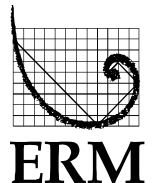


**BRUCEJACK GOLD MINE PROJECT**  
Application for an Environmental Assessment Certificate /  
Environmental Impact Statement

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## **Appendix 21-E**

Construction Phase, Predicted Incremental Change, and  
Predicted Soil Metal Concentrations for Operation Phase  
of Brucejack Gold Mine Project



Appendix 21-E. Construction Phase, Predicted Incremental Change, and Predicted Soil Metal Concentrations for Operation Phase of Brucejack Gold Mine Project

Metals	BJ018			BJ021			BJ022			BJ025		
	Construction Phase Soil Concentration <sup>1</sup> (mg/kg)	Predicted Incremental Soil Concentration <sup>2</sup> (mg/kg)	Predicted Total Soil Concentration <sup>3</sup> (mg/kg)	Construction Phase Soil Concentration <sup>1</sup> (mg/kg)	Predicted Incremental Soil Concentration <sup>2</sup> (mg/kg)	Predicted Total Soil Concentration <sup>3</sup> (mg/kg)	Construction Phase Soil Concentration <sup>1</sup> (mg/kg)	Predicted Incremental Soil Concentration <sup>2</sup> (mg/kg)	Predicted Total Soil Concentration <sup>3</sup> (mg/kg)	Construction Phase Soil Concentration <sup>1</sup> (mg/kg)	Predicted Incremental Soil Concentration <sup>2</sup> (mg/kg)	Predicted Total Soil Concentration <sup>3</sup> (mg/kg)
Aluminum	16411	72.0	16483	29106	38.9	29145	20906	38.9	20945	15506	38.9	15545
Antimony	2.40	2.73	5.12	0.747	1.47	2.22	0.757	1.47	2.23	0.837	1.47	2.31
Arsenic	21.1	0.247	21.4	11.3	0.133	11.5	9.16	0.133	9.29	7.98	0.133	8.11
Barium	115	1.53	117	82.0	0.828	82.9	67.1	0.828	68.0	48.0	0.828	48.9
Beryllium	0.427	0.551	0.978	0.486	0.297	0.783	0.416	0.297	0.713	0.146	0.297	0.443
Bismuth	0.187	0.551	0.738	0.146	0.297	0.443	0.146	0.297	0.443	0.146	0.297	0.443
Cadmium	0.307	0.0705	0.378	0.227	0.0381	0.265	0.397	0.0381	0.435	0.1049	0.0381	0.143
Calcium	4561	577	5138	302	312	614	482	312	794	250	312	562
Chromium	30.6	0.551	31.1	85.3	0.297	85.6	64.7	0.297	65.0	68.9	0.297	69.2
Cobalt	13.1	0.110	13.2	13.8	0.0592	13.9	10.6	0.0592	10.7	4.82	0.0592	4.88
Copper	33.0	28.5	61.5	34.1	15.4	49.5	33.6	15.4	49.0	20.3	15.4	35.7
Iron	39528	176	39703	48915	94.8	49009	33715	94.8	33809	34015	94.8	34109
Lead	11.0	0.874	11.9	8.43	0.472	8.90	7.19	0.472	7.66	9.10	0.472	9.57
Lithium	19.9	5.51	25.4	33.7	2.97	36.6	27.2	2.97	30.1	9.86	2.97	12.8
Magnesium	9823	211	10034	8698	114	8811	10518	114	10631	3878	114	3991
Manganese	669	19.0	688	988	10.3	998	512	10.3	522	534	10.3	544
Mercury	0.104	0.0551	0.159	0.110	0.0297	0.139	0.0723	0.0297	0.102	0.0535	0.0297	0.0832
Molybdenum	1.72	0.0875	1.81	1.73	0.0472	1.77	1.49	0.0472	1.53	1.54	0.0472	1.58
Nickel	26.7	2.50	29.2	57.8	1.35	59.2	69.2	1.35	70.6	33.3	1.35	34.7
Phosphorus	1207	553	1761	949	299	1248	522	299	821	1002	299	1301
Potassium	919	2214	3133	1244	1195	2439	754	1195	1949	724	1195	1919
Selenium	1.34	1.10	2.44	1.16	0.592	1.75	0.601	0.592	1.19	0.601	0.592	1.19
Silver	0.424	0.0247	0.449	0.832	0.0133	0.845	0.822	0.0133	0.835	0.842	0.0133	0.855
Sodium	459	2214	2673	234	1195	1429	234.1	1195	1429	234.1	1195	1429
Strontium	23.3	2.82	26.2	3.99	1.52	5.52	6.11	1.52	7.64	3.73	1.52	5.26
Thallium	0.106	0.110	0.216	0.185	0.0592	0.244	0.109	0.0592	0.1683	0.145	0.0592	0.2043
Tin	1.02	0.110	1.13	1.01	0.0592	1.07	1.01	0.0592	1.07	1.01	0.0592	1.07
Titanium	955	11.0	966	80.2	5.92	86.1	79.9	5.92	85.8	47.0	5.92	52.9
Uranium	0.587	0.0110	0.598	0.310	0.00592	0.316	0.254	0.00592	0.260	0.109	0.00592	0.115
Vanadium	67.9	1.10	69.0	76.0	0.592	76.6	50.8	0.592	51.4	75.3	0.592	75.9
Zinc	75.8	8.05	83.8	83.1	4.35	87.4	81.5	4.35	85.8	39.4	4.35	43.7

Notes:

<sup>1</sup> Construction Phase concentrations based on samples collected in 2012 (dry weights) and dustfall deposition during the Constuction Phase (see Appendix 21-D for further details).

<sup>2</sup> Equation used to calculate incremental soil concentration is from the US EPA (2005):  $C_s = 100 * ((DEPOSITION / (Z_s * BD))) * tD$ , where  $C_s$  = Average soil concentration over exposure duration (mg COPC/kg soil), 100 = Units conversion factor (mg-m<sup>2</sup>/kg-cm<sup>2</sup>), DEPOSITION = Yearly deposition rate of COPC from model (g/m<sup>2</sup>year),  $Z_s$  = Soil mixing zone depth (2 cm), BD = Soil bulk density (1.5 g soil/cm<sup>3</sup> soil), and tD = Time period over which deposition occurs (22 years).

<sup>3</sup> Total soil concentration is the sum of the Construction Phase concentration and the incremental concentration during the Operation Phase of the Project.

<sup>4</sup> Sites Outside the Air Quality Modeling Domain and country foods LSA are expected to have predicted metal concentrations the same baseline concentrations.

$C_s$  = Average soil concentration over exposure duration (mg COPC/kg soil)

100 = Units conversion factor (mg-m<sup>2</sup>/kg-cm<sup>2</sup>)

DEPOSITION = Yearly deposition rate of COPC from model (g/m<sup>2</sup>year)

tD = Time period over which deposition occurs (22 years)

$Z_s$  = Soil mixing zone depth (2 cm)

BD = Soil bulk density (1.5 g soil/cm<sup>3</sup> soil)

Samples where the concentration was below the detection limit were replaced with values of half the detection limit for calculation purposes.

LSA = local study area

Appendix 21-E. Construction Phase, Predicted Incremental Change, and Predicted Soil Metal Concentrations for Operation Phase of Brucejack Gold Mine Project

Metals	BJ030			BJ031			SOIL 4			12-7103		
	Construction Phase Soil Concentration <sup>1</sup> (mg/kg)	Predicted Incremental Soil Concentration <sup>2</sup> (mg/kg)	Predicted Total Soil Concentration <sup>3</sup> (mg/kg)	Construction Phase Soil Concentration <sup>1</sup> (mg/kg)	Predicted Incremental Soil Concentration <sup>2</sup> (mg/kg)	Predicted Total Soil Concentration <sup>3</sup> (mg/kg)	Construction Phase Soil Concentration <sup>1</sup> (mg/kg)	Predicted Incremental Soil Concentration <sup>2</sup> (mg/kg)	Predicted Total Soil Concentration <sup>3</sup> (mg/kg)	Construction Phase Soil Concentration <sup>1</sup> (mg/kg)	Predicted Incremental Soil Concentration <sup>2</sup> (mg/kg)	Predicted Total Soil Concentration <sup>3</sup> (mg/kg)
Aluminum	16901	5.53	16906	12323	101	12424	25906	38.9	25945	12206	38.9	12245
Antimony	1.21	0.209	1.41	1.822	3.84	5.66	0.757	1.47	2.23	2.88	1.47	4.35
Arsenic	13.4	0.0189	13.4	10.7	0.347	11.0	8.87	0.133	9.0	24.5	0.133	24.7
Barium	46.2	0.118	46.3	48.8	2.16	51.0	95.2	0.828	96.1	87.8	0.828	88.7
Beryllium	0.357	0.0423	0.399	0.496	0.775	1.27	0.306	0.297	0.603	0.276	0.297	0.573
Bismuth	0.107	0.0423	0.149	0.276	0.775	1.05	0.146	0.297	0.443	0.146	0.297	0.443
Cadmium	0.563	0.00542	0.568	1.17	0.0993	1.27	0.222	0.0381	0.260	0.138	0.0381	0.176
Calcium	3947	44.3	3992	6925	812	7737	643	312	955	2378	312	2690
Chromium	34.3	0.0423	34.3	25.8	0.775	26.6	72.4	0.297	72.7	2.23	0.297	2.52
Cobalt	14.5	0.00843	14.5	10.8	0.154	11.0	10.1	0.0592	10.2	9.48	0.0592	9.54
Copper	39.7	2.19	41.9	35.0	40.2	75.2	25.3	15.4	40.7	12.2	15.4	27.6
Iron	38202	13.5	38216	29056	247	29303	44615	94.8	44709	29515	94.8	29609
Lead	9.71	0.0672	9.78	8.10	1.23	9.33	7.20	0.472	7.67	10.6	0.472	11.0
Lithium	24.1	0.423	24.5	20.9	7.75	28.6	21.9	2.97	24.8	17.3	2.97	20.2
Magnesium	11503	16.2	11519	8387	297	8685	6738	114	6851	5508	114	5621
Manganese	727	1.46	729	693	26.8	720	867	10.3	877	1102	10.3	1112
Mercury	0.0453	0.00423	0.0495	0.0617	0.0775	0.139	0.107	0.0297	0.136	0.0429	0.0297	0.0726
Molybdenum	1.95	0.00672	1.96	2.03	0.123	2.15	0.927	0.0472	0.975	1.59	0.0472	1.63
Nickel	41.4	0.192	41.6	33.2	3.51	36.7	43.6	1.35	45.0	2.90	1.35	4.25
Phosphorus	977	42.5	1020	1197	779	1976	509	299	808	572	299	871
Potassium	309	170	479	1338	3116	4454	714	1195	1909	844	1195	2039
Selenium	0.614	0.0843	0.698	1.291	1.54	2.83	0.611	0.592	1.20	0.191	0.592	0.78
Silver	0.220	0.00190	0.222	0.228	0.0347	0.263	0.412	0.0133	0.425	0.0521	0.0133	0.065
Sodium	78.7	170	249	758	3116	3874	234	1195	1429	234	1195	1429
Strontium	16.1	0.217	16.4	40.4	3.97	44.4	6.03	1.52	7.56	20.9	1.52	22.5
Thallium	0.101	0.00843	0.110	0.178	0.154	0.332	0.0941	0.0592	0.153	0.145	0.0592	0.204
Tin	1.00	0.00843	1.01	1.04	0.154	1.19	1.01	0.0592	1.07	1.01	0.0592	1.07
Titanium	351	0.843	352	381	15.4	396	377	5.92	383	963	5.92	969
Uranium	0.335	0.000843	0.336	0.311	0.0154	0.326	0.216	0.00592	0.222	0.814	0.00592	0.820
Vanadium	57.0	0.0843	57.1	41.5	1.54	43.0	86.7	0.592	87.3	51.4	0.592	52.0
Zinc	113	0.619	114	129	11.3	140	65.6	4.35	69.9	50.5	4.35	54.8

Notes:

<sup>1</sup> Construction Phase concentrations based on samples collected in 2012 (dry weights) and dustfall deposition during the Constuction Phase (see Appendix 21-D for further details).

<sup>2</sup> Equation used to calculate incremental soil concentration is from the US EPA (2005):  $C_s = 100 * ((DEPOSITION / (Z_s * BD))) * tD$ , where  $C_s$  = Average soil concentration over exposure duration (mg COPC/kg soil), 100 = Units conversion factor (mg-m<sup>2</sup>/kg-cm<sup>2</sup>), DEPOSITION = Yearly deposition rate of COPC from model (g/m<sup>2</sup>year),  $Z_s$  = Soil mixing zone depth (2 cm), BD = Soil bulk density (1.5 g soil/cm<sup>3</sup> soil), and tD = Time period over which deposition occurs (22 years).

<sup>3</sup> Total soil concentration is the sum of the Construction Phase concentration and the incremental concentration during the Operation Phase of the Project.

<sup>4</sup> Sites Outside the Air Quality Modeling Domain and country foods LSA are expected to have predicted metal concentrations the same baseline concentrations.

$C_s$  = Average soil concentration over exposure duration (mg COPC/kg soil)

100 = Units conversion factor (mg-m<sup>2</sup>/kg-cm<sup>2</sup>)

DEPOSITION = Yearly deposition rate of COPC from model (g/m<sup>2</sup>year)

tD = Time period over which deposition occurs (22 years)

$Z_s$  = Soil mixing zone depth (2 cm)

BD = Soil bulk density (1.5 g soil/cm<sup>3</sup> soil)

Samples where the concentration was below the detection limit were replaced with values of half the detection limit for calculation purposes.

LSA = local study area

Appendix 21-E. Construction Phase, Predicted Incremental Change, and Predicted Soil Metal Concentrations for Operation Phase of Brucejack Gold Mine Project

Metals	12-7108			12-7162			12-7166			12-7167		
	Construction Phase Soil Concentration <sup>1</sup> (mg/kg)	Predicted Incremental Soil Concentration <sup>2</sup> (mg/kg)	Predicted Total Soil Concentration <sup>3</sup> (mg/kg)	Construction Phase Soil Concentration <sup>1</sup> (mg/kg)	Predicted Incremental Soil Concentration <sup>2</sup> (mg/kg)	Predicted Total Soil Concentration <sup>3</sup> (mg/kg)	Construction Phase Soil Concentration <sup>1</sup> (mg/kg)	Predicted Incremental Soil Concentration <sup>2</sup> (mg/kg)	Predicted Total Soil Concentration <sup>3</sup> (mg/kg)	Construction Phase Soil Concentration <sup>1</sup> (mg/kg)	Predicted Incremental Soil Concentration <sup>2</sup> (mg/kg)	Predicted Total Soil Concentration <sup>3</sup> (mg/kg)
Aluminum	26606	38.9	26645	23006	38.9	23045	22306	38.9	22345	26106	38.9	26145
Antimony	0.747	1.47	2.22	0.747	1.47	2.22	0.867	1.47	2.34	1.13	1.47	2.60
Arsenic	8.27	0.133	8.40	10.9	0.133	11.1	12.4	0.133	12.6	14.7	0.133	14.9
Barium	84.6	0.828	85.5	64.2	0.828	65.1	130	0.828	131	83.3	0.828	84.2
Beryllium	0.596	0.297	0.893	0.146	0.297	0.443	0.526	0.297	0.823	0.346	0.297	0.643
Bismuth	0.146	0.297	0.443	0.246	0.297	0.543	0.146	0.297	0.443	0.146	0.297	0.443
Cadmium	0.616	0.0381	0.654	0.104	0.0381	0.142	0.803	0.0381	0.841	0.303	0.0381	0.341
Calcium	838	312	1150	230	312	542	454	312	766	1498	312	1810
Chromium	60.5	0.297	60.8	67.3	0.297	67.6	57.6	0.297	57.9	69.0	0.297	69.3
Cobalt	10.3	0.0592	10.4	6.06	0.0592	6.1	13.2	0.0592	13.3	20.6	0.0592	20.7
Copper	57.1	15.4	72.5	19.5	15.4	34.9	32.6	15.4	48.0	32.7	15.4	48.1
Iron	36815	94.8	36909	38715	94.8	38809	34115	94.8	34209	50415	94.8	50509
Lead	7.76	0.472	8.23	8.89	0.472	9.36	9.68	0.472	10.2	10.8	0.472	11.2
Lithium	25.5	2.97	28.4	11.7	2.97	14.6	26.7	2.97	29.6	35.6	2.97	38.5
Magnesium	7728	114	7841	5578	114	5691	5178	114	5291	8898	114	9011
Manganese	614	10.3	624	546	10.3	556	525	10.3	535	1712	10.3	1722
Mercury	0.135	0.0297	0.164	0.0427	0.0297	0.0724	0.101	0.0297	0.131	0.0552	0.0297	0.0849
Molybdenum	3.97	0.0472	4.01	1.33	0.0472	1.37	1.41	0.0472	1.45	1.89	0.0472	1.93
Nickel	54.4	1.35	55.8	36.3	1.35	37.7	47.2	1.35	48.6	59.6	1.35	61.0
Phosphorus	1246	299	1545	1806	299	2105	1246	299	1545	844	299	1143
Potassium	1094	1195	2289	1294	1195	2489	1394	1195	2589	1104	1195	2299
Selenium	1.09	0.592	1.68	0.521	0.592	1.11	0.981	0.592	1.57	0.831	0.592	1.42
Silver	1.12	0.0133	1.14	0.142	0.0133	0.155	1.02	0.0133	1.035	0.572	0.0133	0.585
Sodium	234	1195	1429	234	1195	1429	234	1195	1429	234	1195	1429
Strontium	13.2	1.52	14.8	2.65	1.52	4.18	6.86	1.52	8.4	15.9	1.52	17.5
Thallium	0.150	0.0592	0.209	0.213	0.0592	0.272	0.322	0.0592	0.381	0.182	0.0592	0.241
Tin	1.01	0.0592	1.07	1.01	0.0592	1.07	1.01	0.0592	1.07	1.01	0.0592	1.07
Titanium	106	5.92	112	128	5.92	134	67.8	5.92	74	254	5.92	260
Uranium	0.688	0.00592	0.694	0.124	0.00592	0.130	0.287	0.00592	0.293	0.253	0.00592	0.259
Vanadium	48.8	0.592	49.4	110	0.592	111	64.8	0.592	65.4	83.6	0.592	84.2
Zinc	72.3	4.35	76.6	53.9	4.35	58.2	80.0	4.35	84.3	136	4.35	140.0

Notes:

<sup>1</sup> Construction Phase concentrations based on samples collected in 2012 (dry weights) and dustfall deposition during the Constuction Phase (see Appendix 21-D for further details).

<sup>2</sup> Equation used to calculate incremental soil concentration is from the US EPA (2005):  $C_s = 100 * ((DEPOSITION / (Z_s * BD))) * tD$ , where  $C_s$  = Average soil concentration over exposure duration (mg COPC/kg soil), 100 = Units conversion factor (mg-m<sup>2</sup>/kg-cm<sup>2</sup>), DEPOSITION = Yearly deposition rate of COPC from model (g/m<sup>2</sup>year),  $Z_s$  = Soil mixing zone depth (2 cm), BD = Soil bulk density (1.5 g soil/cm<sup>3</sup> soil), and tD = Time period over which deposition occurs (22 years).

<sup>3</sup> Total soil concentration is the sum of the Construction Phase concentration and the incremental concentration during the Operation Phase of the Project.

<sup>4</sup> Sites Outside the Air Quality Modeling Domain and country foods LSA are expected to have predicted metal concentrations the same baseline concentrations.

$C_s$  = Average soil concentration over exposure duration (mg COPC/kg soil)

100 = Units conversion factor (mg-m<sup>2</sup>/kg-cm<sup>2</sup>)

DEPOSITION = Yearly deposition rate of COPC from model (g/m<sup>2</sup>year)

tD = Time period over which deposition occurs (22 years)

$Z_s$  = Soil mixing zone depth (2 cm)

BD = Soil bulk density (1.5 g soil/cm<sup>3</sup> soil)

Samples where the concentration was below the detection limit were replaced with values of half the detection limit for calculation purposes.

LSA = local study area

Appendix 21-E. Construction Phase, Predicted Incremental Change, and Predicted Soil Metal Concentrations for Operation Phase of Brucejack Gold Mine Project

Metals	12-7168			12-7169		
	Construction Phase Soil Concentration <sup>1</sup> (mg/kg)	Predicted Incremental Soil Concentration <sup>2</sup> (mg/kg)	Predicted Total Soil Concentration <sup>3</sup> (mg/kg)	Construction Phase Soil Concentration <sup>1</sup> (mg/kg)	Predicted Incremental Soil Concentration <sup>2</sup> (mg/kg)	Predicted Total Soil Concentration <sup>3</sup> (mg/kg)
Aluminum	21706	38.9	21745	16001	5.744	16006
Antimony	1.99	1.47	3.46	2.02	0.21733836	2.24
Arsenic	40.5	0.133	40.6	20.1	0.01966	20.1
Barium	77.3	0.828	78.1	79.2	0.12238	79.3
Beryllium	0.411	0.297	0.708	0.315	0.04393576	0.359
Bismuth	0.146	0.297	0.443	0.105	0.04393576	0.149
Cadmium	0.209	0.0381	0.247	0.246	0.00562644	0.251
Calcium	2777	312	3089	4785	46.029	4831
Chromium	38.9	0.297	39.2	31.6	0.04394	31.6
Cobalt	7.36	0.0592	7.42	11.8	0.008747	11.8
Copper	78.8	15.4	94.2	27.9	2.27610	30.2
Iron	34215	94.8	34309	38302	14.01	38316
Lead	11.9	0.472	12.4	11.5	0.069735	11.6
Lithium	8.56	2.97	11.5	19.6	0.4393576	20.1
Magnesium	4213	114	4326	10102	16.832	10119
Manganese	437	10.3	447	548	1.5184	550
Mercury	0.230	0.0297	0.259	0.0562	0.004393576	0.0606
Molybdenum	1.30	0.0472	1.35	1.83	0.0069782	1.84
Nickel	15.3	1.35	16.7	28.0	0.19914	28.2
Phosphorus	1954	299	2252	1095	44.13386158	1139
Potassium	659	1195	1854	739	176.568	916
Selenium	1.36	0.592	1.95	0.960	0.08746609	1.047
Silver	1.88	0.0133	1.89	0.310	0.00196862	0.312
Sodium	234	1195	1429	139	176.5677	316
Strontium	25.6	1.52	27.1	24.7	0.224790	24.9
Thallium	0.146	0.0592	0.205	0.0870	0.00874661	0.0957
Tin	1.01	0.0592	1.07	1.00	0.00874661	1.01
Titanium	884	5.92	890	882	0.8747	883
Uranium	0.821	0.00592	0.827	0.407	0.0008747	0.408
Vanadium	59.4	0.592	60.0	63.8	0.08747	63.9
Zinc	34.7	4.35	39.1	74.5	0.64242	75.1

Notes:

<sup>1</sup> Construction Phase concentrations based on samples collected in 2012 (dry weights) and dustfall deposition during the Constuction Phase (see Appendix 21-D for further details).

<sup>2</sup> Equation used to calculate incremental soil concentration is from the US EPA (2005):  $C_s = 100 * ((DEPOSITION / (Z_s * BD))) * tD$ , where  $C_s$  = Average soil concentration over exposure duration (mg COPC/kg soil), 100 = Units conversion factor (mg-m<sup>2</sup>/kg-cm<sup>2</sup>), DEPOSITION = Yearly deposition rate of COPC from model (g/m<sup>2</sup>year),  $Z_s$  = Soil mixing zone depth (2 cm), BD = Soil bulk density (1.5 g soil/cm<sup>3</sup> soil), and tD = Time period over which deposition occurs (22 years).

<sup>3</sup> Total soil concentration is the sum of the Construction Phase concentration and the incremental concentration during the Operation Phase of the Project.

<sup>4</sup> Sites Outside the Air Quality Modeling Domain and country foods LSA are expected to have predicted metal concentrations the same baseline concentrations.

$C_s$  = Average soil concentration over exposure duration (mg COPC/kg soil)

100 = Units conversion factor (mg-m<sup>2</sup>/kg-cm<sup>2</sup>)

DEPOSITION = Yearly deposition rate of COPC from model (g/m<sup>2</sup>year)

tD = Time period over which deposition occurs (22 years)

$Z_s$  = Soil mixing zone depth (2 cm)

BD = Soil bulk density (1.5 g soil/cm<sup>3</sup> soil)

Samples where the concentration was below the detection limit were replaced with values of half the detection limit for calculation purposes.

LSA = local study area