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TO Rick Schryer
Fortune Minerals Limited

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NICO PROJECT: UPDATE OF RECEIVING WATER QUALITY PREDICTIONS FOR THE OPERATIONS PERIOD WITH REVISED EFFLUENT TREATMENT FACILITY DISCHARGE QUALITY

1.0 INTRODUCTION

Predicted changes to surface water quality in Nico Lake, Peanut Lake, Burke Lake, and the Marian River due to the NICO Project were presented in Section 7.6.3 of the Developer's Assessment Report (DAR) (Fortune 2011a), submitted to the Mackenzie Valley Review Board (MVRB) in May 2011. This section was followed by a summary of residual effects in Section 7.10.2.1, classification of residual impacts in Section 7.11.2.2, and determination of environmental significance in Section 7.12.2. The projected changes in Section 7.6.3 were based on dust deposition to Nico, Peanut, and Burke lakes from air emissions from the mine site during construction and operations, active mine discharges to Peanut Lake from the Effluent Treatment Facility (ETF) during operations, and Co-Disposal Facility (CDF) seepage flow through treatment wetlands to Nico Lake in post-closure.

Following submission of the DAR, Fortune Minerals Limited (Fortune) altered the effluent treatment technology from the ion exchange (IX) treatment system presented in the DAR, to a treatment system based on reverse osmosis (RO) with chemical and biological treatment of the brine (Fortune 2011b). Although the IX treatment system originally selected and presented in the DAR had higher removal efficiencies for some metals relative to the RO based system (Table 1), the IX system was sensitive to changes in influent water quality (i.e., influenced by increases in calcium, magnesium and other background water quality parameters), but was not projected to meet the SSWQO for selenium. The IX system also produced a waste stream that must be managed by energy intensive evaporation and off-site disposal. In contrast, the RO treatment system produces an effluent quality that is projected to meet all SSWQOs, is more robust to changes in influent quality than the IX system, and is expected to produce an effluent quality that is consistent. The RO system also produces a secondary waste in the form of precipitated metal hydroxides that is more stable and compatible for disposal at the site relative to the IX system.

During technical sessions held in Yellowknife from 7 through 9 February 2012, Fortune agreed to provide information on water quality, sediment quality and biotic effects related to the RO ETF including downstream effects as part of Undertaking #1 (MVRB 2012). The purpose of this memorandum is to provide an overview of the changes made to the water quality assessment, through providing updated receiving water quality modelling projections that incorporate the change in ETF discharge quality, comparing the updated projections to those evaluated in the DAR, and determining whether the updated projections change the conclusions of the assessment presented in the DAR.

2.0 MODELLING REVISION, RESULTS, AND DISCUSSION

The receiving water quality model was updated with the ETF effluent quality projections for the revised RO treatment system presented in Table 1, which were also provided in a memorandum submitted to the MVRB as part of the response to Undertaking #1 (Golder 2012a). Consistent with the methods described in Appendix 7.I of the DAR, a linear interpolation was applied annually during operations between the “early years” and “worst case” effluent quality projections. No changes were made to ETF flow rates, nor were any changes made to other model inputs and assumptions, including the highly conservative loading of metals associated with deposition of fugitive dust emissions. Fugitive dust deposition was noted as the largest source of projected changes in receiving water quality for the majority of metals during construction and operations. The updated model was run with the same stochastic sampling sequences as used for the projections presented in the DAR (i.e., 100 realizations were run with the same sequences of daily background flows and chemistry).

Revised receiving water quality projections for the operations period are presented (i.e., the average and 95th percentile data projections), with corresponding projections from the DAR, in Table 2 for Peanut Lake, Burke Lake and the Marian River immediately downstream of outflows from Burke Lake. Inputs to, and projections for, Nico Lake have not changed from those presented in the DAR, as the ETF only discharges to Peanut Lake during operations; model inputs have not changed for the construction and closure periods. Suspended solids inputs and assumptions have not changed from the DAR; total suspended solids (TSS) concentration projections have not changed and are not included in Table 2. Operations projections for Nico Lake from the DAR are included in Table 2 for reference, as are modelled baseline concentrations from the DAR for Nico Lake, Peanut Lake, Burke Lake, and the Marian River. Overall trends and patterns in the time series projections are consistent with those presented in the DAR and the average and 95th percentile values presented and discussed herein are summary statistics for the same modelling periods defined in the DAR.

2.1 Total Dissolved Solids and Major Ions

The updated receiving water quality projections during operations for Peanut Lake, Burke Lake, and the Marian River have higher total dissolved concentrations relative to those presented in the DAR:

- Modelled concentrations of calcium, chloride, potassium, sodium, and sulphate are higher, while magnesium concentrations are anticipated to be similar.

Chloride concentrations are projected to remain well below the CCME water quality guideline for the protection of aquatic life (WQG) during operations in Peanut Lake and downstream waters; sulphate concentrations are projected to remain well below site-specific water quality objective (SSWQO) concentrations during operations in Peanut Lake and downstream waters.

2.2 Nutrients

Nutrient concentrations in Peanut Lake, Burke Lake, and the Marian River are projected to be higher during operations than the modelled concentrations presented in the DAR:

- Nitrate and ammonia concentrations are projected to remain below SSWQO concentrations in Peanut Lake and below CCME guideline concentrations in Burke Lake and at the confluence with the Marian River.
- Projected total Kjeldahl nitrogen concentrations during operations are less than 8% higher in Peanut Lake, less than 4% higher in Burke Lake, and less than 1% higher in the Marian River.
- Projected total phosphorus concentrations during operations are less than 19% higher in Peanut Lake, less than 6% higher in Burke Lake, and less than 1% higher in the Marian River.

The projected changes in nutrient concentrations are not expected to result in residual effects to aquatic life (Golder 2012b) or changes in trophic status in Peanut Lake and in the downstream environment relative to the previous assessment projections.

Changes in nitrate concentrations in Peanut Lake during operations, in addition to the projected TP increment, may result in an increase to primary productivity and lead to changes to overwintering habitat availability. However, baseline overwintering habitat quality is variable in Peanut Lake based on observed late winter under-ice water column dissolved oxygen concentrations (Appendix V, Figure V-3 [Fortune 2011a]). It is anticipated that potential effects to overwintering habitat availability in Peanut Lake could be mitigated to some extent, as the ETF effluent discharge is expected to be well oxygenated.

2.3 Metals

Receiving water concentrations of many metals are projected to be consistent with, or lower than, those presented in the DAR for the operations period. These include barium, beryllium, cadmium, chromium, copper, iron, manganese, nickel, selenium, uranium, vanadium, and zinc. The decrease in selenium concentrations in Peanut Lake is particularly notable, reflecting a decrease in end-of-pipe concentrations from the ETF of more than 50 percent. However, some metals are projected to be higher relative to those presented in the DAR during operations; these are discussed in more detail below:

- In the DAR, total aluminum concentration projections were above the SSWQO in Peanut Lake and Burke Lake during operations primarily due to conservative estimates of loading due to dust deposition, whereas dissolved aluminum concentrations were projected to remain below the SSWQO in these lakes. Updated total aluminum projections with the revised RO ETF effluent quality are projected to be higher than the IX treatment system; 95th percentile aluminum concentration projections are less than 9% higher in Peanut Lake, less than 5% higher in Burke Lake, and less than 4% higher in the Marian River, with dissolved aluminum concentrations remaining below the SSWQO in Peanut Lake and Burke Lake.

  Aluminum concentration projections are above the CCME WQG during operations in Burke Lake and occasionally in the Marian River, with concentrations declining during closure. Aluminum concentrations in the revised ETF effluent discharge are less than the SSWQO value and the projected values in the receiving environment during operations are still primarily due to conservative estimates of loading due to dust deposition. Aluminum concentrations have also occasionally exceeded the CCME WQG under measured baseline conditions in Peanut Lake, Burke Lake and the Marian River.

- The 95th percentile concentration projections for arsenic during operations are less than 11% higher in Peanut Lake, less than 6% higher in Burke Lake, and less than 2% higher in the Marian River relative to DAR projections. Arsenic concentrations are projected to remain below the SSWQO value in Peanut Lake and Burke Lake, and below the CCME WQG in the Marian River. As noted in the DAR, arsenic concentrations in Burke Lake are projected to be above the CCME guideline during operations, primarily due to dust deposition, and decline to levels below the CCME guideline during the closure period. Arsenic concentrations in the Burke Lake watershed are elevated under baseline conditions (Section 7.3, Table 7.3-3 [Fortune 2011a]), frequently exceeding the CCME WQG in Nico Lake.

- Total cobalt concentrations are projected to be higher in Peanut Lake and the downstream waters during operations relative to those presented in the DAR. However, the updated cobalt concentrations are projected to remain below the SSWQO value in these waters.

- Silver concentrations are projected to be higher during operations relative to DAR projections, and 95th percentile concentrations are projected to exceed the CCME WQG in Peanut Lake and remain below the guideline concentration in Burke Lake and the Marian River.
- Mercury concentrations are projected to be higher in Peanut and Burke lakes during operations relative to those presented in the DAR, but are also projected to remain below CCME WQGs. Projected mercury concentrations in the Marian River during operations are unchanged from those presented in the DAR, which were indistinguishable from modelled baseline values that occasionally exceeded CCME WQGs.
- Concentrations of total antimony, boron, lead, molybdenum, and thallium are also projected to be higher in Peanut Lake and downstream waters during operations relative to those presented in the DAR. However, the updated modelled concentrations of these metals during operations remain below CCME WQGs.

Modelled cadmium, mercury and silver concentrations are influenced by inputs derived from monitoring data that have a large proportion of results lower than method detection limits (MDLs). MDL values or half the MDL values were used to derive input concentrations and loading for these metals. This will result in an overestimation of modelled concentrations and is therefore another source of conservatism in the modelling.

Although total iron concentrations are projected to be lower during operations relative to DAR projections in Peanut Lake and downstream waters, the projected concentrations exceed the SSWQO in Nico, Peanut, and Burke lakes primarily as a result of the deposition of fugitive dust. However, as noted in the DAR, dissolved iron concentrations may only exceed SSWQO values occasionally in Nico Lake, and are expected to remain below SSWQO values in Peanut Lake and Burke Lake. Iron concentrations have also exceeded the CCME WQG under measured baseline conditions in Nico Lake, Peanut Lake, Burke Lake, and the Marian River.

2.4 Closure Projections

Although closure inputs and assumptions did not change in the receiving water quality model, the changes in operations water quality projections for Peanut Lake and downstream waters have some residual influence on the active closure projections presented in the DAR, which represent a transitional period after the end of operations when ETF discharge and dust deposition have ceased and treatment wetlands begin discharging to Nico Lake.

Active closure projections in Nico Lake are not expected to change due to changes in ETF treatment, whereas active closure projections for Peanut Lake, Burke Lake, and the Marian River may be expected to trend in the same direction as the updated operations projections. Post-closure projections for Nico Lake and downstream waters are expected to be similar to those presented in the DAR, as the modelled watershed system for this period approaches a dynamic equilibrium based on unchanged closure inputs and assumptions.

2.5 Sediment Quality

Potential effects to sediment quality in the DAR were evaluated based on deposition of dust and associated metals from air emissions. Assumptions regarding TSS loading to surface waters and sediments in the receiving environment have not changed from those presented in the DAR, and changes in water column concentrations due to the change in ETF discharge quality are minor relative to the change from baseline due to loading from dust deposition. Therefore, projected residual effects to sediment quality are expected to be consistent with those presented in the DAR.

3.0 RESIDUAL IMPACTS, ENVIRONMENTAL SIGNIFICANCE, AND UNCERTAINTY

The changes in operations water quality projections described above are based on a change in treatment technology with an effluent quality meeting all SSWQOs. The changes include reductions in concentrations of beryllium, cadmium, chromium, copper, iron, manganese, nickel, selenium, uranium, vanadium, and zinc. Increases in other constituent concentrations are generally small relative to contributions from dust deposition during operations. Projected operations concentrations, including those that exceed CCME WQGs present negligible to low and likely negligible risks to aquatic life (Golder 2012b).

Exceedances of CCME WQGs for those parameters that do not have derived SSWQOs in the DAR does not necessarily imply toxicity will occur, only that effects may potentially occur. CCME WQGs are conservative, and are intended to protect all forms of aquatic life during all life stages. As discussed in the DAR, follow-up monitoring will be used when operations commence to assess whether effects are occurring and to track the uncertainties of projections. Fortune is committed to undertaking regular monitoring and follow-up testing of water quality and aquatic health during the NICO Project.

3.1 Residual Impacts

The overall changes in water quality throughout the project timeline in Peanut Lake, Burke Lake, and the Marian River remain consistent with the ranges in direction, magnitude, geographic extent, duration, reversibility, frequency, and likelihood of residual effects to water quality presented in Section 7.11.2.2 of the DAR. Therefore, the residual impact classification remains unchanged.

3.2 Environmental Significance

Section 7.12.2 of the DAR stated that the weight of evidence from the analysis of the primary pathways predicts that the incremental impacts from the NICO Project will result in changes to water quality in Nico, Peanut, and Burke lakes, but that these changes, incorporating the evaluation of risk to aquatic life (Golder 2012b), will not have a significant adverse impact on the suitability of water in these lakes to support a viable and self-sustaining aquatic ecosystem. Since the water quality residual impact classification has not changed with the updates to receiving water quality projections for the operations period, the environmental significance associated with the updated projections are consistent with those presented in the DAR.

3.3 Uncertainty

As noted in the DAR, there were a number of uncertainties in the assessment of effects to water quality, and conservative assumptions were applied in the receiving water quality modelling so that potential effects would not be underestimated. The major uncertainties included metals loading due to dust deposition during construction and operations and effectiveness of wetland treatment systems during the post closure period.

While conservative assumptions were used in the assessment to provide confidence that changes to water quality will not be worse than projected, they also provide an upper bound in order to develop adequate mitigation. Projected water quality is based on several inputs (i.e., surface flows, groundwater flows and seepage, background water quality and geochemical characterization), all of which have inherent variability and uncertainty. As such, it is suggested that water quality projections should not be used to predict absolute concentrations, but rather as a planning tool and to develop monitoring plans. It is anticipated that ETF discharge and seepage will be monitored during operations to compare to DAR projections. If it is identified that the quality of discharge or seepage varies from the projections, adaptive management strategies will be triggered.

The air quality and deposition rate projections used the maximum emission rates from the NICO Project during construction and operations, and projected annual deposition rates were based on the maximum of the daily road dust emissions during summer and winter. Emissions of road dust from on-site haul roads, the primary sources of particulate matter and metal compounds, do not include potential mitigating effects of weather (such as precipitation or snow-covered ground), which results in an overestimate of annual fugitive dust emissions and deposition rates. Furthermore, the receiving water quality model assumed no retention on the landscape and that deposited dust particles, and associated metals, less than 10 microns in diameter would remain in suspension indefinitely. These highly conservative assumptions have likely resulted in an overestimation of metals concentrations in receiving waters during operations.

Conservatism was also applied to the quality of discharges from the Wetland Treatment Systems after closure, in that the projected outflow quality is generally expected be better than the influent quality projections that were applied to the outflows. However, influent concentrations were only adjusted to cap projected exceedances of SSWQO concentrations at the respective objective concentrations. No further adjustments were applied due to uncertainty regarding the constituent-specific effectiveness of the planned passive treatment system. Therefore, projected water quality presented in the DAR for closure periods is expected to be overestimated for constituents without SSWQO values.

Work is ongoing towards defining the effectiveness of wetland treatment systems. Results of bench scale testing of a passive treatment system, constructed to demonstrate the feasibility of passive treatment as a post-closure water treatment strategy for the NICO Project, showed effective removal of aluminum, arsenic, cadmium, cobalt, lead, iron, selenium, and uranium from a concentrated brine created from process water generated pilot plant operations at the NICO site (Golder 2012c). The bench test results appear to support the assertion that the receiving water quality model assumptions regarding Wetland Treatment System effluent concentrations are conservative.

4.0 CLOSURE

We trust that this memorandum meets your needs. If you require more information, please contact the undersigned.

Sincerely,

GOLDER ASSOCIATES LTD.

Original Signed By

Jason Parviainen, M.Sc.
Water Quality Specialist

Original Signed By

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5.0 REFERENCES

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Golder (Golder Associates Ltd.). 2012a. Undertaking #1: Effluent Treatment System Information. Submitted to Fortune Minerals Limited. 23 February 2012.

Golder. 2012b. NICO Cobalt-Golder-Bismuth-Copper Project: Incorporation of Water Quality Predictions for Reverse Osmosis Water Treatment Option into Human Health and Ecological Risk Assessment. Submitted to Fortune Minerals Limited. April 2012.

Golder. 2012c. DRAFT Bench Scale Passive Treatment Testing Results. Submitted to Fortune Minerals Limited. 13 March 2012.

MVRB (Mackenzie Valley Review Board). 2012. Re: Technical Meetings, Summary of Undertakings and Commitments, 17 February 2012. Submitted to Distribution List EA0809-004 Fortune Minerals Ltd. NICO Project.

Table 1: Projected Effluent Quality for ETF Options

Constituent	Units	Site Specific Water Quality Objectives	ETF Influent Design Basis	End of Pipe Projections for Ion Exchange Treatment System (as presented in the DAR)		End of Pipe Projections for RO System with Brine Treatment by Chemical Precipitation and Biotreatment	
				Early Years	Worst Case	Early Years	Worst Case
Major Ions							
Calcium	mg/L	-	72.5	1.66	3.63	78.1	117
Chloride	mg/L	353	107	2.90	5.35	58.0	107
Magnesium	mg/L	-	24.7	0.64	1.24	0.48	0.93
Potassium	mg/L	-	527	26.5	52.7	265	527
Sodium	mg/L	-	120	3.5	12	35	120
Sulfate	mg/L	500	421	7.8	21.1	117	317
Nutrients							
Ammonia	mg-N/L	4.16	**15.4**	1.54	1.54	2.0	2.0
Nitrate	mg-N/L	30	15.5	1.55	1.55	2.0	2.0
Phosphorus	mg/L	-	0.264	0.014	0.026	0.022	0.044
Total Metals							
Aluminum	mg/L	0.41	**5.8**	0.024	0.058	0.16	0.38
Antimony	mg/L	0.03	**0.051**	0.00028	0.00051	0.0041	0.0075
Arsenic	mg/L	0.05	**0.72**	0.0041	0.0072	0.011	0.018
Barium	mg/L	-	0.21	0.008	0.011	0.0093	0.012
Beryllium	mg/L	-	0.00309	0.000066	0.00015	0.000026	0.000061
Boron	mg/L	-	0.59	0.022	0.059	0.13	0.36
Cadmium	mg/L	0.00015	**0.00074**	0.000037	0.000037	0.000011	0.000011
Chromium	mg/L	-	0.0066	0.00033	0.00033	0.00026	0.00026
Cobalt	mg/L	0.01	**0.47**	0.0045	0.0047	0.0050	0.0052
Copper	mg/L	0.022	**0.032**	0.0014	0.0016	0.00060	0.00069
Iron	mg/L	1.5	**9.3**	0.38	0.47	0.19	0.24
Lead	mg/L	0.0076	**0.015**	0.000072	0.00015	0.000085	0.00018
Manganese	mg/L	-	0.278	0.0026	0.0028	0.0031	0.0029
Mercury	mg/L	-	0.00016	0.0000012	0.0000016	0.0000058	0.0000076
Molybdenum	mg/L	-	0.11	0.0028	0.0055	0.0087	0.017
Nickel	mg/L	-	0.034	0.00095	0.0017	0.00067	0.0012
Selenium	mg/L	0.005	**0.127**	0.0025	**0.0063**	0.003	0.003
Silver	mg/L	-	0.0026	0.00026	0.00026	0.00058	0.00058
Thallium	mg/L	-	0.0259	0.00026	0.00026	0.00038	0.00038
Uranium	mg/L	0.027	**0.122**	0.0035	0.0061	0.0010	0.0018
Vanadium	mg/L	-	0.0047	0.00018	0.00024	0.00013	0.00017
Zinc	mg/L	0.11	**0.116**	0.0050	0.0058	0.0030	0.0035

Notes:

Values in bold are higher than site specific water quality objectives.

Table 2: Summary of Baseline and Operations Receiving Water Quality Modelling Predictions for the Fortune NICO Project

Parameter	Units	CCME Freshwater Aquatic Life Guidelines	Site Specific Water Quality Objectives	Nico Lake				Peanut Lake						Burke Lake						Marian River					
						Operations[b]				Operations[b]						Operations[c]						Operations[c]			
				Modelled Baseline[a] (As Presented in DAR)		Ion Exchange System (As Presented in DAR)		Modelled Baseline[a] (As Presented in DAR)		Ion Exchange System (As Presented in DAR)		RO System with Treatment of Brine		Modelled Baseline[a] (As Presented in DAR)		Ion Exchange System (As Presented in DAR)		RO System with Treatment of Brine		Modelled Baseline[a] (As Presented in DAR)		Ion Exchange System (As Presented in DAR)		RO System with Treatment of Brine	
				Average	95^{th} %ile	Average	95^{th} %ile	Average	95^{th} %ile	Average	95^{th} %ile	Average	95^{th} %ile	Average	95^{th} %ile	Average	95^{th} %ile	Average	95^{th} %ile	Average	95^{th} %ile	Average	95^{th} %ile	Average	95^{th} %ile
Major Ions and TDS																									
Calcium	mg/L	-	-	9.1	11.7	19.2	32.8	8.1	10.8	6.95	9.92	19.2	32.8	8.73	12.8	8.24	12.5	12.8	18.0	25.5	51.1	25.4	50.9	25.6	51.0
Chloride	mg/L	120	353	0.8	1.3	11.6	24.1	0.9	1.3	1.5	1.9	11.6	24.1	1.18	1.6	1.4	1.9	5.0	9.6	2.7	5.4	2.7	5.3	2.8	5.5
Magnesium	mg/L	-	-	4.2	5.5	3.0	5.3	3.5	5.7	3.1	5.3	3.0	5.3	3.5	5.4	3.3	5.2	3.3	5.2	11.0	22.0	10.9	21.8	10.9	21.8
Potassium	mg/L	-	-	1.1	1.5	52.6	113	1.1	1.7	6.7	12.5	52.6	113	1.3	1.6	3.4	5.5	19.9	42.7	1.9	3.9	2.0	3.9	2.4	5.0
Sodium	mg/L	-	-	2.7	3.6	12.3	23.1	2.7	3.8	3.4	4.2	12.3	23.1	2.8	3.8	3.1	4.1	6.1	9.8	3.8	7.5	3.8	7.5	3.9	7.7
Sulphate	mg/L	-	500	3.9	5.5	29.4	61.4	1.6	2.5	3.2	5.1	29.4	61.4	2.0	2.9	2.5	3.4	11.7	23.4	20.9	42.0	20.8	41.7	21.1	42.2
Total Dissolved Solids	mg/L	-	-	54.0	78.2	157	289	42.6	70.3	47.4	70.1	157	289	42.3	66.9	43.6	66.5	84.1	127	119	239	119	238	120	239
Nutrients																									
Nitrate	mg N/L	2.93	30	0.070	0.14	1.94	4.15	0.056	0.15	0.31	0.54	1.94	4.15	0.052	0.12	0.16	0.26	0.77	1.64	0.057	0.15	0.061	0.16	0.079	0.19
Ammonia	mg N/L	1.1	4.16	0.025	0.048	0.33	0.65	0.020	0.050	0.27	0.52	0.33	0.65	0.020	0.042	0.13	0.23	0.15	0.27	0.028	0.065	0.031	0.070	0.032	0.072
Total Kjeldahl Nitrogen	mg N/L	-	-	0.72	1.05	0.84	1.22	0.60	1.11	0.78	1.20	0.84	1.22	0.60	0.93	0.67	0.99	0.69	1.01	0.76	1.51	0.76	1.51	0.76	1.51
Total Phosphorus	mg P/L	-	-	0.020	0.023	0.018	0.023	0.015	0.018	0.016	0.020	0.018	0.023	0.015	0.017	0.016	0.018	0.016	0.019	0.0088	0.018	0.0089	0.018	0.0089	0.018
Total Metals																									
Aluminum	mg/L	0.1	0.41	0.056	0.071	**0.46**	**0.79**	0.099	0.14	**0.43**	**0.73**	**0.46**	**0.79**	0.090	0.12	**0.34**	***0.58***	**0.35**	***0.61***	0.032	0.070	0.044	**0.10**	0.045	**0.10**
Antimony	mg/L	0.006	0.03	0.00032	0.00039	0.0011	0.0021	0.00025	0.00034	0.00040	0.00052	0.0011	0.0021	0.00025	0.00032	0.00035	0.00043	0.00061	0.00099	0.000025	0.000050	0.000029	0.000057	0.000035	0.000076
Arsenic	mg/L	0.005	0.05	0.014	0.016	0.014	0.027	0.0040	0.0047	0.013	0.024	0.014	0.027	0.0028	0.0032	**0.010**	**0.018**	**0.010**	**0.019**	0.00041	0.0010	0.00063	0.0017	0.00064	0.0017
Barium	mg/L	-	-	0.0078	0.011	0.013	0.016	0.0092	0.011	0.013	0.016	0.013	0.016	0.0090	0.011	0.012	0.014	0.012	0.015	0.015	0.030	0.015	0.030	0.015	0.030
Beryllium	mg/L	-	-	0.000013	0.000014	0.000032	0.000048	0.000011	0.000013	0.000041	0.000066	0.000032	0.000048	0.000011	0.000012	0.000027	0.000042	0.000024	0.000035	0.000011	0.000031	0.000011	0.000032	0.000011	0.000032
Boron	mg/L	1.5	-	0.0070	0.011	0.039	0.074	0.0073	0.0094	0.012	0.016	0.039	0.074	0.0061	0.0082	0.0079	0.010	0.017	0.030	0.017	0.035	0.017	0.035	0.017	0.036
Cadmium	mg/L	0.000017	0.00015	0.000011	0.000019	0.000024	0.000034	0.000010	0.000025	0.000027	0.000040	0.000024	0.000034	0.0000097	0.000019	**0.000020**	**0.000031**	**0.000019**	**0.000029**	0.000016	0.000047	0.000016	**0.000047**	0.000016	**0.000047**
Chromium	mg/L	0.001	-	0.00043	0.00052	0.00087	0.0012	0.00055	0.00075	0.00088	0.0012	0.00087	0.0012	0.00058	0.00076	0.00083	**0.0011**	0.00083	**0.0011**	0.00038	0.00076	0.00039	0.00077	0.00039	0.00077
Cobalt	mg/L	-	0.01	0.00036	0.00061	0.0024	0.0043	0.00020	0.00037	0.0023	0.0042	0.0024	0.0043	0.00017	0.00030	0.0015	0.0027	0.0015	0.0028	0.00010	0.00020	0.00014	0.00028	0.00014	0.00029
Copper	mg/L	0.002	0.022	0.0018	0.0020	0.0019	0.0028	0.0011	0.0014	0.0020	0.0030	0.0019	0.0028	0.0012	0.0014	0.0019	**0.0026**	0.0018	**0.0025**	0.00064	0.0017	0.00067	0.0017	0.00067	0.0017
Iron	mg/L	0.3	1.5	0.38	0.46	1.09	**1.75**	0.37	0.48	1.12	**1.81**	1.09	**1.75**	0.38	0.47	**0.94**	**1.48**	**0.93**	**1.46**	0.14	0.27	0.16	**0.31**	0.16	**0.31**
Lead	mg/L	0.001	0.008	0.00007	0.00010	0.00015	0.00021	0.000075	0.00015	0.00014	0.00020	0.00015	0.00021	0.000080	0.00013	0.00013	0.00017	0.00013	0.00018	0.000068	0.00029	0.000070	0.00029	0.000070	0.00029
Manganese	mg/L	-	-	0.022	0.037	0.027	0.055	0.024	0.052	0.027	0.055	0.027	0.055	0.025	0.048	0.028	0.051	0.028	0.051	0.031	0.062	0.031	0.062	0.031	0.062
Mercury	mg/L	0.000026	-	0.0000084	0.000011	0.0000093	0.000014	0.0000088	0.000014	0.0000086	0.000014	0.0000093	0.000014	0.0000087	0.000012	0.0000088	0.000013	0.0000091	0.000013	0.000011	0.000078	0.000011	**0.000077**	0.000011	**0.000077**
Molybdenum	mg/L	0.073	-	0.00049	0.00058	0.0020	0.0040	0.00022	0.00030	0.00080	0.0014	0.0020	0.0040	0.00021	0.00025	0.00043	0.00067	0.00084	0.0016	0.00021	0.00042	0.00021	0.00043	0.00023	0.00046
Nickel	mg/L	0.025	-	0.00052	0.00088	0.00095	0.0014	0.00079	0.0013	0.0010	0.0014	0.00095	0.0014	0.00073	0.0011	0.00085	0.0012	0.00083	0.0012	0.00100	0.0020	0.0010	0.0020	0.00100	0.0020
Selenium	mg/L	0.001	0.005	0.00014	0.00019	0.00069	0.0012	0.00014	0.00024	0.00086	0.0015	0.00069	0.0012	0.00013	0.00021	0.00042	0.00067	0.00037	0.00057	0.00018	0.00070	0.00019	0.00071	0.00019	0.00070
Silver	mg/L	0.0001	-	0.0000064	0.0000090	0.000092	**0.00019**	0.0000064	0.000012	0.000049	0.000092	0.000092	**0.00019**	0.0000062	0.0000099	0.000025	0.000043	0.000041	0.000079	0.0000027	0.000011	0.0000035	0.000012	0.0000042	0.000015
Thallium	mg/L	0.0008	-	0.0000017	0.0000021	0.00012	0.00020	0.0000016	0.0000022	0.00011	0.00017	0.00012	0.00020	0.0000015	0.0000020	0.000056	0.000092	0.000063	0.00011	0.0000013	0.0000022	0.0000026	0.0000055	0.0000027	0.0000060
Uranium	mg/L	0.015	0.027	0.00032	0.00041	0.00073	0.0010	0.00020	0.00029	0.0012	0.0019	0.00073	0.0010	0.00023	0.00033	0.00065	0.00099	0.00049	0.00068	0.00086	0.0017	0.00088	0.0017	0.00087	0.0017
Vanadium	mg/L	-	-	0.00033	0.00052	0.00059	0.00092	0.00034	0.00078	0.00060	0.00092	0.00059	0.00092	0.00040	0.00073	0.00058	0.00087	0.00058	0.00087	0.00042	0.0011	0.00042	0.0011	0.00042	0.0011
Zinc	mg/L	0.03	0.11	0.0044	0.0053	0.0046	0.0057	0.0044	0.0058	0.0049	0.0062	0.0046	0.0057	0.0045	0.0057	0.0048	0.0060	0.0047	0.0058	0.0070	0.024	0.0070	0.023	0.0070	0.023
Dissolved Metals																									
Aluminum	mg/L	0.1	0.41	0.025	0.050	0.11	0.29	0.044	0.094	0.10	0.27	0.11	0.29	0.040	0.083	0.092	**0.23**	0.095	**0.24**	0.016	0.045	0.021	0.056	0.021	0.057
Antimony	mg/L	0.006	0.03	0.00023	0.00033	0.00051	0.0011	0.00018	0.00028	0.00019	0.00034	0.00051	0.0011	0.00018	0.00027	0.00018	0.00030	0.00031	0.00059	0.000018	0.000040	0.000021	0.000044	0.000026	0.000058
Arsenic	mg/L	0.005	0.05	0.011	0.015	0.0093	0.019	0.0034	0.0044	0.0085	0.018	0.0093	0.019	0.0023	0.0030	**0.0068**	**0.014**	**0.0072**	0.015	0.00035	0.0009	0.00053	0.0014	0.00054	0.0014
Barium	mg/L	-	-	0.0068	0.0095	0.0094	0.014	0.0079	0.0099	0.0093	0.013	0.0094	0.014	0.0077	0.010	0.0088	0.013	0.0088	0.013	0.013	0.027	0.013	0.027	0.013	0.027
Beryllium	mg/L	-	-	0.0000092	0.000011	0.000014	0.000022	0.0000080	0.000010	0.000018	0.000029	0.000014	0.000022	0.000008	0.000010	0.000013	0.000021	0.000012	0.000018	0.0000078	0.000024	0.0000081	0.000024	0.0000080	0.000024
Boron	mg/L	1.5	-	0.0058	0.0088	0.023	0.049	0.0059	0.0081	0.0076	0.012	0.023	0.049	0.0050	0.0069	0.0052	0.0078	0.011	0.020	0.014	0.030	0.014	0.030	0.014	0.030
Cadmium	mg/L	0.000017	0.00015	0.0000046	0.000010	0.0000047	0.000013	0.0000041	0.000010	0.0000054	0.000015	0.0000047	0.000013	0.0000038	0.0000091	0.0000046	0.000012	0.0000043	0.000012	0.0000073	0.000024	0.0000071	**0.000024**	0.0000071	**0.000024**
Chromium	mg/L	0.001	-	0.00022	0.00039	0.00024	0.00057	0.00028	0.00053	0.00024	0.00057	0.00024	0.00057	0.00029	0.00053	0.00026	0.00057	0.00026	0.00057	0.00021	0.00051	0.00021	0.00051	0.00021	0.00051
Cobalt	mg/L	-	0.01	0.00024	0.00045	0.0010	0.0023	0.00013	0.00028	0.0010	0.0023	0.0010	0.0023	0.00011	0.0002	0.00071	0.0016	0.00072	0.0016	0.000070	0.00016	0.000096	0.00022	0.000096	0.00022
Copper	mg/L	0.002	0.022	0.0013	0.0018	0.00092	0.0016	0.00082	0.0012	0.00097	0.0017	0.00092	0.0016	0.00086	0.0012	0.00097	0.0016	0.00095	0.0016	0.00048	0.0013	0.00049	0.0013	0.00049	0.0013
Iron	mg/L	0.3	1.5	0.21	0.36	0.36	0.83	0.21	0.37	0.37	0.85	0.36	0.83	0.21	0.36	**0.34**	**0.76**	**0.34**	**0.75**	0.082	0.19	0.092	0.21	0.091	0.21
Lead	mg/L	0.001	0.008	0.000042	0.000076	0.000056	0.00013	0.000044	0.00010	0.000055	0.00013	0.000056	0.00013	0.000048	0.00009	0.000053	0.00011	0.000053	0.00011	0.000043	0.00019	0.000043	0.00019	0.000043	0.00019
Manganese	mg/L	-	-	0.013	0.028	0.011	0.034	0.014	0.037	0.011	0.034	0.011	0.034	0.014	0.033	0.012	0.032	0.012	0.032	0.019	0.046	0.019	0.045	0.019	0.045
Mercury	mg/L	0.000026	-	0.0000018	0.0000033	0.00000082	0.0000019	0.0000019	0.0000037	0.00000077	0.0000019	0.00000082	0.0000019	0.0000019	0.0000036	0.00000091	0.0000020	0.00000093	0.0000020	0.0000030	0.000019	0.0000028	0.000018	0.0000028	0.000018
Molybdenum	mg/L	0.073	-	0.00041	0.00052	0.0012	0.0027	0.00019	0.00026	0.00051	0.0010	0.0012	0.0027	0.00017	0.00022	0.00029	0.00050	0.00057	0.0012	0.00017	0.00037	0.00018	0.00037	0.00019	0.00040
Nickel	mg/L	0.025	-	0.00040	0.00069	0.00055	0.0010	0.00060	0.0010	0.00057	0.0010	0.00055	0.0010	0.00056	0.00089	0.00052	0.00089	0.00051	0.00088	0.00078	0.0016	0.00077	0.0016	0.00077	0.0016
Selenium	mg/L	0.001	0.005	0.00012	0.00017	0.00044	0.00062	0.00012	0.00020	0.00055	0.00081	0.00044	0.00062	0.00011	0.00018	0.00029	0.00041	0.00025	0.00035	0.00016	0.00060	0.00017	0.00060	0.00016	0.00060
Uranium	mg/L	0.015	0.027	0.00027	0.00037	0.00049	0.00085	0.00017	0.00026	0.00078	0.0015	0.00049	0.00085	0.00019	0.00028	0.00046	0.00081	0.00034	0.00058	0.00073	0.0015	0.00074	0.0015	0.00073	0.0015
Vanadium	mg/L	-	-	0.00018	0.00034	0.00018	0.00045	0.00018	0.00045	0.00019	0.00046	0.00018	0.00045	0.00021	0.00043	0.00020	0.00045	0.00020	0.00045	0.00025	0.00072	0.00024	0.00071	0.00024	0.00071
Zinc	mg/L	0.03	0.11	0.0026	0.0044	0.0016	0.0038	0.0025	0.0046	0.0017	0.0041	0.0016	0.0038	0.0025	0.0045	0.0019	0.0041	0.0019	0.0041	0.0043	0.015	0.0042	0.015	0.0042	0.015

(a) = Underlined values in bold are above CCME guidelines under modelled baseline conditions
(b) = Values in bold are greater than site specific water quality objectives (SSWQO) or above CCME guidelines for parameters that do not have a SSWQO
(c) = Predicted values in bold are higher than CCME guidelines; values in bold italics are higher than site specific water quality objectives