingestion rate	g DW/d	SIRgro	2	calculated from Beyer *et al* ., 1994.
Berry ingestion rate	g FW/d	BIRgro	18	U.S. EPA, 1993
Browse ingestion rate	g FW/d	BrIRgro	99	U.S. EPA, 1993
Toxicity Reference Value	mg/kg-d	toxgro	12.84	USFWS 1964(a)
Fraction of time at site	-	fgro	1	assumed to be in the area of the Mill all year
Intake of COC from water by body weight	mg/kg-d	Iwgro	0.136	=WIRgro*Watc*fgro/Bwgro/1000 grams per liter
Intake of COC from soil by body weight	mg/kg-d	Isgro	1.84	=SIRgro*Soilc*fgro/Bwgro/1000 grams per kilogram
Intake of COC from berries by body weight	mg/kg-d	Ibegro	0.00	=BIRgro*Berryc*fgro/Bwgro/1000 g per kg
Intake of COC from browse by body weight	mg/kg-d	Ibrgro	5.07	=BrIRgro*Browsec*fgro/Bwgro/1000 g per kg
Total intake	mg/kg-d	Itotgro	7.05	=Iwgro+Isgro+Ibegro+Ibrgro
Screening Index	-	SIgro	0.55	=Itotgro/toxgro
Hare				
Body weight	kg	BWhar	1.4	U.S. EPA, 1993
Water ingestion rate	g/d	WIRhar	130	U.S. EPA, 1993
Soil ingestion rate	g DW/d	SIRhar	5.700	calculated from Beyer *et al* ., 1994.
Browse ingestion rate	g FW/d	BrIRhar	180	U.S. EPA, 1993
Forage ingestion rate	g FW/d	FIRhar	114	U.S. EPA, 1993
Toxicity Reference Value	mg/kg-d	toxhar	1.26	Schroeder and Mitchener (1971)
Fraction of time at site	-	fhar	1	assumed to be at the site for 6 months a year
Intake of COC from water by body weight	mg/kg-d	Iwhar	0.017	=WIRhar*Watc*fhar/Bwhar/1000 grams per liter
Intake of COC from soil by body weight	mg/kg-d	Ishar	1.97	=SIRhar*Soilc*fhar/Bwhar/1000 grams per kilogram
Intake of COC from browse by body weight	mg/kg-d	Ibrhar	3.14	=BrIRhar*Browsec*fhar/Bwhar/1000 g per kg
Intake of COC from forage by body weight	mg/kg-d	Ifrhar	0.17	=FIRhar*Foragec*fhar/Bwhar/1000 g per kg
Total intake	mg/kg-d	Itothar	5.30	=Iwhar+Ishar+Ibrhar+Ifrhar
Screening Index	-	SIhar	**4.20**	=Itothar/toxhar
Gray Jay				
Body weight	kg	BWjay	0.07	U.S. EPA, 1993
Water ingestion rate	g/d	WIRjay	10	U.S. EPA, 1993
Soil ingestion rate	g DW/d	SIRjay	1	calculated from Beyer *et al* ., 1994.
Berry ingestion rate	g FW/d	BIRjay	16	U.S. EPA, 1993
Fungi ingestion rate	g FW/d	FuIRjay	10	U.S. EPA, 1993
Shrew ingestion rate	g FW/d	ShIRjay	26	U.S. EPA, 1993
Toxicity Reference Value	mg/kg-d	toxjay	12.84	USFWS 1964(a)
Fraction of time at site	-	fjay	1	assumed to be in the area of the Mill all year
Intake of COC from water by body weight	mg/kg-d	Iwjay	0.026	=WIRjay*Watc*fjay/Bwjay/1000 grams per liter
Intake of COC from soil by body weight	mg/kg-d	Isjay	3.46	=SIRjay*Soilc*fjay/Bwjay/1000 grams per kilogram
Intake of COC from berries by body weight	mg/kg-d	Ibejay	0.03	=BIRjay*Berryc*fjay/Bwjay/1000 g per kg
Intake of COC from fungi by body weight	mg/kg-d	Ifujay	0.16	=FuIRjay*Fungic*fjay/Bwjay/1000 g per kg
Intake of COC from shrew by body weight	mg/kg-d	Ishjay	0.25	=ShIRjay*Shrewsc*fjay/Bwjay/1000 g per kg
Total intake	mg/kg-d	Itotjay	3.93	=Iwjay+Isjay+Ibejay+Ifujay+Ishjay
Screening Index	-	SIjay	0.31	=Itotjay/toxjay

Mallard				
Body weight	kg	BWmal	1.08	U.S. EPA, 1993
Water ingestion rate	g/d	WIRmal	62	U.S. EPA, 1993
Sediment ingestion rate	g DW/d	SIRmal	2	calculated from Beyer *et al* ., 1994.
Aquatic vegetation ingestion rate	g FW/d	AVIRmal	63	U.S. EPA, 1993
Benthic invertebrate ingestion rate	g FW/d	BIIRmal	185	U.S. EPA, 1993
Toxicity Reference Value	mg/kg-d	toxmal	12.84	USFWS 1964(a)
Fraction of time at site	-	fmal	0.5	assumed to migrate in winter
Intake of COC from water by body weight	mg/kg-d	Iwmal	0.005	=WIRmal*Watc*fmal/Bwmal/1000 grams per liter
Intake of COC from sediment by body weight	mg/kg-d	Ismal	1.97	=SIRmal*Sedc*fmal/Bwmal/1000 grams per kilogram
Intake of COC from aquatic vegetation by body weight	mg/kg-d	Iavmal	0.03	=AVIRmal*Aqvegc*fmal/Bwmal/1000 g per kg
Intake of COC from benthic invertebrate by body weight	mg/kg-d	Ibimal	26.21	=BIIRmal*Benthicc*fmal/Bwmal/1000 g per kg
Total intake	mg/kg-d	Itotmal	28.21	=Iwmal+Ismal+Iavmal+Ibimal
Screening Index	-	SImal	**2.2**	=Itotmal/toxmal
Merganser				
Body weight	kg	BWmer	1.47	U.S. EPA, 1993
Water ingestion rate	g/d	WIRmer	76	U.S. EPA, 1993
Sediment ingestion rate	g DW/d	SIRmer	2	calculated from Beyer *et al* ., 1994.
Fish ingestion rate	g FW/d	FIRmer	369	U.S. EPA, 1993
Toxicity Reference Value	mg/kg-d	toxmer	12.84	USFWS 1964(a)
Fraction of time at site	-	fmer	0.5	assumed to migrate in winter
Intake of COC from water by body weight	mg/kg-d	Iwmer	0.005	=WIRmer*Watc*fmer/Bwmer/1000 grams per liter
Intake of COC from sediment by body weight	mg/kg-d	Ismer	1.28	=SIRmer*Sedc*fmer/Bwmer/1000 grams per kilogram
Intake of COC from fish by body weight	mg/kg-d	Ifmer	0.09	=FIRmer*Fishc*fmer/Bwmer/1000 g per kg
Total intake	mg/kg-d	Itotmer	1.37	=Iwmer+Ismer+Ifmer
Screening Index	-	SImer	0.1	=Itotmer/toxmer
Porcupine				
Body weight	kg	BWpor	10	U.S. EPA, 1993
Water ingestion rate	g/d	WIRpor	800	U.S. EPA, 1993
Soil ingestion rate	g DW/d	SIRpor	23	calculated from Beyer *et al* ., 1994.
Browse ingestion rate	g FW/d	BrIRpor	608	U.S. EPA, 1993
Spruce ingestion rate	g FW/d	SpIRpor	608	U.S. EPA, 1993
Aquatic vegetation ingestion rate	g FW/d	AvIRpor	304	U.S. EPA, 1993
Toxicity Reference Value	mg/kg-d	toxpor	1.26	Schroeder and Mitchener (1971)
Fraction of time at site	-	fpor	1	assumed to be in the area of the Mill all year
Intake of COC from water by body weight	mg/kg-d	Iwpor	0.014	=WIRpor*Watc*fpor/Bwpor/1000 grams per liter
Intake of COC from soil by body weight	mg/kg-d	Ispor	1.12	=SIRpor*Soilc*fpor/Bwpor/1000 grams per kilogram
Intake of COC from browse by body weight	mg/kg-d	Ibrpor	1.48	=BrIRpor*Browsec*fpor/Bwpor/1000 g per kg
Intake of COC from spruce by body weight	mg/kg-d	Isppor	0.01	=SpIRpor*Sprucec*fpor/Bwpor/1000 g per kg
Intake of COC from aquatic vegetation by body weight	mg/kg-d	Iavpor	0.03	=AvIRpor*Aqvegc*fpor/Bwpor/1000 g per kg
Total intake	mg/kg-d	Itotpor	2.65	=Iwpor+Ispor+Ibrpor+Isppor+Iavpor
Screening Index	-	SIpor	**2.10**	=Itotpor/toxpor
Scaup				
Body weight	kg	BWsca	0.82	U.S. EPA, 1993
Water ingestion rate	g/d	WIRsca	52	U.S. EPA, 1993
Sediment ingestion rate	g DW/d	SIRsca	6	calculated from Beyer *et al* ., 1994.
Aquatic vegetation ingestion rate	g FW/d	AVIRsca	23	U.S. EPA, 1993
Benthic invertebrate ingestion rate	g FW/d	BIIRsca	227	U.S. EPA, 1993
Toxicity Reference Value	mg/kg-d	toxsca	12.84	USFWS 1964(a)
Fraction of time at site	-	fsca	0.5	assumed to migrate in winter
Intake of COC from water by body weight	mg/kg-d	Iwsca	0.006	=WIRsca*Watc*fsca/Bwsca/1000 grams per liter
Intake of COC from sediment by body weight	mg/kg-d	Issca	8.54	=SIRsca*Sedc*fsca/Bwsca/1000 grams per kilogram
Intake of COC from aquatic vegetation by body weight	mg/kg-d	Iavsca	0.01	=AVIRsca*Aqvegc*fsca/Bwsca/1000 g per kg
Intake of COC from benthic invertebrate by body weight	mg/kg-d	Ibisca	42.35	=BIIRsca*Benthicc*fsca/Bwsca/1000 g per kg
Total intake	mg/kg-d	Itotsca	50.90	=Iwsca+Issca+Iavsca+Ibisca
Screening Index	-	SIsca	**4.0**	=Itotsca/toxsca

SAMPLE CALCULATION **ARSENIC - Mine Site**

Notes:
fw indicates fresh weight
dw indicates dry weight

Parameter	Units	Symbol	Value	Reference or Equation
Water-to-aquatic vegetation transfer factor	L/kg (FW)	TFav	5.0	CSA1987, Bird and Schwartx 1996 (geomean)
Water concentration	mg/L	Watc	0.10	95th percentile at Victoria Creek
Sediment concentration	mg/kg dw	Sedc	63	95th percentile at Victoria Creek
Soil concentration	mg/kg dw	Soilc	485	Maximum measured at Mine Site
Berry concentration	mg/kg (FW)	Berryc	0.1	Maximum measured at Mine Site
Forage concentration	mg/kg (FW)	Foragec	24.4	Maximum measured at Mine Site
Browse concentration	mg/kg (FW)	Browsec	24.4	Maximum of 95th percentiles measured at Mine Site
Lichen concentration	mg/kg (FW)	Lichenc	10	Maximum measured at the Site
Fish concentration	mg/kg (FW)	Fishc	0.7	Maximum measured in Victoria Creek
Aquatic Vegetation concentration	mg/kg (FW)	Aqvegc	0.50	=Watc*Tfav
Moose concentration	mg/kg (FW)	Moosec	0.00	Maximum measured at the Site
Caribou concentration	mg/kg (FW)	Caribouc	0.00	Maximum measured at the Site
Shrew concentration	mg/kg (FW)	Shrewc	0.68	Maximum measured at the Site
Squirrel concentration	mg/kg (FW)	Squirrelc	2.57	Maximum measured at the Site
Hare concentration	mg/kg (FW)	Harec	0.10	Maximum measured at the Site
Grouse concentration	mg/kg (FW)	Grousec	0.33	Maximum measured at the Site
Black Bear				
Body weight	kg	BWbea	225	U.S. EPA, 1993
Water ingestion rate	g/d	WIRbea	9500	U.S. EPA, 1993
Soil ingestion rate	g DW/d	SIRbea	393	calculated from Beyer *et al* ., 1994.
Berry ingestion rate	g FW/d	BIRbea	5960	U.S. EPA, 1993
Forage ingestion rate	g FW/d	FIRbea	4917	U.S. EPA, 1993
Fish ingestion rate	g FW/d	FsIRbea	2235	U.S. EPA, 1993
Moose ingestion rate	g FW/d	MIRbea	745	U.S. EPA, 1993
Caribou ingestion rate	g FW/d	CIRbea	745	U.S. EPA, 1993
Toxicity Reference Value	mg/kg-d	toxbea	1.26	Schroeder and Mitchener (1971)
Fraction of time at site	-	fbea	1	assumed to be at the site all year
Intake of COC from water by body weight	mg/kg-d	Iwbea	0.004	=WIRbea*Watcmine*fbea/Bwbea/1000 grams per liter
Intake of COC from soil by body weight	mg/kg-d	Isbea	0.85	=SIRbea*Soilc*fbea/Bwbea/1000 grams per kilogram
Intake of COC from berries by body weight	mg/kg-d	Ibebea	0.00	=BIRbea*Berryc*fbea/Bwbea/1000 g per kg
Intake of COC from forage by body weight	mg/kg-d	Ifbea	0.53	=FIRbea*Foragec*fbea/Bwbea/1000 g per kg
Intake of COC from fish by body weight	mg/kg-d	Ifsbea	0.01	=FsIRbea*Fishc*fbea/Bwbea/1000 g per kg
Intake of COC from moose by body weight	mg/kg-d	Imbea	7.77E-06	=MIRbea*Moosec*fbea/Bwbea/1000 g per kg
Intake of COC from caribou by body weight	mg/kg-d	Icbea	9.91E-06	=CIRbea*Caribouc*fbea/Bwbea/1000 g per kg
Total intake	mg/kg-d	Itotbea	1.39	=Iwbea+Isbea+Ibebea+Ifbea+Ifsbea+Imbea+Icbea
Screening Index	-	SIbea	1.11	=Itotbea/toxbea
Bison				
Body weight	kg	BWbis	650	U.S. EPA, 1993
Water ingestion rate	L/d	WIRbis	33700	U.S. EPA, 1993
Soil ingestion rate	g DW/d	SIRbis	705	calculated from Beyer *et al* ., 1994.
Forage ingestion rate	g FW/d	FIRbis	46300	U.S. EPA, 1993
Toxicity Reference Value	mg/kg-d	toxbis	1.26	Schroeder and Mitchener (1971)
Fraction of time at site	-	fbis	1	assumed to be at the site all year
Intake of COC from water by body weight	mg/kg-d	Iwbis	0.005	=WIRbis*Watcmine*fbis/Bwbis/1000 grams per liter
Intake of COC from soil by body weight	mg/kg-d	Isbis	0.53	=SIRbis*Soilc*fbis/Bwbis/1000 grams per kilogram
Intake of COC from forage by body weight	mg/kg-d	Ifbis	1.74	=FIRbis*Foragec*fbis/Bwbis/1000 g per kg
Total intake	mg/kg-d	Itotbis	2.27	=Iwbis+Isbis+Ifbis
Screening Index	-	SIbis	**1.80**	=Itotbis/toxbis

Caribou				
Body weight	kg	BWcar	105	U.S. EPA, 1993
Water ingestion rate	L/d	WIRcar	9500	U.S. EPA, 1993
Soil ingestion rate	g DW/d	SIRcar	240	calculated from Beyer *et al* ., 1994.
Forage ingestion rate	g FW/d	FIRcar	80	U.S. EPA, 1993
Browse ingestion rate	g FW/d	BrIRcar	400	U.S. EPA, 1993
Lichen ingestion rate	g FW/d	LIRcar	7280	U.S. EPA, 1993
Toxicity Reference Value	mg/kg-d	toxcar	1.26	Schroeder and Mitchener (1971)
Fraction of time at site	-	fcar	0.5	assumed to be at the site for half of the year
Intake of COC from water by body weight	mg/kg-d	Iwcar	0.005	=WIRcar*Watcmine*fcar/Bwcar/1000 grams per liter
Intake of COC from soil by body weight	mg/kg-d	Iscar	0.55	=SIRcar*Soilc*fcar/Bwcar/1000 grams per kilogram
Intake of COC from forage by body weight	mg/kg-d	Ifcar	0.01	=FIRcar*Foragec*fcar/Bwcar/1000 g per kg
Intake of COC from browse by body weight	mg/kg-d	Ibrcar	0.05	=BrIRcar*Browsec*fcar/Bwcar/1000 g per kg
Intake of COC from lichen by body weight	mg/kg-d	Ilcar	0.34	=LIRcar*Lichenc*fcar/Bwcar/1000 g per kg
Total intake	mg/kg-d	Itotcar	0.96	=Iwcar+Iscar+Ifcar+Ibrcar+Ilcar
Screening Index	-	SIcar	**0.76**	=Itotcar/toxcar
Marten				
Body weight	kg	BWmar	0.9	U.S. EPA, 1993
Water ingestion rate	g/d	WIRmar	100	U.S. EPA, 1993
Soil ingestion rate	g DW/d	SIRmar	1	calculated from Beyer *et al* ., 1994.
Berry ingestion rate	g FW/d	BIRmar	6	U.S. EPA, 1993
Squirrel ingestion rate	g FW/d	SqIRmar	19	U.S. EPA, 1993
Hare ingestion rate	g FW/d	HIRmar	19	U.S. EPA, 1993
Grouse ingestion rate	g FW/d	GIRmar	19	U.S. EPA, 1993
Toxicity Reference Value	mg/kg-d	toxmar	1.26	Schroeder and Mitchener (1971)
Fraction of time at site	-	fmar	1	assumed to be at the site all year
Intake of COC from water by body weight	mg/kg-d	Iwmar	0.011	=WIRmar*Watcmine*fmar/Bwmar/1000 grams per liter
Intake of COC from soil by body weight	mg/kg-d	Ismar	0.27	=SIRmar*Soilc*fmar/Bwmar/1000 grams per kilogram
Intake of COC from berries by body weight	mg/kg-d	Ibemar	0.00	=BIRmar*Berryc*fmar/Bwmar/1000 g per kg
Intake of COC from squirrel by body weight	mg/kg-d	Isqmar	0.05	=SqIRmar*Squirrelc*fmar/Bwmar/1000 g per kg
Intake of COC from hare by body weight	mg/kg-d	Ihmar	2.05E-03	=HIRmar*Harec*fmar/Bwmar/1000 g per kg
Intake of COC from grouse by body weight	mg/kg-d	Igmar	6.89E-03	=GIRmar*Grousec*fmar/Bwmar/1000 g per kg
Total intake	mg/kg-d	Itotmar	0.34	=Iwmar+Ismar+Ibemar+Isqmar+Ihmar+Igmar
Screening Index	-	SImar	0.27	=Itotmar/toxmar
Moose				
Body weight	kg	BWmoo	600	U.S. EPA, 1993
Water ingestion rate	L/d	WIRmoo	31300	U.S. EPA, 1993
Sediment ingestion rate	g DW/d	SIRmoo	138	calculated from Beyer *et al* ., 1994.
Aquatic Vegetation ingestion rate	g FW/d	AvIRmoo	2070	U.S. EPA, 1993
Browse ingestion rate	g FW/d	BrIRmoo	20700	U.S. EPA, 1993
Toxicity Reference Value	mg/kg-d	toxmoo	1.26	Schroeder and Mitchener (1971)
Fraction of time at site	-	fmoo	1	assumed to be at the site for half of the year
Intake of COC from water by body weight	mg/kg-d	Iwmoo	0.005	=WIRmoo*Watcmine*fmoo/Bwmoo/1000 grams per liter
Intake of COC from sediment by body weight	mg/kg-d	Ismoo	0.01	=SIRmoo*Sedcmine*fmoo/Bwmoo/1000 grams per kilogram
Intake of COC from aquatic vegetation by body weight	mg/kg-d	Iavmoo	0.00	=AvIRmoo*Aqvegc*fmoo/Bwmoo/1000 g per kg
Intake of COC from browse by body weight	mg/kg-d	Ibrmoo	0.84	=BrIRmoo*Browsec*fmoo/Bwmoo/1000 g per kg
Total intake	mg/kg-d	Itotmoo	0.86	=Iwmoo+Ismoo+Iavmoo+Ibrmoo+Ilmoo
Screening Index	-	SImoo	0.69	=Itotmoo/toxmoo
Wolf				
Body weight	kg	BWwol	43	U.S. EPA, 1993
Water ingestion rate	g/d	WIRwol	2920	U.S. EPA, 1993
Soil ingestion rate	g DW/d	SIRwol	46	calculated from Beyer *et al* ., 1994.
Hare ingestion rate	g FW/d	HIRwol	1045	U.S. EPA, 1993
Moose ingestion rate	g FW/d	MIRwol	2200	U.S. EPA, 1993
Caribou ingestion rate	g FW/d	CIRwol	2200	U.S. EPA, 1993
Toxicity Reference Value	mg/kg-d	toxwol	1.26	Schroeder and Mitchener (1971)
Fraction of time at site	-	fwol	0.25	assumed to be at the site 3 months of the year
Intake of COC from water by body weight	mg/kg-d	Iwwol	0.002	=WIRwol*Watcmine*fwol/Bwwol/1000 grams per liter
Intake of COC from soil by body weight	mg/kg-d	Iswol	0.13	=SIRwol*Soilc*fwol/Bwwol/1000 grams per kilogram
Intake of COC from hare by body weight	mg/kg-d	Ihwol	0.001	=HIRwol*Harec*fwol/Bwwol/1000 g per kg
Intake of COC from moose by body weight	mg/kg-d	Imwol	3.00E-05	=MIRwol*Moosec*fwol/Bwwol/1000 g per kg
Intake of COC from caribou by body weight	mg/kg-d	Icwol	3.83E-05	=CIRwol*Caribouc*fwol/Bwwol/1000 g per kg
Total intake	mg/kg-d	Itotwol	0.13	=Iwwol+Iswol+Ibewol+Ifwol+Ifswol+Imwol+Icwol
Screening Index	-	SIwol	0.11	=Itotwol/toxwol

APPENDIX D

TERRESTRIAL ECOLOGICAL RECEPTOR CHARACTERISTICS

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APPENDIX D: ECOLOGICAL CHARACTERISTICS OF TERRESTRIAL ECOLOGICAL RECEPTORS

D.1 GENERAL OVERVIEW

This appendix presents the summary table of ecological characteristics of the terrestrial ecological receptors considered in this assessment. The ecological receptors considered in this assessment included the following: woodland caribou, snowshoe hare, moose, wood bison, grouse, gray jay, black bear, wolf, porcupine, and marten. Information on water and food ingestion rates were obtained from literature sources, as is the typical approach for ecological risk assessments. The soil and sediment ingestion rates were obtained from Beyer *et al.* (1994). The dietary characteristics and time spent in the study area are entered into the pathways model so that estimates of exposure can be obtained.

Table D-1 Woodland Caribou Receptor Characteristics

Parameter Description	Units	Default Value	Reference
water ingestion rate	g/d	9500	based on Kirk (1977) and Wales *et al.* (1975)
food ingestion rate	g(wet wt.)/d	8000	calculated from U.S. EPA 1993
fraction of food that is forage[a]	-	0.01	based on Thomas and Barry 1991
fraction of food that is browse[a]	-	0.05	based on Thomas and Barry 1991
fraction of food that is lichen[a]	-	0.91	based on Thomas and Barry 1991
soil ingestion rate	g(dry wt.)/d	240	calculated from Beyer *et al*. 1994
body weight	kg	105	Schmidt 1978
fraction of time in study area	-	0.5	assumed

Note:

a) Browse comprises shrubs and conifers and make up 5% of the diet; forage is approximately 1% of the diet and the remainder of the food is assumed to be lichen at 91% and soil at 3%.

Table D-2 Snowshoe Hare Receptor Characteristics

Parameter Description	Units	Default Value	Reference
water ingestion rate[a]	g/d	130	calculated from U.S. EPA 1993
food ingestion rate[b]	g(wet wt.)/d	300	Pease *et al.* 1979
fraction of food that is forage[c]	-	0.38	U.S. EPA 1993
fraction of food that is browse[c]	-	0.6	U.S. EPA 1993
soil ingestion rate	g(dry wt.)/d	5.7	calculated from Beyer *et al*. 1994
body weight	kg	1.4	U.S. EPA 1993
fraction of time in study area	-	1	assumed

Notes:

a) Based on allometric equation for water intake from U.S. EPA (1993) and using the body weight of a hare of 1.4 kg and water intake of Eastern Cottontail Rabbit from U.S. EPA (1993).

b) This value is consistent with the value obtained for an allometric equation for herbivores given in U.S. EPA (1993).

c) Based on the dietary composition of Eastern Cottontail Rabbit from U.S. EPA (1993).

Table D-3 Moose Receptor Characteristics

Parameter Description	Units	Default Value	Reference
water ingestion rate[a]	g/d	31,300	calculated from U.S. EPA 1993
food ingestion rate[b]	g(wet wt.)/d	23,000	Canadian Wildlife Service 1997
fraction of food that is browse	-	0.9	Belovsky *et al.* 1973
fraction of food that is aquatic vegetation	-	0.09	Belovsky *et al.* 1973
sediment ingestion rate	g(dry wt.)/d	138	calculated from Beyer *et al.* 1994
body weight	kg	600	Canadian Wildlife Service 1997
fraction of time in study area	-	1	assumed

Notes:
a) Based on the allometric equation provided in U.S. EPA 1993 and a body weight of 600 kg for moose (CWS 1997).
b) The Canadian Wildlife Service (CWS) report that moose eat 15 – 20 kg/d twigs and shrubs in the winter and 20 – 30 kg/d forage consisting of twigs, leaves, shrubs, upland and water plants in the summer.

Table D-4 Wood Bison Receptor Characteristics

Parameter Description	Units	Default Value	Reference
water ingestion rate[a]	g/d	33,700	calculated from U.S. EPA 1993
food ingestion rate[a]	g(wet wt.)/d	46,300	calculated from U.S. EPA 1993
fraction of food that is forage	-	1.0	assumed from Newell 2003
soil ingestion rate	g(dry wt.)/d	705	calculated from Beyer *et al.* 1994
body weight	kg	650	Newell 2003
fraction of time in study area	-	1	assumed

Notes:
a) Based on the allometric equation provided in U.S. EPA (1993) and a body weight of 659 kg for a wood bison (Newell 2003).

Table D-5 Grouse Receptor Characteristics

Parameter Description	Units	Default Value	Reference
water ingestion rate[a]	g/d	358	calculated from U.S. EPA 1993
food ingestion rate[b]	g(wet wt.)/d	119	calculated from U.S. EPA 1993
fraction of food that is browse[c]	-	0.83	U.S. EPA 1993
fraction of food that is berries[c]	-	0.15	U.S. EPA 1993
soil ingestion rate	g(dry wt.)/d	1.8	calculated from Beyer *et al*. 1994
body weight	kg	0.475	Canadian Wildlife Service 1997
fraction of time in study area	-	1	assumed

Notes:
a) Based on allometric equation provided in U.S. EPA (1993).
b) Based on the allometric equation provided in U.S. EPA (1993) and a body weight of 475 g for a grouse (Newfoundland Government 2001).
c) Based on breakdown of food intake by a quail in U.S. EPA (1993).

Table D-6 Gray Jay Receptor Characteristics

Parameter Description	Units	Default Value	Reference
water ingestion rate[a]	g/d	10	calculated from U.S. EPA 1993
food ingestion rate[a]	g(wet wt.)/d	52	calculated from U.S. EPA 1993
fraction of food that is berry	-	0.3	assumed based on information in Dietz 2001
fraction of food that is fungi	-	0.2	assumed based on information in Dietz 2001
fraction of food that is shrew	-	0.5	assumed based on information in Dietz 2001
soil ingestion rate	g(dry wt.)/d	0.5	calculated from Beyer *et al.* 1994
body weight	kg	0.07	Dietz 2001
fraction of time in study area	-	1	assumed

Notes:
a) Based on the allometric equation provided in U.S. EPA (1993) and a body weight of 70 g for a gray jay (Dietz 2001).

Table D-7 Black Bear Receptor Characteristics

Parameter Description	Units	Default Value	Reference
water ingestion rate[a]	g/d	9,500	U.S. EPA 1993
food ingestion rate[a]	g(wet wt.)/d	14,900	U.S. EPA 1993
fraction of food that is berries	-	0.4	Holcroft and Herrero 1991
fraction of food that is forage	-	0.33	Holcroft and Herrero 1991
fraction of food that is fish	-	0.15	Canadian Wildlife Service 1993
fraction of food that is moose	-	0.05	Canadian Wildlife Service 1993
fraction of food that is caribou	-	0.05	Canadian Wildlife Service 1993
soil ingestion rate	g(dry wt.)/d	393	Calculated from Beyer *et al.* 1994
body weight	kg	225	Kronk 2002
fraction of time in study area	-	1	assumed

Notes:
a) Based on the allometric equation provided in U.S. EPA (1993) and a body weight of 225 kg for a black bear.

Table D-8 Wolf Receptor Characteristics

Parameter Description	Units	Default Value	Reference
water ingestion rate[a]	g/d	2,920	U.S. EPA 1993
food ingestion rate[b]	g(wet wt.)/d	5,500	Fuller and Keith 1980
fraction of food that is hare[c]	-	0.19	U.S. EPA 1993
fraction of food that is moose[c]	-	0.40	U.S. EPA 1993
fraction of food that is caribou[c]	-	0.40	U.S. EPA 1993
soil ingestion rate	g(dry wt.)/d	46.2	calculated from Beyer *et al.* 1994
body weight	kg	43	Schmidt and Gilbert 1978
fraction of time in study area	-	0.25	Assumed

Notes:
a) Based on the allometric equation provided in U.S. EPA (1993) and a body weight of 43 kg for a gray wolf (Schmidt and Gilbert 1978).
b) Based on study of Fuller and Keith (1980) which estimate that gray wolf in northeastern Alberta eat 5.5 kg/d.
c) Based on the intake of foxes from U.S. EPA (1993) and wolves from the Canadian Wildlife Service (1993b).

Table D-9 Porcupine Receptor Characteristics

Parameter Description	Units	Default Value	Reference
water ingestion rate[a]	g/d	800	calculated from U.S. EPA 1993
food ingestion rate[a]	g(wet wt.)/d	1520	calculated from U.S. EPA 1993
fraction of food that is aquatic vegetation	-	0.2	assumed based on information in Weber and Meyers 2004
fraction of food that is browse	-	0.4	assumed based on information in Weber and Meyers 2004
fraction of food that is spruce	-	0.4	assumed based on information in Weber and Meyers 2004
soil ingestion rate	g(dry wt.)/d	23	calculated from Beyer *et al.* 1994
body weight	kg	10	Weber and Meyers 2004
fraction of time in study area	-	1	assumed

Notes:
a) Based on the allometric equation provided in U.S. EPA (1993) and a body weight of 10 kg for a porcupine (Weber and Meyers 2004).

Table D-10 Marten Receptor Characteristics

Parameter Description	Units	Default Value	Reference
water ingestion rate[a]	g/d	100	calculated from U.S. EPA 1993
food ingestion rate[a]	g(wet wt.)/d	62	calculated from U.S. EPA 1993
fraction of food that is berries	-	0.1	assumed based on information in Ellis 1999
fraction of food that is squirrel	-	0.3	assumed based on information in Ellis 1999
fraction of food that is hare	-	0.3	assumed based on information in Ellis 1999
fraction of food that is grouse	-	0.3	assumed based on information in Ellis 1999
soil ingestion rate	g(dry wt.)/d	0.5	calculated from Beyer *et al.* 1994
body weight	kg	0.9	Ellis 1999
fraction of time in study area	-	1	assumed

Notes:
a) Based on allometric equation provided in U.S. EPA (1993) and the body weight of 900 g for a marten (Ellis 1999)

Table D-11 Duck Receptor Characteristics

Parameter Description	Units	Default Value	Reference
food ingestion rate[a] mallard common merganser scaup	g(wet wt.)/d	250 370 255	CCME 1999 CCME 1999 CCME 1999
fraction of time spent in study area[b] mallard common merganser scaup	-	0.50	U.S. EPA 1993
fraction of food that is fish mallard common merganser scaup	-	0.0 0.996 0.0	U.S. EPA 1993 Andress and Parker 1995 U.S. EPA 1993
fraction of food that is benthic invertebrates mallard common merganser scaup	-	0.74 0.0 0.89	U.S. EPA 1993 U.S. EPA 1993 U.S. EPA 1993
fraction of food that is aquatic vegetation mallard common merganser scaup	-	0.25 0.0 0.09	U.S. EPA 1993 U.S. EPA 1993
Sediment ingestion rate mallard common merganser scaup	g(dry wt.)/d	1.7 1.5 5.6	Calculated from Beyer *et al.* 1994
water ingestion rate[c] mallard common merganser scaup	g/d	62 76 52	Calculated from U.S. EPA 1993
Body weight mallard common merganser scaup	kg	1.08 1.47 0.82	U.S. EPA 1993 U.S. EPA 1993 U.S. EPA 1993

Notes:
a) Taken from CCME (1999) along with body weights of 1082g for a mallard, 820g for a scaup and 1470g for common merganser.
b) Based on information that scaup and mallards migrate and spend 4 – 8 months away from this area.
c) Based on the allometric equation published in U.S. EPA (1993).

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APPENDIX E

TERRESTRIAL ECOLOGICAL RECEPTOR INTAKES BY PATHWAY

APPENDIX E
BREAKDOWN BY PATHWAY FOR TERRESTRIAL ECOLOGICAL RECEPTORS

%	Black Bear		Bison		Caribou	Grouse				Hare			
Arsenic	BG	Mine	BG	Mine	Mine	BG	Mill	Tailings	Pit	BG	Mill	Tailings	Pit
Water	3%	0%	5%	0%	0%	18%	2%	9%	14%	2%	0%	1%	1%
Sed													
Soil	93%	61%	85%	23%	58%	76%	26%	46%	10%	90%	37%	25%	7%
Berry	1%	0%				0%	0%	0%	0%				
Forage	2%	38%	10%	77%	1%					3%	3%	61%	59%
Browse					5%	6%	72%	44%	76%	4%	59%	14%	33%
Lichen					36%								
Fungi													
Spruce													
Fish	2%	1%											
AqVeg													
Moose	0%	0%											
Caribou	0%	0%											
Shrew													
Squirrel													
Hare													
Grouse													
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

%	Black Bear		Bison		Caribou	Grouse				Hare			
Boron	BG	Mine	BG	Mine	Mine	BG	Mill	Tailings	Pit	BG	Mill	Tailings	Pit
Water	1%	0%	0%	0%	1%	3%	1%	3%	1%	0%	0%	1%	0%
Sed													
Soil	1%	5%	0%	1%	7%	0%	0%	1%	0%	0%	0%	1%	0%
Berry	21%	30%				8%	3%	2%	8%				
Forage	76%	65%	100%	98%	2%					57%	25%	23%	39%
Browse					22%	89%	95%	94%	90%	43%	74%	75%	60%
Lichen					67%								
Fungi													
Spruce													
Fish	1%	1%											
AqVeg													
Moose	0%	0%											
Caribou	0%	0%											
Shrew													
Squirrel													
Hare													
Grouse													
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

APPENDIX E
BREAKDOWN BY PATHWAY FOR TERRESTRIAL ECOLOGICAL RECEPTORS

%	Black Bear		Bison		Caribou	Grouse				Hare			
Cadmium	BG	Mine	BG	Mine	Mine	BG	Mill	Tailings	Pit	BG	Mill	Tailings	Pit
Water	1%	1%	3%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Sed													
Soil	26%	29%	26%	10%	13%	0%	1%	1%	1%	1%	1%	1%	1%
Berry	53%	21%				0%	0%	0%	0%				
Forage	13%	47%	71%	89%	1%					0%	1%	5%	1%
Browse					52%	99%	99%	99%	98%	99%	97%	94%	97%
Lichen					34%								
Fungi													
Spruce													
Fish	5%	3%											
AqVeg													
Moose	0%	0%											
Caribou	1%	0%											
Shrew													
Squirrel													
Hare													
Grouse													
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

%	Black Bear		Bison		Caribou	Grouse				Hare			
Copper	BG	Mine	BG	Mine	Mine	BG	Mill	Tailings	Pit	BG	Mill	Tailings	Pit
Water	0%	0%	0%	0%	0%	1%	17%	91%	4%	0%	3%	36%	0%
Sed													
Soil	35%	24%	18%	6%	54%	20%	18%	3%	15%	23%	26%	9%	17%
Berry	15%	3%				6%	3%	0%	4%				
Forage	30%	71%	81%	94%	4%					31%	20%	43%	33%
Browse					4%	73%	62%	6%	78%	47%	51%	12%	50%
Lichen					37%								
Fungi													
Spruce													
Fish	11%	2%											
AqVeg													
Moose	3%	0%											
Caribou	6%	0%											
Shrew													
Squirrel													
Hare													
Grouse													
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

%	Black Bear		Bison		Caribou	Grouse				Hare			
Lead	BG	Mine	BG	Mine	Mine	BG	Mill	Tailings	Pit	BG	Mill	Tailings	Pit
Water	1%	0%	0%	0%	0%	6%	1%	9%	5%	0%	0%	0%	1%
Sed													
Soil	27%	30%	7%	8%	31%	34%	14%	6%	2%	16%	20%	2%	2%
Berry	0%	0%				0%	0%	0%	0%				
Forage	70%	70%	93%	92%	2%					68%	6%	83%	45%
Browse					6%	60%	86%	85%	93%	16%	73%	14%	52%
Lichen					61%								
Fungi													
Spruce													
Fish	0%	0%											
AqVeg													
Moose	2%	0%											
Caribou	0%	0%											
Shrew													
Squirrel													
Hare													
Grouse													
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

%	Black Bear		Bison		Caribou	Grouse				Hare			
Manganese	BG	Mine	BG	Mine	Mine	BG	Mill	Tailings	Pit	BG	Mill	Tailings	Pit
Water	0%	0%	0%	0%	0%	0%	4%	5%	1%	0%	0%	0%	0%
Sed													
Soil	2%	32%	1%	11%	57%	1%	21%	22%	9%	1%	19%	19%	8%
Berry	25%	18%				6%	13%	5%	4%				
Forage	72%	50%	99%	89%	2%					44%	49%	47%	45%
Browse					5%	93%	62%	69%	87%	55%	32%	34%	46%
Lichen					35%								
Fungi													
Spruce													
Fish	1%	1%											
AqVeg													
Moose	0%	0%											
Caribou	0%	0%											
Shrew													
Squirrel													
Hare													
Grouse													
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

%	Black Bear		Bison		Caribou	Grouse				Hare			
Selenium	BG	Mine	BG	Mine	Mine	BG	Mill	Tailings	Pit	BG	Mill	Tailings	Pit
Water	19%	12%	58%	47%	46%	87%	82%	78%	86%	46%	36%	34%	44%
Sed													
Soil	1%	10%	1%	20%	23%	0%	8%	3%	3%	2%	31%	10%	12%
Berry	2%	2%				1%	1%	1%	1%				
Forage	5%	3%	40%	34%	0%					20%	15%	16%	19%
Browse					2%	12%	9%	18%	10%	31%	19%	40%	26%
Lichen					29%								
Fungi													
Spruce													
Fish	65%	71%											
AqVeg													
Moose	3%	0%											
Caribou	6%	0%											
Shrew													
Squirrel													
Hare													
Grouse													
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

%	Black Bear		Bison		Caribou	Grouse				Hare			
Strontium	BG	Mine	BG	Mine	Mine	BG	Mill	Tailings	Pit	BG	Mill	Tailings	Pit
Water	2%	1%	3%	2%	3%	2%	8%	11%	5%	0%	1%	2%	1%
Sed													
Soil	8%	22%	7%	18%	35%	1%	5%	2%	3%	1%	8%	4%	6%
Berry	12%	34%				1%	2%	1%	3%				
Forage	19%	18%	90%	80%	1%					6%	10%	12%	5%
Browse					28%	97%	86%	85%	88%	93%	81%	82%	88%
Lichen					33%								
Fungi													
Spruce													
Fish	59%	24%											
AqVeg													
Moose	0%	0%											
Caribou	0%	0%											
Shrew													
Squirrel													
Hare													
Grouse													
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

APPENDIX E
BREAKDOWN BY PATHWAY FOR TERRESTRIAL ECOLOGICAL RECEPTORS

%	Black Bear		Bison		Caribou	Grouse				Hare			
Tin	BG	Mine	BG	Mine	Mine	BG	Mill	Tailings	Pit	BG	Mill	Tailings	Pit
Water	8%	4%	9%	6%	4%	38%	31%	40%	24%	6%	6%	7%	5%
Sed													
Soil	57%	74%	31%	51%	39%	32%	26%	49%	20%	44%	45%	77%	34%
Berry	3%	3%				1%	1%	1%	1%				
Forage	21%	12%	61%	42%	0%					27%	9%	7%	7%
Browse					1%	29%	41%	9%	55%	23%	40%	9%	55%
Lichen					56%								
Fungi													
Spruce													
Fish	11%	7%											
AqVeg													
Moose	0%	0%											
Caribou	0%	0%											
Shrew													
Squirrel													
Hare													
Grouse													
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

%	Black Bear		Bison		Caribou	Grouse				Hare			
Zinc	BG	Mine	BG	Mine	Mine	BG	Mill	Tailings	Pit	BG	Mill	Tailings	Pit
Water	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%
Sed													
Soil	15%	12%	10%	3%	12%	1%	1%	1%	0%	1%	2%	1%	1%
Berry	14%	10%				0%	0%	0%	0%				
Forage	26%	70%	90%	97%	2%					3%	6%	16%	12%
Browse					42%	99%	98%	98%	98%	95%	92%	83%	87%
Lichen					44%								
Fungi													
Spruce													
Fish	21%	7%											
AqVeg													
Moose	12%	1%											
Caribou	11%	1%											
Shrew													
Squirrel													
Hare													
Grouse													
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

APPENDIX E
BREAKDOWN BY PATHWAY FOR TERRESTRIAL ECOLOGICAL RECEPTORS

%	Gray Jay				Marten		Moose	Porcupine				Wolf
Arsenic	BG	Mill	Tailings	Pit	BG	Mine	Mine	BG	Mill	Tailings	Pit	Mine
Water	2%	1%	2%	3%	18%	3%	1%	4%	1%	2%	3%	1%
Sed							2%					
Soil	96%	88%	76%	19%	75%	78%		87%	42%	64%	13%	98%
Berry	1%	1%	0%	3%	0%	0%						
Forage												
Browse							98%	3%	56%	29%	50%	
Lichen												
Fungi		4%	9%	30%								
Spruce								0%	0%	0%	27%	
Fish												
AqVeg							0%	7%	1%	4%	6%	
Moose												0%
Caribou												0%
Shrew	1%	6%	13%	47%								
Squirrel						15%						
Hare					0%	1%						0%
Grouse					7%	2%						
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

%	Gray Jay				Marten		Moose	Porcupine				Wolf
Boron	BG	Mill	Tailings	Pit	BG	Mine	Mine	BG	Mill	Tailings	Pit	Mine
Water	1%	1%	3%	0%	16%	7%	0%	1%	0%	1%	0%	12%
Sed							1%					
Soil	1%	2%	8%	1%	1%	11%		1%	1%	2%	1%	65%
Berry	83%	75%	58%	76%	49%	55%						
Forage												
Browse							99%	98%	98%	96%	97%	
Lichen												
Fungi		4%	6%	4%								
Spruce								0%	1%	1%	2%	
Fish												
AqVeg												
Moose												0%
Caribou												0%
Shrew	14%	18%	24%	18%								
Squirrel						13%						
Hare					17%	6%						23%
Grouse					17%	7%						
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

APPENDIX E
BREAKDOWN BY PATHWAY FOR TERRESTRIAL ECOLOGICAL RECEPTORS

%	Gray Jay				Marten		Moose	Porcupine				Wolf
Cadmium	BG	Mill	Tailings	Pit	BG	Mine	Mine	BG	Mill	Tailings	Pit	Mine
Water	1%	0%	0%	1%	11%	0%	0%	0%	0%	0%	0%	3%
Sed							0%					
Soil	16%	9%	10%	12%	24%	1%		1%	1%	1%	1%	61%
Berry	69%	15%	5%	18%	40%	1%						
Forage												
Browse							94%	70%	69%	67%	50%	
Lichen												
Fungi		6%	7%	6%								
Spruce								0%	0%	0%	0%	
Fish												
AqVeg							6%	29%	30%	32%	49%	
Moose												1%
Caribou												4%
Shrew	14%	69%	78%	63%								
Squirrel						96%						
Hare					23%	1%						31%
Grouse					2%	0%						
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

%	Gray Jay				Marten		Moose	Porcupine				Wolf
Copper	BG	Mill	Tailings	Pit	BG	Mine	Mine	BG	Mill	Tailings	Pit	Mine
Water	0%	1%	46%	0%	1%	1%	0%	0%	0%	0%	0%	1%
Sed							7%					
Soil	12%	14%	13%	11%	16%	22%		15%	1%	0%	5%	46%
Berry	11%	7%	3%	8%	6%	2%						
Forage												
Browse							66%	26%	2%	0%	13%	
Lichen												
Fungi		18%	9%	18%								
Spruce								0%	0%	0%	1%	
Fish												
AqVeg							26%	59%	96%	100%	81%	
Moose												7%
Caribou												20%
Shrew	77%	61%	29%	63%								
Squirrel						42%						
Hare					51%	21%						26%
Grouse					26%	12%						
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

APPENDIX E
BREAKDOWN BY PATHWAY FOR TERRESTRIAL ECOLOGICAL RECEPTORS

%	Gray Jay				Marten		Moose	Porcupine				Wolf
Lead	BG	Mill	Tailings	Pit	BG	Mine	Mine	BG	Mill	Tailings	Pit	Mine
Water	2%	0%	4%	2%	12%	2%	0%	1%	0%	1%	1%	1%
Sed							3%					
Soil	89%	84%	28%	9%	66%	63%		27%	22%	4%	2%	99%
Berry	1%	1%	1%	2%	0%	0%						
Forage												
Browse							94%	23%	68%	30%	36%	
Lichen												
Fungi		9%	40%	53%								
Spruce								0%	0%	0%	24%	
Fish												
AqVeg							2%	49%	9%	65%	38%	
Moose												0%
Caribou												0%
Shrew	8%	6%	26%	34%								
Squirrel						17%						
Hare					8%	0%						0%
Grouse					14%	18%						
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

%	Gray Jay				Marten		Moose	Porcupine				Wolf
Manganese	BG	Mill	Tailings	Pit	BG	Mine	Mine	BG	Mill	Tailings	Pit	Mine
Water	0%	1%	1%	0%	0%	0%	0%	0%	1%	1%	0%	0%
Sed							2%					
Soil	4%	33%	57%	39%	9%	68%		2%	22%	21%	16%	100%
Berry	94%	61%	37%	48%	88%	31%						
Forage												
Browse							98%	98%	31%	31%	72%	
Lichen												
Fungi		1%	1%	3%								
Spruce								0%	0%	0%	1%	
Fish												
AqVeg							1%	1%	47%	48%	12%	
Moose												0%
Caribou												0%
Shrew	2%	4%	4%	10%								
Squirrel						1%						
Hare					0%	0%						0%
Grouse					2%	0%						
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

APPENDIX E
BREAKDOWN BY PATHWAY FOR TERRESTRIAL ECOLOGICAL RECEPTORS

%	Gray Jay				Marten		Moose	Porcupine				Wolf
Selenium	BG	Mill	Tailings	Pit	BG	Mine	Mine	BG	Mill	Tailings	Pit	Mine
Water	13%	5%	5%	5%	89%	30%	16%	4%	4%	4%	4%	53%
Sed							6%					
Soil	1%	5%	2%	1%	0%	3%		0%	2%	1%	1%	17%
Berry	3%	2%	1%	2%	1%	1%						
Forage												
Browse							9%	1%	1%	2%	1%	
Lichen												
Fungi		1%	1%	1%								
Spruce								0%	1%	1%	1%	
Fish												
AqVeg							69%	94%	92%	92%	93%	
Moose												9%
Caribou												7%
Shrew	83%	88%	91%	90%								
Squirrel						59%						
Hare					5%	4%						14%
Grouse					5%	3%						
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

%	Gray Jay				Marten		Moose	Porcupine				Wolf
Strontium	BG	Mill	Tailings	Pit	BG	Mine	Mine	BG	Mill	Tailings	Pit	Mine
Water	2%	2%	4%	2%	42%	17%	1%	0%	1%	1%	1%	13%
Sed							1%					
Soil	9%	14%	10%	13%	23%	35%		1%	3%	1%	3%	85%
Berry	28%	20%	17%	43%	29%	44%						
Forage												
Browse							87%	62%	23%	18%	33%	
Lichen												
Fungi		1%	1%	1%								
Spruce								0%	0%	0%	1%	
Fish												
AqVeg							12%	36%	73%	80%	63%	
Moose												0%
Caribou												0%
Shrew	61%	63%	68%	42%								
Squirrel						1%						
Hare					4%	1%						1%
Grouse					2%	2%						
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

APPENDIX E
BREAKDOWN BY PATHWAY FOR TERRESTRIAL ECOLOGICAL RECEPTORS

%	Gray Jay				Marten		Moose	Porcupine				Wolf
Tin	BG	Mill	Tailings	Pit	BG	Mine	Mine	BG	Mill	Tailings	Pit	Mine
Water	7%	7%	6%	7%	37%	20%	6%	2%	2%	2%	2%	12%
Sed							15%					
Soil	57%	57%	73%	55%	30%	40%		10%	10%	15%	9%	74%
Berry	6%	9%	6%	11%	1%	1%						
Forage												
Browse							36%	5%	7%	1%	13%	
Lichen												
Fungi		7%	4%	7%								
Spruce								0%	2%	1%	1%	
Fish												
AqVeg							42%	83%	79%	81%	75%	
Moose												0%
Caribou												0%
Shrew	30%	21%	11%	20%								
Squirrel						7%						
Hare					25%	12%						14%
Grouse					6%	19%						
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

%	Gray Jay				Marten		Moose	Porcupine				Wolf
Zinc	BG	Mill	Tailings	Pit	BG	Mine	Mine	BG	Mill	Tailings	Pit	Mine
Water	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%
Sed							0%					
Soil	7%	8%	6%	3%	5%	7%		1%	2%	2%	0%	13%
Berry	12%	10%	7%	13%	4%	5%						
Forage												
Browse							100%	97%	87%	81%	57%	
Lichen												
Fungi		21%	22%	21%								
Spruce								0%	0%	0%	0%	
Fish												
AqVeg							0%	2%	11%	17%	42%	
Moose												30%
Caribou												18%
Shrew	81%	61%	65%	61%								
Squirrel						30%						
Hare					49%	34%						39%
Grouse					42%	23%						
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

%	Mallard						Merganser						Scaup					
Antimony	BG	Mill	Tailings	Pit	Pony	Victoria	BG	Mill	Tailings	Pit	Pony	Victoria	BG	Mill	Tailings	Pit	Pony	Victoria
Water	0%	0%	0%	0%	0%	0%	56%	6%	8%	8%	0%	17%	0%	0%	0%	0%	0%	0%
Sed	0%	1%	1%	1%	55%	0%	0%	88%	83%	83%	98%	67%	0%	10%	7%	7%	91%	3%
Fish							44%	6%	8%	8%	2%	16%						
AqVeg	98%	97%	97%	97%	44%	98%							94%	85%	87%	87%	8%	91%
Benthic	2%	2%	2%	2%	1%	2%							6%	6%	6%	6%	1%	6%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

%	Mallard						Merganser						Scaup					
Arsenic	BG	Mill	Tailings	Pit	Pony	Victoria	BG	Mill	Tailings	Pit	Pony	Victoria	BG	Mill	Tailings	Pit	Pony	Victoria
Water	0%	0%	0%	0%	0%	0%	3%	0%	1%	1%	0%	2%	0%	0%	0%	0%	0%	0%
Sed	1%	7%	3%	3%	9%	0%	63%	93%	85%	74%	96%	25%	2%	17%	7%	7%	21%	1%
Fish							34%	7%	15%	25%	4%	73%						
AqVeg	0%	0%	0%	0%	0%	0%							0%	0%	0%	0%	0%	0%
Benthic	99%	93%	97%	97%	91%	100%							98%	83%	93%	93%	79%	99%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

%	Mallard						Merganser						Scaup					
Barium	BG	Mill	Tailings	Pit	Pony	Victoria	BG	Mill	Tailings	Pit	Pony	Victoria	BG	Mill	Tailings	Pit	Pony	Victoria
Water	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Sed	5%	6%	9%	9%	15%	7%	9%	23%	14%	6%	32%	21%	16%	19%	29%	29%	40%	24%
Fish							91%	77%	86%	94%	67%	78%						
AqVeg	44%	43%	41%	41%	39%	42%							17%	16%	14%	14%	12%	15%
Benthic	52%	51%	49%	49%	46%	50%							67%	65%	56%	56%	48%	60%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

%	Mallard						Merganser						Scaup					
Boron	BG	Mill	Tailings	Pit	Pony	Victoria	BG	Mill	Tailings	Pit	Pony	Victoria	BG	Mill	Tailings	Pit	Pony	Victoria
Water	100%	6%	19%	19%	100%	3%	3%	3%	10%	2%	0%	2%	100%	2%	5%	5%	100%	1%
Sed	0%	94%	81%	81%	0%	97%	0%	38%	30%	7%	0%	34%	0%	98%	95%	95%	0%	99%
Fish							97%	59%	60%	90%	100%	65%						
AqVeg																		
Benthic																		
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

%	Mallard						Merganser						Scaup					
Cadmium	BG	Mill	Tailings	Pit	Pony	Victoria	BG	Mill	Tailings	Pit	Pony	Victoria	BG	Mill	Tailings	Pit	Pony	Victoria
Water	0%	0%	0%	0%	0%	0%	1%	0%	1%	1%	1%	1%	0%	0%	0%	0%	0%	0%
Sed	0%	1%	0%	0%	1%	0%	5%	51%	30%	56%	55%	3%	0%	3%	1%	1%	3%	0%
Fish							94%	49%	69%	42%	44%	96%						
AqVeg	14%	14%	14%	14%	14%	14%							5%	4%	5%	5%	4%	5%
Benthic	86%	85%	86%	86%	85%	86%							95%	93%	94%	94%	93%	95%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

%	Mallard						Merganser						Scaup					
Chromium	BG	Mill	Tailings	Pit	Pony	Victoria	BG	Mill	Tailings	Pit	Pony	Victoria	BG	Mill	Tailings	Pit	Pony	Victoria
Water	1%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Sed	51%	76%	86%	86%	78%	76%	23%	51%	55%	55%	33%	40%	74%	89%	94%	94%	91%	90%
Fish							77%	49%	44%	44%	66%	60%						
AqVeg	0%	0%	0%	0%	0%	0%							0%	0%	0%	0%	0%	0%
Benthic	48%	24%	14%	14%	21%	24%							26%	11%	6%	6%	9%	10%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

APPENDIX E
BREAKDOWN BY PATHWAY FOR TERRESTRIAL ECOLOGICAL RECEPTORS

%	Mallard						Merganser						Scaup					
Cobalt	BG	Mill	Tailings	Pit	Pony	Victoria	BG	Mill	Tailings	Pit	Pony	Victoria	BG	Mill	Tailings	Pit	Pony	Victoria
Water	0%	0%	0%	0%	0%	0%	0%	3%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Sed	3%	0%	5%	5%	4%	3%	35%	34%	96%	49%	23%	35%	8%	1%	14%	14%	12%	8%
Fish							65%	64%	3%	50%	77%	65%						
AqVeg	28%	29%	28%	28%	28%	28%							10%	11%	9%	9%	10%	10%
Benthic	69%	71%	68%	68%	68%	69%							82%	88%	77%	77%	79%	82%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

%	Mallard						Merganser						Scaup					
Copper	BG	Mill	Tailings	Pit	Pony	Victoria	BG	Mill	Tailings	Pit	Pony	Victoria	BG	Mill	Tailings	Pit	Pony	Victoria
Water	0%	0%	0%	0%	0%	0%	0%	3%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Sed	1%	0%	4%	4%	8%	3%	3%	32%	99%	45%	78%	19%	3%	1%	11%	11%	22%	8%
Fish							97%	65%	0%	54%	22%	80%						
AqVeg	25%	25%	24%	24%	23%	25%							9%	9%	8%	8%	7%	8%
Benthic	74%	74%	72%	72%	69%	73%							88%	90%	81%	81%	71%	83%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

%	Mallard						Merganser						Scaup					
Iron	BG	Mill	Tailings	Pit	Pony	Victoria	BG	Mill	Tailings	Pit	Pony	Victoria	BG	Mill	Tailings	Pit	Pony	Victoria
Water	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Sed	100%	99%	100%	100%	100%	100%	34%	40%	71%	11%	58%	35%	100%	100%	100%	100%	100%	100%
Fish							66%	59%	29%	89%	42%	65%						
AqVeg																		
Benthic																		
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

%	Mallard						Merganser						Scaup					
Lead	BG	Mill	Tailings	Pit	Pony	Victoria	BG	Mill	Tailings	Pit	Pony	Victoria	BG	Mill	Tailings	Pit	Pony	Victoria
Water	0%	0%	0%	0%	0%	0%	3%	0%	1%	0%	0%	1%	0%	0%	0%	0%	0%	0%
Sed	7%	56%	34%	34%	59%	16%	66%	91%	92%	80%	99%	60%	20%	82%	65%	65%	84%	41%
Fish							31%	9%	7%	20%	1%	39%						
AqVeg	31%	15%	22%	22%	14%	28%							11%	2%	5%	5%	2%	8%
Benthic	62%	29%	44%	44%	27%	55%							70%	16%	31%	31%	14%	51%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

%	Mallard						Merganser						Scaup					
Manganese	BG	Mill	Tailings	Pit	Pony	Victoria	BG	Mill	Tailings	Pit	Pony	Victoria	BG	Mill	Tailings	Pit	Pony	Victoria
Water	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Sed	45%	28%	56%	56%	41%	55%	6%	61%	90%	47%	28%	14%	88%	78%	92%	92%	86%	92%
Fish							94%	38%	10%	53%	72%	86%						
AqVeg	54%	71%	44%	44%	59%	44%							12%	22%	8%	8%	14%	8%
Benthic	0%	0%	0%	0%	0%	0%							0%	0%	0%	0%	0%	0%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

%	Mallard						Merganser						Scaup					
Selenium	BG	Mill	Tailings	Pit	Pony	Victoria	BG	Mill	Tailings	Pit	Pony	Victoria	BG	Mill	Tailings	Pit	Pony	Victoria
Water	0%	0%	0%	0%	0%	0%	1%	1%	1%	1%	0%	1%	0%	0%	0%	0%	0%	0%
Sed	0%	0%	0%	0%	2%	0%	0%	1%	0%	0%	0%	1%	0%	0%	0%	0%	6%	0%
Fish							99%	98%	99%	99%	100%	98%						
AqVeg	3%	3%	3%	3%	3%	3%							1%	1%	1%	1%	1%	1%
Benthic	97%	97%	97%	97%	95%	97%							99%	99%	99%	99%	93%	99%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

APPENDIX E
BREAKDOWN BY PATHWAY FOR TERRESTRIAL ECOLOGICAL RECEPTORS

%	Mallard						Merganser						Scaup					
Silver	BG	Mill	Tailings	Pit	Pony	Victoria	BG	Mill	Tailings	Pit	Pony	Victoria	BG	Mill	Tailings	Pit	Pony	Victoria
Water	0%	0%	0%	0%	0%	0%	9%	3%	4%	4%	0%	6%	0%	0%	0%	0%	0%	0%
Sed	0%	2%	1%	1%	41%	0%	69%	76%	93%	82%	98%	48%	1%	4%	3%	3%	66%	1%
Fish							22%	21%	2%	14%	2%	46%						
AqVeg	8%	8%	8%	8%	5%	8%							3%	2%	2%	2%	1%	3%
Benthic	91%	91%	91%	91%	54%	91%							96%	93%	94%	94%	33%	96%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

%	Mallard						Merganser						Scaup					
Strontium	BG	Mill	Tailings	Pit	Pony	Victoria	BG	Mill	Tailings	Pit	Pony	Victoria	BG	Mill	Tailings	Pit	Pony	Victoria
Water	0%	0%	0%	0%	0%	0%	0%	1%	1%	1%	0%	0%	0%	0%	0%	0%	0%	0%
Sed	0%	0%	0%	0%	0%	0%	0%	1%	3%	2%	1%	1%	1%	0%	1%	1%	1%	1%
Fish							100%	98%	96%	97%	98%	99%						
AqVeg	16%	16%	16%	16%	16%	16%							5%	5%	5%	5%	5%	5%
Benthic	83%	83%	83%	83%	83%	83%							94%	94%	94%	94%	93%	93%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

%	Mallard						Merganser						Scaup					
Vanadium	BG	Mill	Tailings	Pit	Pony	Victoria	BG	Mill	Tailings	Pit	Pony	Victoria	BG	Mill	Tailings	Pit	Pony	Victoria
Water	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Sed	3%	5%	19%	19%	8%	7%	29%	37%	75%	62%	25%	35%	20%	28%	61%	61%	38%	35%
Fish							71%	62%	24%	38%	75%	64%						
AqVeg	84%	82%	71%	71%	80%	81%							54%	48%	26%	26%	41%	43%
Benthic	12%	12%	10%	10%	12%	12%							27%	24%	13%	13%	20%	21%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

%	Mallard						Merganser						Scaup					
Zinc	BG	Mill	Tailings	Pit	Pony	Victoria	BG	Mill	Tailings	Pit	Pony	Victoria	BG	Mill	Tailings	Pit	Pony	Victoria
Water	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Sed	0%	0%	0%	0%	0%	0%	2%	33%	20%	58%	25%	2%	0%	1%	0%	0%	0%	1%
Fish							98%	67%	80%	42%	75%	98%						
AqVeg	0%	0%	0%	0%	0%	0%							0%	0%	0%	0%	0%	0%
Benthic	99%	99%	99%	99%	99%	99%							99%	99%	99%	99%	100%	99%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

APPENDIX F

SAMPLE CALCULATION FOR HUMAN RECEPTORS

SAMPLE CALCULATION FOR HUMAN HEALTH — CADMIUM - CHILD (NON-CARCINOGENIC)

Parameter	Units	Symbol	Value	Reference or Equation
Human Receptor Characteristics (Child)				
Body Weight	kg	BW	32.9	Richardson 1997
Soil Ingestion Rate	g/d	SIRc	0.02	CCME 1996, MADEP 2002
Time at site	-	loc	0.125	assumed 200 hrs/year
Skin Surface Area				
Exposed	cm^2	Sae	5140	Richardson 1997
Soil loading to exposed skin				
Child	kg/(cm2-event)	AFh	2.03E-08	Kissel et al., 1996, 1998
Soil Dermal Contact Rate	kg/d	SR	1.30E-05	=(SAe*AFh) x 1 event/d x loc
Fraction of food from the site	-	floc	0.5	assumed that 50% of annual food is taken home from the site
Water Ingestion Rate	L/d	WIRc	8.00E-01	Richardson 1997
Fish Ingestion Rate	g/d	FIRc	1.75E+01	Richardson 1997
Hare Ingestion Rate	g/d	HIRc	4.53E+00	Richardson 1997
Moose Ingestion Rate	g/d	MIRc	1.08E+02	Richardson 1997
Caribou Ingestion Rate	g/d	CIRc	8.70E+00	Richardson 1997
Porcupine Ingestion Rate	g/d	PIRc	3.02E+00	Richardson 1997
Squirrel Ingestion Rate	g/d	SQIRc	3.02E+00	Richardson 1997
Grouse Ingestion Rate	g/d	GIRc	7.40E-01	Richardson 1997
Berry Ingestion Rate	g/d	BIRc	1.78E+00	Richardson 1997
Labrador Tea Ingestion Rate	L/d	LTIRc	0.00E+00	assumed
Concentrations				
Soil concentration	mg/kg	Soilc	6.5	maximum measured at site
Water concentration	mg/L	Watc	0.005	maximum measured in Victoria Creek
Fish concentration	mg/kg	Fishc	0.10	maximum measured in Victoria Creek
Hare concentration	mg/kg	Harec	1.47E-01	maximum measured from mine site
Moose concentration	mg/kg	Moosec	1.57E-03	maximum measured from mine site
Caribou concentration	mg/kg	Caribouc	9.82E-03	maximum measured from mine site
Porcupine concentration	mg/kg	Porc	9.47E-04	calculated from exposure pathways in ecological risk assessment
Squirrel concentration	mg/kg	Squirc	1.17E+01	maximum measured from mine site, kidney and liver
Grouse concentration	mg/kg	Grousec	3.30E-02	maximum measured from mine site
Berry concentration	mg/kg	Berryc	0.3	maximum measured from mine site
Labrador Tea concentration	mg/L	Labtc	0.0005	maximum measured from mine site
Toxicity Data				
Reference Dose - oral	mg/kg bw-d	RfDo	8.00E-04	HC, 2004
Reference Dose - dermal	mg/kg bw-d	RfDd	0.0008	Assume equal to oral
Relative Absorption Factor for skin	-	RAFd	0.14	HC, 2004
Camper 2 at Mine Site				
Dose from soil ingestion	mg/kg bw-d	Dsoil	4.94E-07	=Soilc*(SIRc)*locc/BW/1000
Dose from water ingestion	mg/kg bw-d	Dwater	1.52E-05	=Watc*WIRc*locc/BW
Dose from fish ingestion	mg/kg bw-d	Dfish	2.74E-05	=Fishc*FIRc*floc/BW/1000
Dose from hare ingestion	mg/kg bw-d	Dhare	1.01E-05	=Harec*HIRc*floc/BW/1000
Dose from moose ingestion	mg/kg bw-d	Dmoose	2.58E-06	=Moosec*MIRc*floc/BW/1000
Dose from caribou ingestion	mg/kg bw-d	Dcaribou	1.30E-06	=Caribouc*CIRc*floc/BW/1000
Dose from porcupine ingestion	mg/kg bw-d	Dpor	4.34E-08	=Porc*PIRc*floc/BW/1000
Dose from squirrel ingestion	mg/kg bw-d	Dsquir	5.39E-04	=Squirc*SQIRc*floc/BW/1000
Dose from grouse ingestion	mg/kg bw-d	Dgrouse	3.71E-07	=Grousec*GIRc*floc/BW/1000
Dose from berry ingestion	mg/kg bw-d	Dberry	2.05E-06	=Berryc*BIRc*loc/BW/1000
Dose from Labrador tea ingestion	mg/kg bw-d	Dlabt	0.00E+00	=Labtc*LTIRc*floc/BW
Total ingestion dose	mg/kg bw-d	Ding	5.98E-04	=Dsoil+Dwater+Dfish+Dhare+Dmoose+Dcaribou+Dpor+Dsquir+Dgrouse+Dberry+Dlabt
Dose from dermal exposure	mg/kg bw-d	Ddermal	3.61E-07	=Soilc*SR*RAFd/BW
Hazard Quotient - ingestion	-	HQing	7.48E-01	=Ding/RfDo
Hazard Quotient - dermal	-	HQderm	4.51E-04	=Ddermal/RfDd
Total Hazard Quotient	-	HQtotal	**7.48E-01**	=HQing+HQderm

SAMPLE CALCULATION FOR HUMAN HEALTH — ARSENIC (CARCINOGENIC)

Parameter	Units	Symbol	Value	Reference or Equation
Toxicity Data				
Slope Factor - oral	(mg/(kg bw -d))[1]	SFo	1.20E+00	HC, 2004
Relative Absorption Factor for skin	-	RAFd	0.032	HC, 2004
Target Risk	-	TR	1.00E-05	HC
Concentrations				
Soil concentrations	mg/kg	Soilc	485	maximum measured at site
Water concentration	mg/L	Watc	0.10	maximum measured in Victoria Creek
Fish concentration	mg/kg	Fishc	0.74	maximum measured in Victoria Creek
Hare concentration	mg/kg	Harec	9.92E-02	maximum measured from mine site
Moose concentration	mg/kg	Moosec	2.35E-03	maximum measured from mine site
Caribou concentration	mg/kg	Caribouc	2.99E-03	maximum measured from mine site
Porcupine concentration	mg/kg	Porc	5.29E-03	calculated from exposure pathways in ecological risk assessment
Squirrel concentration	mg/kg	Squirc	2.57	maximum measured from mine site, kidney and liver
Grouse concentration	mg/kg	Grousec	0.33	maximum measured from mine site
Berry concentration	mg/kg	Berryc	0.1318	maximum measured from mine site
Labrador tea concentration	mg/L	Labtc	0.034	maximum measured from mine site

Human Receptor Characteristics

Parameter (Units)	Symbol	Toddler (0-5 yrs)	Child (5-12 yrs)	Adult (12-75 yrs)	Reference or Equation
Body Weight (kg)	BW	16.5	32.9	70.7	Richardson 1997
Soil Ingestion Rate (kg/d)	IRs	0.08	0.02	0.02	CCME 1996, MADEP 2002
Skin Surface Area					
Exposed (cm^2)	SAe	3010	5140	9110	Richardson 1997
Soil loading to skin					
Exposed (kg/cm^2/event)	AFh	2.29E-08	2.03E-08	1.88E-08	Kissel et al., 1996, 1998
Soil Dermal Contact Rate (g/d)	SR	8.62E-06	1.30E-05	2.14E-05	=(SAh*AFh+SAo*AFo)/1000 x 1 event/d x loc
Fraction of time at the site (-)	loc	2.50E-02	2.50E-02	2.50E-02	assumed 200 hrs/d
Fraction of food from the site (-)	floc	0.5	0.5	0.5	assumed that 50% of annual food is taken home from the site
Water Ingestion Rate (L/d)	WIR	6.00E-01	8.00E-01	1.50E+00	Richardson 1997
Fish Ingestion Rate (g/d)	FIR	1.08E+01	1.75E+01	2.16E+01	Richardson 1997
Hare Ingestion Rate (g/d)	HIR	3.18E+00	4.53E+00	6.12E+00	Richardson 1997
Moose Ingestion Rate (g/d)	MIR	7.59E+01	1.08E+02	1.46E+02	Richardson 1997
Caribou Ingestion Rate (g/d)	CIR	6.11E+00	8.70E+00	1.18E+01	Richardson 1997
Porcupine Ingestion Rate (g/d)	PIR	2.12E+00	3.02E+00	4.08E+00	Richardson 1997
Squirrel Ingestion Rate (g/d)	SQIR	2.12E+00	3.02E+00	4.08E+00	Richardson 1997
Grouse Ingestion Rate (g/d)	GIR	5.20E-01	7.40E-01	1.00E+00	Richardson 1997
Berry Ingestion Rate (g/d)	BIR	1.56E+00	1.78E+00	1.63E+00	Richardson 1997
Labrador Tea Ingestion Rate (g/d)	LTIR	0.00E+00	0.00E+00	4.25E-02	Richardson 1997
Exposure Duration (y)	ED	5	7	63	
Averaging Time (y)	AT	75	75	75	

Camper 2 at Mine Site

	Symbol	Toddler (0-5 yrs)	Child (5-11 yrs)	Adult (12-70 yrs)	
Dose from soil ingestion (mg/kg bw-d)	Dsoil	2.94E-04	3.69E-05	1.71E-05	=Soilc*(SIRc)*locc/BW/1000
Dose from water ingestion (mg/kg bw-d)	Dwater	4.55E-04	3.04E-04	2.65E-04	=Watc*WIRc*locc/BW
Dose from fish ingestion (mg/kg bw-d)	Dfish	2.42E-04	1.97E-04	1.13E-04	=Fishc*FIRc*floc/BW/1000
Dose from hare ingestion (mg/kg bw-d)	Dhare	9.57E-06	6.83E-06	4.29E-06	=Harec*HIRc*floc/BW/1000
Dose from moose ingestion (mg/kg bw-d)	Dmoose	5.40E-06	3.85E-06	2.42E-06	=Moosec*MIRc*floc/BW/1000
Dose from caribou ingestion (mg/kg bw-d)	Dcaribou	5.54E-07	3.95E-07	2.49E-07	=Caribouc*CIRc*floc/BW/1000
Dose from porcupine ingestion (mg/kg bw-d)	Dpor	3.40E-07	2.43E-07	1.53E-07	=Porc*PIRc*floc/BW/1000
Dose from squirrel ingestion (mg/kg bw-d)	Dsquir	1.65E-04	1.18E-04	7.41E-05	=Squirc*SQIRc*floc/BW/1000
Dose from grouse ingestion (mg/kg bw-d)	Dgrouse	5.25E-06	3.75E-06	2.36E-06	=Grousec*GIRc*floc/BW/1000
Dose from berry ingestion (mg/kg bw-d)	Dberry	1.56E-06	8.90E-07	3.80E-07	=Berryc*BIRc*loc/BW/1000
Dose from Labrador tea ingestion (mg/kg bw-d)	Dlabt	0.00E+00	0.00E+00	2.04E-05	=Labtc*LTIRc/BW
Total ingestion dose (mg/kg bw-d)	Ding	1.18E-03	6.71E-04	5.00E-04	=Dsoil+Dwater+Dfish+Dhare+Dmoose+Dcaribou+Dpor+Dsquir+Dgrouse+Dberry+Dlabt
Dose from dermal exposure (mg/kg bw-d)	Ddermal	8.10E-06	6.15E-06	4.70E-06	=Soilc*SR*RAFd/BW
Overall dose (mg/kg bw-d)	Dtotal	1.19E-03	6.78E-04	5.05E-04	=Ding+Ddermal

Incremental Risk - Toddler	-	Rtoddler	9.49E-05	=SFo*Dtotal - toddler*ED/Att
Incremental Risk - Child	-	Rchild	7.59E-05	=SFo*Dtotal - child*ED/Atc
Incremental Risk - Adult	-	Radult	5.09E-04	=SFo*Dtotal - adult*ED/Ata
Total Incremental Risk Composite	-	Rtot	**6.79E-04**	=Rtoddler+Rchild+Radult

APPENDIX G

CALCULATED HAZARD QUOTIENT VALUES

APPENDIX G
CALCULATED HAZARD QUOTIENTS FOR HUMAN RECEPTORS

Camper 1	Toddler			Child			Adult		
	Ingestion	Dermal	Total	Ingestion	Dermal	Total	Ingestion	Dermal	Total
Arsenic	-	-	-	-	-	-	-	-	-
Boron	0.022506857	0.00000269	0.022509543	0.015817588	0.00000204	0.01581963	0.02582647	0.00000156	0.025828024
Cadmium	0.139794777	0.00020287	0.139997647	0.099719021	0.00015402	0.09987304	0.06589139	0.00011764	0.066009035
Copper	0.142989415	0.00005222	0.143041634	0.103286623	0.00003964	0.10332627	0.06588371	0.00003028	0.065913988
Lead	0.758411556	0.00002437	0.758435925	0.537574481	0.00001850	0.53759298	0.34329254	0.00001413	0.343306668
Manganese	0.087180406	0.00013279	0.087313191	0.063395875	0.00010081	0.06349668	0.04033931	0.00007700	0.040416309
Selenium	0.29633312	0.00000002	0.296333141	0.216822931	0.00000002	0.21682295	0.14723959	0.00000001	0.147239606
Strontium	0.023324782	0.00000261	0.023327393	0.018619528	0.00000198	0.01862151	0.01133322	0.00000151	0.011334737
Tin	0.000171711	0.00000022	0.000171928	0.000120455	0.00000017	0.00012062	0.00009417	0.00000013	0.00009430
Zinc	0.222892157	0.00000205	0.222894205	0.160539189	0.00000155	0.16054074	0.10038562	0.00000119	0.100386805

Camper 2	Toddler			Child			Adult		
	Ingestion	Dermal	Total	Ingestion	Dermal	Total	Ingestion	Dermal	Total
Arsenic	-	-	-	-	-	-	-	-	-
Boron	0.02929214	0.00005073	0.029342867	0.020049953	0.00003851	0.02008846	0.01797646	0.00002942	0.018005875
Cadmium	1.048543759	0.00059399	1.04913775	0.747684903	0.00045095	0.74813585	0.47270349	0.00034444	0.473047934
Copper	0.08563257	0.00019147	0.085824039	0.061019364	0.00014536	0.06116472	0.04036765	0.00011103	0.040478683
Lead	0.097929641	0.00011227	0.098041911	0.057618757	0.00008523	0.05770399	0.04105407	0.00006510	0.041119169
Manganese	0.162975925	0.00368517	0.16666109	0.094669609	0.00279771	0.09746732	0.05485987	0.00213696	0.056996829
Selenium	0.27751118	0.00000042	0.277511597	0.209573322	0.00000032	0.20957364	0.13984482	0.00000024	0.139845063
Strontium	0.019141071	0.00001305	0.019154126	0.014963229	0.00000991	0.01497314	0.00932707	0.00000757	0.009334643
Tin	0.000183597	0.00000052	0.000184119	0.000127293	0.00000040	0.00012769	0.00146876	0.00000030	0.00146906
Zinc	0.075879139	0.00000467	0.075883807	0.055394223	0.00000354	0.05539777	0.03426713	0.00000271	0.034269833

Camper 2							Adult		
Organs							Ingestion	Dermal	Total
Arsenic							-	-	-
Boron							0.01797646	0.00002942	0.018005875
Cadmium							0.949948	0.00034444	0.950292441
Copper							0.13109157	0.00011103	0.131202595
Lead							0.04130614	0.00006510	0.04137124
Manganese							0.05555586	0.00213696	0.057692812
Selenium							0.14484328	0.00000024	0.144843524
Strontium							0.00933289	0.00000757	0.009340456
Tin							0.00146876	0.00000030	0.00146906
Zinc							0.03605132	0.00000271	0.036054029