Sabina
GOLD & SILVER CORP.

The BACK RIVER PROJECT

SUPPLEMENTAL TYPE A WATER LICENCE TECHNICAL COMMENT RESPONSES

April 2018
NWB File No. 2AM-BRP----

Submitted to:
Nunavut Water Board
PO Box 119
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The BACK RIVER PROJECT

Technical Comment Responses

Kitikmeot Inuit Association

Interested Party:	KIA	**TC No.:**	**WT-KIA-NWB-03**
Subject/Topic:	Consideration of total concentrations in mine effluents		

Reference to Type A:

- MAD Appendix E-2_Water Load Balance Report, Section 5.4.1, Section 7.
- MAD Appendix F-1_Site-WideWater Management Report, Section 4.2.1.
- Attachment A Type A_IR Responses, KIA-IR12.

Detailed Review Comment:

Section 7 of the Water Load Balance report indicates that the water load balance model generates dissolved concentrations (e.g. Section 7.2, "*Monthly average water quality predictions for dissolved metal concentrations were evaluated…*". The comparison of the modelled dissolved concentrations with the CCME benchmarks for the protection of aquatic life, which are expressed in terms of total concentrations, is not appropriate and leads to underestimating the number of constituents with concentrations above the guidelines, as well as the concentrations in excess of the guidelines. In response to this observation, which is presented in KIA-IR12, the Proponent states that the mine effluents have minimal to no presence of Total Suspended Solids (TSS), so that dissolved concentrations are effectively equal to total concentrations. However, in Section 5.4.1 of the Water Load Balance Report and in section 4.2.1 of the Site-wide Water Management Report it is stated that the water from Llama Lake and Umwelt Lake that will be pre-dewatered and pumped into Goose Lake has a high content of suspended solids. Table 5-1 of the Water Load Balance Report indicates that 50% of the water removed from Umwelt Lake will be discharged directly into Goose Lake, and the water removed from Llama Lake will be treated for TSS and Arsenic only at the final dewatering stage. Therefore, the assumption of negligible TSS in the effluent to Goose Lake does not seem to hold. The discharge of a TSS load can have an adverse effect on the aquatic habitat in Goose Lake, as it may lead to a local reduction in water clarity near the effluent discharge point. The presence of a TSS load in the effluent also implies that constituents with toxicity potential, such as metals, will be discharged not only in dissolved form but also in suspended form. Not including TSS in the water load balance model and considering only dissolved concentrations leads to an underestimate of the substances with potential toxicity that are discharged into Goose Lake.

Recommendation/Request:

The water load balance model should be modified to include consideration of Total Suspended Solids (TSS) and total constituent concentrations, so that water treatment requirements based on the comparison with CCME benchmarks can be adequately defined. The modeling of total metals is also included in the list of the Proponent's commitments of the FEIS and FEIS Addendum Project Certificate (170601-12MN036-FHA EX 45-Recommended PC Terms and Conditions Committments-IA2E), item INAC-C-1.

Sabina Response:

Sabina confirms that the Water and Load Balance Model is currently being updated to meet Sabina's commitments for the FEIS and FEIS Addendum Project Certificate (170601-12MN036-FHA EX 45-Recommended PC Terms and Conditions Committments-IA2E), item INAC-C-1.

As discussed in the response to WT- ECCC-TC-5, the Water and Load Balance Model update will include an evaluation the effect of suspended solids of an assumed composition on the total parameter concentrations in mine discharges during Operations, Closure, and Post-Closure. Sabina will provide the results of the Water and Load Balance Model update prior to the Technical Meeting.

Attachment:

N/A

Supplemental Request:

N/A

Sabina Supplemental Response:

Sabina stated that the results of the Water and Load Balance Model update would be provided prior to the Technical Meeting. Sabina directs the reviewer to Appendix A Technical Memorandum for the Load Balance Update in Support of the Type A Water Licence.

Supplemental Attachment:

N/A

Interested Party:	KIA	**TC No.:**	**WT-KIA-NWB-06**
Subject/Topic:	Discrepancy in mine inflows reported in the Hydrogeology and Modeling Report, the Water Load Balance Report and the Site-Wide Management Plan		

Reference to Type A:

- MAD Appendix F-5_Hydrogeological Characterization and Modeling Report, Section 6.2, Table 5;
- MAD Appendix E-2_Water Load Balance Report, Section 3.2.7, Table 3-10;
- SD05-Water Management Plan, Section 5.1.3, Table 5.1-1

Detailed Review Comment:

The following mine inflows listed in Table 5 of the Hydrogeology and Modeling Report differ from those listed in Table 3-10 of the Water Load Balance Report and Table 5.1-1 of the Site-Wide Water Management Plan:

Unwelt U/G 2028: 156 m3/d (Table 5) vs. 312 m3/d (Table 3-10 and 5.1.-1)

Llama U/G 2022: 185 m3/d (Table 5) vs. 246 m3/d (Table 3-10 and 5.1.-1)

Llama Open Pit 2020: 109 m3/d (Table 5) vs. 76 m3/d (Table 3-10 and 5.1.-1)

Llama Open Pit 2021: 702 m3/d (Table 5) vs. 19 m3/d (Table 3-10 and 5.1.-1)

Goose Main U/G 2027: 64 m3/d (Table 5) vs. 16 m3/d (Table 3-10 and 5.1.-1)

These discrepancies may be a 'typo', but if they are not, they need to be resolved or a clarification is needed to justify them.

Recommendation/Request:

Resolve or clarify the discrepancies in the mine inflows listed in the Hydrogeology and Modeling Report, Table 5, and those listed in the Water Load Balance Report, Table 3-10, and in the Site-Wide Water Management Plan, Table 5.1-1.

Sabina Response:

Sabina acknowledges this inconsistency. As outlined in the Technical Review of Water, Waste Rock, and Tailings Management/Design (171005 2AM-BRP----MAD App F-7_TechReview-IMLE), Golder completed a review of the water balance, load balance, and water management design. As part of this review, inconsistencies for mine flows were identified and Sabina requested the water and load balance model be updated for groundwater inflows to the open pits and underground mines for consistency with values reported in Hydrogeological Characterization Report (171005 2AM-BRP----MAD App F-5_HydrogCharactModelRpt-IMLE).

The groundwater inflows to open pit and underground facilities (facilities) reported in Table 5 of the Hydrogeological Characterization Report were obtained using yearly average inflow rates, meaning that they are estimated as total inflow volumes to the facilities equally distributed of a period of 12 months. As such, these do not account for the actual schedule of mining completion in the last year of each open pit and underground mines within their last year of operation.

If the facilities are completed in the first few months of their last year, the higher inflow rates for those months would be higher than the yearly average inflow rates, the total inflow volume would be concentrated in a period of time shorter than 12 months.

For the purpose of the water and load balance modelling, the predicted yearly average inflow rates were linearly scaled accounting for the actual duration of the facilities within their last year of operation. As such, the potential discrepancies identified by KIA are all related to the last year of operation of facilities. The one exception is for the Llama Open Pit in Year 2. For this year, Sabina acknowledges a typographical error in Table 5 of the Hydrogeological Characterization Report, where an inflow of 76 m^3/d is incorrectly reported, instead of the model predicted inflow of 109 m^3/d.

Further explanations about the discrepancy in the last year of Llama Open Pit operations will be provided for the Technical Meetings.

Attachment:

N/A

Supplemental Request:

N/A

Sabina Supplemental Response:

Sabina stated that further explanation regarding the discrepancy in the last year of Llama Open Pit operations inflows would be provided prior to the Technical Meeting.

Sabina elaborates that, as further to the above, the discrepancy in groundwater inflows to Llama Open Pit during its last year of operations is also due to typographical errors in the reports. The estimated inflows to Llama Open Pit during its last year of operation is 72 m^3/day; this value will replace the previous value of 702 m^3/day in Table 5.1-1 of the Water Management Plan (171005 2AM-BRP----SD05-WaterMgmtPlan_IMLE), and Table 3-10 of the Water and Load Balance Report (171005 2AM-BRP----MAD App E-2_WaterLoadBalanceRpt-IMLE). Sabina confirms this updated value is significantly smaller than the value used for the water balance, and therefore the results of the water balance are expected to be significantly conservative for the last year of Llama Open Pit operations. The correct value of 72 m^3/day will be included in the water balance model to support the next update to Appendix B of the Water Management Plan (171005 2AM-BRP----SD05-WaterMgmtPlan_IMLE); this will be completed prior to construction.

Supplemental Attachment:

N/A

Interested Party:	KIA	TC No.:	WT-KIA-NWB-26
Subject/Topic:	Phosphorus enrichment		

Reference to Type A:

- Main Application Document (MAD) Section 5.3.2; Table 5.3-1; Water and Load Balance Report Appendix D.

Detailed Review Comment:

Gap/Issue
Sabina indicates "Treated effluent [from the wastewater treatment plant will be] discharged to active tailings facility during Operations. If effluent discharge from the STP meets discharge criteria, effluent will be discharged to land."

We note that effluent in the tailings facility will only reach the receiving environment during closure. We express concern maximum modelled phosphorus concentrations resulting from the discharges indicates a shift in trophic level at PN02, PN03, PN04, PN06, PN10 and in Goose Lake.

Disagreement with WL information/ conclusion
It is unclear if Sabina has accounted for the potential effects of a large influx of nutrients, namely phosphorus, in the receiving environment, and whether the potential for a shift in the receiving environment's trophic status is a potentiality. An alternate steady trophic state may present a potential unmitigated risk to the receiving environment that may be rectified with more stringent sewage effluent criteria for nutrients.

Reasons for disagreement
A significant pulse of phosphorus can result in long-term internal loading within the receiving environment, which may not have been incorporated into modelling results.

Recommendation/Request:

Please indicate the length of time phosphorus concentrations will be elevated above the baseline trophic levels in Goose Lake and at the prediction nodes. Please provide a discussion as to the impact-elevated concentrations will have with respect to a shift in trophic levels.

Note the modeled length of time phosphorus concentrations will be elevated should rely on the updated model as requested in the KIA Technical Comment titled "Water quality modelling results".

Sabina Response:

Prior to the Technical Meeting, Sabina will provide information for discussion regarding the potential for a shift in trophic status in receiving environment waterbodies based on review of monthly predictions from the updated Water and Load Balance model that is currently underway (see WT-KIA-NWB-03). Sabina will consider the potential impact of any shift in trophic status on aquatic life in these waterbodies in the discussion information provided to the KIA.

Attachment:

N/A

Supplemental Request:

We look forward to reviewing the updated Water and Load Balance Model to assess whether the information presented therein resolves this issue.

Sabina Supplemental Response:

Sabina notes that maximum monthly total phosphorus concentrations predicted at assessment nodes PN02, PN03, PN04, PN06, PN10, and Goose Lake at Closure are predicted to be above 0.010 mg/L according to the updated Water and Load Balance; these updated results are provided in a technical memorandum by Golder (Appendix A). Given that the baseline condition for these assessment nodes is assumed to be oligotrophic, total phosphorus concentrations above 0.010 mg/L indicate some potential for a trophic shift to more nutrient rich conditions, according to trigger ranges provided for the Canadian Guidance Framework for developing phosphorus guidelines (CCME 2004). Use of these trigger ranges necessitates consideration of site-specific conditions in determining the potential for a trophic shift. For example, the CCME trigger ranges were adopted from trophic status values mainly developed for lakes but the nodes assessed by Golder (Appendix A) are in stream environments (PN02, PN03, PN12, and PN13 are located in lake outlets), with the exception of Goose Lake.

The relationship between nutrient concentrations and periphyton growth remains the subject of ongoing research but it is generally understood that both phosphorus and nitrogen have the potential to stimulate algal growth in streams and rivers. Regardless of the limiting nutrient, the relationship between nutrient concentrations and periphyton biomass is weaker in rivers and streams than in lakes (Dodds et al. 2002; Wetzel 2001). In rivers and streams, periphyton biomass is influenced to a greater degree by a number of factors other than nutrient concentrations; these include, but are not limited to, light availability, flow velocities, stability and type of substrate, length of the growing season, suspended sediment load, invertebrate grazing, flood and drought frequencies, time since the last freshet, and water temperature (Allen 1995; Dodds et al. 2002; Tank and Dodds 2003; Lewis and McCutchan 2010; Wetzel 2001).

Therefore, monthly total phosphorus concentrations were assessed at the Goose Lake assessment node as reported by Golder (Appendix A). Furthermore, with the exception of PN10 that represents a stream environment, the maximum concentration predicted at Closure in Goose Lake is higher than at the other assessment nodes.

At the Goose Lake assessment node, total phosphorus concentrations are predicted to increase above 0.010 mg/L during the Closure Phase (Year 10 to Year 18), before decreasing during Post-Closure to 0.011 mg/L. During the Closure Phase, the updated predictions indicate the potential for a trophic shift in Goose Lake based on the model baseline input value. However, Table 4.1.6. of the FEIS (Volume 4) suggests that Goose Lake as a whole spans a number of tropic levels from ultra-oligotrophic to eutrophic, due to annual and seasonal variability in baseline total phosphorus concentrations. Additional data collection is ongoing and the data will be evaluated to confirm baseline trophic status and inform water quality modelling for Goose Lake. Water quality model inputs for phosphorus will also be evaluated further. Should the potential for a trophic change still be identified after refinement of the water quality model, Sabina will consider additional mitigation measures to reduce mine-related nutrient inputs to the receiving environment, if necessary.

<u>References:</u>

Allan J.D. 1995. Stream Ecology: Structure and Function of Running Waters. Chapman and Hall, London. 388 pp.

CCME (Canadian Council of Ministers of the Environment). 2004. Canadian Water Quality Guidelines for the Protection of Aquatic Life: Phosphorus: Canadian Guidance Framework for the Management of Freshwater Systems. Canadian Council of Ministers of the Environment, Winnipeg, Manitoba.

Dodds W.K., V.H. Smith and K. Lohman. 2002. Nitrogen and phosphorus relationships to benthic algal Environment Canada, 2004, Canadian Guidance Framework for the Management of Phosphorus in Freshwater Systems. Ecosystem Health: Science-based Solutions, National Guidelines and Standards, Report No. 1-8.

Lewis W.M. Jr. and J.H. McCutchan Jr. 2010. Ecological responses to nutrients in streams and rivers of the Colorado mountains and foothills. Freshwater Biology. 55:1973-1983.

Tank J.L. and W.L. Dodds. 2003. Nutrient limitation of epilithic and epixylic biofilms in ten North American streams. Freshwater Biology 48: 1031-1049.

Wetzel R. 2001. Limnology: Lake and River Ecosystems. 3rd Ed. Academic Press. San Diego, CA. 850 pp

Supplemental Attachment:

N/A

Interested Party:	KIA	**TC No.:**	**WT-KIA-NWB-29**
Subject/Topic:	Water Quality Model Results		

Reference to Type A:

- Water and Load Balance Report (WLBR) Section 4, Section 7.2

Detailed Review Comment:

Gap/Issue
Sabina indicates, "*The predicted water quality concentrations are based on a deterministic modelling approach, assuming average hydrological conditions. This approach is consistent with the derivation of source terms, which are developed based on average hydrology. The predicted water quality under these conditions provides the most likely results to occur.*"

While the sensitivity analysis provides variances from this average "base case", no discussion as to how these "upper cases" reflect realistic potentialities. Many of these scenarios currently appear arbitrary; no rationale has been provided to indicate how realistic these scenarios are, and whether Sabina has a response framework in place should they occur.

Disagreement with WL information/ conclusion
Sabina has not provided a discussion as to how the varying "upper case" scenarios in the water and load balance sensitivity analysis reflect potentialities at the project site.

Reasons for disagreement
Failure to accurately model and evaluate scenarios diverging from the base case may improperly characterize the impacts of project activities under conditions less optimal than average.

Recommendation/Request:

We recommend Sabina provide a discussion as to how the "upper case" scenarios presented in the water and load balance sensitivity analysis reflect realistic potentialities at the Project site, what factors may cause such deviation and whether a more conservative sensitivity analysis is warranted.

We further request Sabina provide a discussion as to how these "upper case" scenarios may be adaptively managed. We are particularly concerned with arsenic concentrations resulting from the "upper case" scenarios as outlined in Figure 9-1, which shows exceedances of the SSWQO (0.01 mg/L) in perpetuity. If this information has already been provided, we request Sabina direct us to that information.

Sabina Response:

Sabina will provide a discussion of the "upper case" scenarios relative to Project conditions and factors that could result in the development of "upper case" arsenic conditions prior to the Technical Meeting. This discussion will include proposed adaptive management scenarios to mitigate the potential for formation of "upper case" conditions.

Attachment:

N/A

Supplemental Request:

We look forward to reviewing Sabina's discussion to assess whether this issue is resolved.

Sabina Supplemental Response:

Sabina clarifies that the sensitivity analyses included in the Water and Load Balance Report (171005 2AM-BRP----MAD App E-2_WaterLoadBalanceRpt-IMLE) are not intended to reflect realistic potentialities at the Back River Project. These sensitivity analyses are intended to highlight the Water and Load Balance Model's sensitivity to a selected parameter. In this case, the parameter for discussion is the arsenic source term. The result of the sensitivity analysis for the arsenic source term, which applies a factor of 2.0 increase to this parameter, show that arsenic source terms are a sensitive parameter to the model results. This particular parameter example highlights the importance of characterizing the source terms, but does not reflect uncertainty in the source terms themselves.

Sabina will implement adaptive management measures into regular Operations should site-specific results show that the arsenic source terms are underestimated or that concentrations in contact water runoff occur in higher magnitudes than predicted in the geochemistry characterization (171005 2AM-BRP----MAD App E-3_GeochemCharactRpt-IMLE) and water and load balance model. Adaptive management measures may include blending of contact water runoff with freshwater for use in the Process Plant; blending of contact water with saline water, and pumping this blended water to the bottom of the Llama Reservoir meromictic system; or other operational adjustments to reduce contact water volumes thereby reduce loading to Goose Lake and other waterbodies.

Supplemental Attachment:

N/A

The BACK RIVER PROJECT

Technical Comment Responses

Crown-Indigenous Relations and Northern Affairs Canada

Interested Party:	CIRNA	**TC No.:**	**WT-INAC-TRC-4**
Subject/Topic:	Design Criteria for Culverts and Diversion Berms		

Reference to Type A:

- Water Management Plan
- Section 6.2: Hydrotechnical Design Criteria
- Tables 6.2-2, 6.2-3, 6.2-4
- Section 6.5: Culvert Sizing
- Table 6.5-1
- Figure A-01

Detailed Review Comment:

Water Management Plan Figure A-01, Goose Property Catchments, shows proposed culverts but corresponding catchment areas are not delineated.

Water Management Plan Section 6.2, Hydrotechnical Design Criteria, presents criteria for designing diversion berms and culverts in Tables 6.2-3 and 6.2-4, respectively. In both tables, the criterion for conveyance capacity is the 24-hour total rainfall volume, plus snowmelt, in units of cubic metres of volume. This proposed criterion does not follow normal practice which is to design conveyance features for a peak flow rate (discharge) expressed in m3/s or equivalent units. The tables identified in Section 6.2 should either be revised to indicate conventional units, or amended to include a detailed explanation if a non-standard approach is proposed.

Water Management Plan Section 6.5, Culvert Sizing, presents additional design criteria not included in Table 6.2-4, specifically (1) The fish bearing crossings will be sized to keep maximum water velocities below 1.5 m/s for the average June flow, and (2) all culverts will be sized to meet a 0.3 m criterion for maximum water depth above the top of culvert. The plan also states that fish bearing culverts will be embedded at depth and a "thin layer of streambed material" will be placed to promote fish passage and habitat suitability.

The origins of the above criteria are not provided. DFO may wish to review the suggested criteria for fish passage design. INAC notes that the suggested maximum headwater depth may exceed standard practice for other northern projects and provides no factor of safety against possible ice or debris blockage of the culvert inlet.

Table 6.5-1, Goose Property Culvert Characteristics, presents culvert characteristics (slope, diameter, embedment, etc.) and design storm hydraulic characteristics, including total discharge (m3/s), depths and velocities. No information is given for catchment area size or fish passage criteria other than is inferred by a non-zero embedment depth. No information is given for hydraulic characteristics corresponding to the average June flow referenced in the criteria for sizing fish passage culverts.

Of five culverts listed in Table 6.5-1, only the Gander Pond Culvert (C2) is designed with a non-zero embedment depth (0.4 m) indicating design for fish passage. Details for this culvert include a relatively steep slope of 3.6% and, for the 100-year storm event, supercritical flow conditions (normal depth less than critical) and an outlet flow velocity of 4.2 m/s. A proposed "thin layer of streambed material" through the culvert is unlikely to withstand such velocities.

Recommendation/Request:

1. INAC requests that Water Management Plan Figure A-01 be amended or supplemented to show watershed areas draining to proposed culverts.

2. INAC requests clarification on whether conveyance capacity criteria for diversions and culverts is intended to be based on a peak flow (discharge) rate and if the tables showing conveyance capacity in volume units are in error.

3. INAC requests further information on the origin of proposed criteria that (1) fish bearing crossings be sized to keep maximum water velocities below 1.5 m/s for the average June flow, and (2) culverts meet a 0.3 m criterion for maximum water depth above the top of culvert.

4. For culverts being sized for fish passage, please provide results of hydraulic calculations for depths and velocities corresponding to the mean June flow identified in the criteria. Also, please review whether a proposed thin layer of substrate through the culvert(s) would withstand ordinary peak flows and/or if alternate measures should be considered to enhance fish passage and habitat.

Sabina Response:

1. Sabina acknowledges and agrees with CIRNA's request to update Figure A-01 of the Water Management Plan (WMP; 171005 2AM-BRP----SD05-WaterMgmtPlan_IMLE) to show watershed areas draining to proposed culverts. Sabina will provide the amended figure prior to the Technical Meeting.

2. Sabina acknowledges an error in the units of measure for the conveyance capacity of the diversion berms and culverts. Diversion berms and culverts are designed to convey peak flows generated during the 24-hour duration design event. The amended tables 6.2-3 and 6.2-4 are provided below, and will be included in the next revision of the Water Management Plan. As stated in the Water Management Plan, Sabina will initiate update to the plan prior to start of construction and will incorporate issue for construction engineering drawings of associated water management infrastructure.

Table 6.2-3: Containment Dams (Event and Saline Water Ponds) and Diversion Berm Design Criteria

	Item	Value	Unit	Source/Comments
Diversion Berm Design	Event Return Period	10-100	Years	BMP
	Conveyance Capacity	24-hour total rainfall volume + Snowmelt	m^3/s	BMP
	Manning's Roughness	0.035	-	For minor natural steam with stones and weeds (Chow 1994)
	Minimum Slope	0.005	m/m	BMP
	Upstream Side Slopes	2:1	(H:V)	Constructability consideration
	Downstream Side Slopes	1.5:1	(H:V)	Engineering judgement
	Berm Top Width	6	m	Constructability consideration
	Minimum Berm Height	2	m	Constructability consideration
	Minimum Berm Freeboard	0.5	m	Engineering judgement
Event Pond Containment Dam Design	Minimum Dam Height	2	m	Constructability consideration
	Bedding Material Thickness around GCL	0.5	m	Engineering judgement
	Liner Tie-Back Length	3	m	Engineering judgement
	Upstream Side Slope (Ponded Water Level > 4m)	3:1	(H:V)	Constructability consideration
	Upstream Side Slope (Ponded Water Level < 4m)	2:1	(H:V)	Constructability consideration
	Downstream Side Slopes	1.5:1	(H:V)	Engineering judgement
Saline Water Pond Containment Dam Design	Bedding Material Thickness around GCL	0.5	m	Engineering judgement
	Dam Top Width	8	m	Constructability consideration
	Minimum Dam Height	2	m	Constructability consideration
	Upstream Side Slope	3:1	(H:V)	Constructability consideration
	Downstream Side Slope	2:1	(H:V)	Engineering Judgement
	Liner Tie-Back Length	3	m	Engineering Judgement
	Key Trench Tie-in Depth	2.2	m	MAD Appendix F-1, Appendix C

Table 6.2-4: Culvert Design Criteria

Item	Value	Unit	Source
Event Return Period	100	Years	BMP; SRK (2014)
Conveyance Capacity	24-hour total rainfall volume	m^3/s	BMP; SRK (2014)
Maximum Velocity during Average June flow for Fish Passage	1.5	m/s	SRK (2014)
Manning's Roughness for culverts with cobble stone base	0.040	-	Chow (1994)
Manning's Roughness for culverts without cobble stone base	0.024	-	Chow (1994)

3. The Gander Pond Outflow culvert is the only culvert crossing that requires a design with considerations for fish passage. The culvert will be designed to maintain fish passage as per requirements under the *Fisheries Act*, specifically that maximum velocities will be below the expected threshold for an adult Arctic Grayling to successfully navigate Rascal Stream West. The culvert guideline of a maximum velocity of 1.5 m/s for mean flows in June is expected to be a protective for fish. This velocity is similar in application to use of the mean annual maximum velocity for June, where the maximum passable velocity is approximately 1.9 m/s for an adult Arctic Grayling based on the fatigue curve derived from Katopodis and Gervais (2016). Additional information on culvert designs for Rascal Stream West will be provided with the Request for Review application or a *Fisheries Act* authorization application submitted to Fisheries and Oceans Canada (DFO). Please also see Sabina's Technical Comment responses to WT-DFO-TC-3.2 and WT-DFO-TC-3.4 for additional information.

   The 0.3 m criterion for maximum water depth above the top of the culvert during the passage of the peak flow, generated during the design event, was selected based on engineering judgement. As shown in Table 6.5-1 from the Water Management Plan, the maximum headwater for all culverts during design event peak flows is below the crest of the culverts (range from 0.11 m to 0.27 m below the top of the culvert). For these culverts, the space between the maximum headwater and the crest of the culvert plus the minimum 0.3 m allowance between the crest of the culverts and the crest of the roads provides contingency for potential ice blockage. Sabina notes that Echo culvert does not align with this design; this culvert will be updated to match the other culverts as part of final culvert design.

Table 6.5-1: Goose Property Culvert Characteristics – Design Storm

	Culvert Description	Goose Culvert	Gander Pond Culvert	Goose Airstrip Culvert	Echo Culvert	Goose Creek Culvert
	Culvert ID	C1	C2	C3	C4	C5
Characteristics	Slope (%)	1.0	3.6	1.0	1.5	3.5
	Diameter (m)	2.5	2.5	2.5	1.2	2.5
	Culvert Shape	Circ.	Circ.	Circ.	Circ.	Circ.
	Number of Barrels	2	2	2	1	1
	Culvert Material	CSP	CSP	CSP	CSP	CSP
	Embedment Depth (m)	0	0.4	0	0	0
100 Year Event	Total Discharge (m^3/s)	19.27	9.64	18.82	1.99	10.47
	Culvert Inlet Elevation (m)	100	100	100	100	100
	Headwater Elevation (m)	102.27	101.89	102.23	101.46	102.39
	Water Depth above Culvert (m)	0	0	0	0.26	0
	Invert Control Depth (m)	2.27	1.49	2.23	1.32	2.39
	Outlet Control Depth (m)	1.31	0	0.23	1.46	1.01
	Normal Depth (m)	1.18	0.98	1.17	1.20	1.06
	Critical Depth (m)	1.41	1.21	1.4	0.77	1.10
	Outlet Depth (m)	1.20	0.99	1.18	0.77	1.47
	Tail Water Depth (m)	0.82	0.54	0.83	0.06	0.12
	Outlet Velocity (m/s)	4.14	4.21	4.12	2.58	5.03
	Tail Water Velocity (m/s)	2.34	1.78	2.27	0.64	0.49

4. Sabina provided the estimated flow depth and velocity in the Gander Pond culvert during the mean June flow in Table 3-6 of Appendix F-1 of the WMP. For reference, this table is provided below.

Table 3-6 Gander Pond Outflow Stream Culvert – Average June Flow Characteristics

Parameter	**Value**
Total Discharge (m3/s)	0.065
Headwater Elevation (m)	100.55
Invert Control Depth (m)	0.15
Outlet Control Depth (m)	0
Normal Depth (m)	0.08
Critical Depth (m)	0.12
Outlet Depth (m)	0.11
Tail Water Depth (m)	0.06
Outlet Velocity (m/s)	0.80
Tail Water Velocity (m/s)	0.43

As stated above, additional information on culvert design, including fish passage considerations, for the Gander Pond culvert crossing will be provided with the Request for Review application or a Fisheries Act authorization application submitted to DFO. Sabina's proposed design includes embedding culverts on fish-bearing streams, which is a standard best management practice to mitigate effects to fish habitat related to a closed-bottom culvert installation (M.C. Ministry of Forests et al. 2012). Assuming that mean peak velocities are in the range of 1.0 to 1.5 m/s, Sabina does not expect that placed substrate (primarily cobble, with some small boulder substrate) will be dislodged or will be susceptible to movement (Gordon et al. 2004). A key design consideration will be a culvert size that spans the channel width to ensure that the flows are not constricted. Sabina intends to perform annual inspections of culverts for bed erosion as outlined in Table 8.4-1 of the Environmental Monitoring and Protection Plan (171005 2AM-BRP----SD20-EMPP-IMLE).

References:

B.C. Ministry of Forests, Lands and Natural Resource Operations, B.C. Ministry of Environment, and Fisheries and Oceans Canada. 2012. Fish-stream crossing guidebook. Rev. ed. For. Prac. Invest. Br. Victoria, B.C.

Gordon ND, McMahon TA, Finlayson BK, Gippel CJ, Nathan RJ. 2004. Stream Hydrology: An Introduction for Ecologists, 2nd Edition. Wiley and Sons NY. 444 pp.

Katopodis C, Gervais R. 2016. Fish swimming performance database and analyses, DFO. Can. Sci. Advis. Sec. Res. Doc. 2016/002. Vi + 550 p

Attachment:

N/A

Supplemental Request:

This comment is partially resolved. INAC accepts that Sabina will provide the amended Figure A-01 of the Water Management Plan prior to the Technical Meeting.

Sabina has acknowledged an error in the units of measure for the conveyance capacity of the diversion berms and culverts, and has provided amended tables 6.2-3 and 6.2-4 to be included in the next revision of the Water Management Plan. However, the amended tables still have errors in the unit of measure: the value for design of diversion berms and culverts continues to be shown to be based on a 24-hour total volume, instead of peak flow. This should be corrected. On a related point, the response to INAC-TRC-3 described the probable maximum flood (PMF) in units of depth, which is non-standard. INAC expects that Sabina is referring to the Probable Maximum Precipitation (a depth amount) over the contributing basin area and requests that Sabina be more diligent in its accurate use of units of measurement.

Sabina's response to INAC's request for information on the origin of proposed criteria for fish bearing crossings does identify a source for the maximum passible velocity for an Artic Grayling. How this is then related to mean flow in June is not clear. Depending on hydrograph shapes and period of record considered, the mean June flow might be exceeded in 50% of all days in a given year, or for the entire month of June for half of all years. INAC will defer to DFO for further assessment of this issue, as warranted.

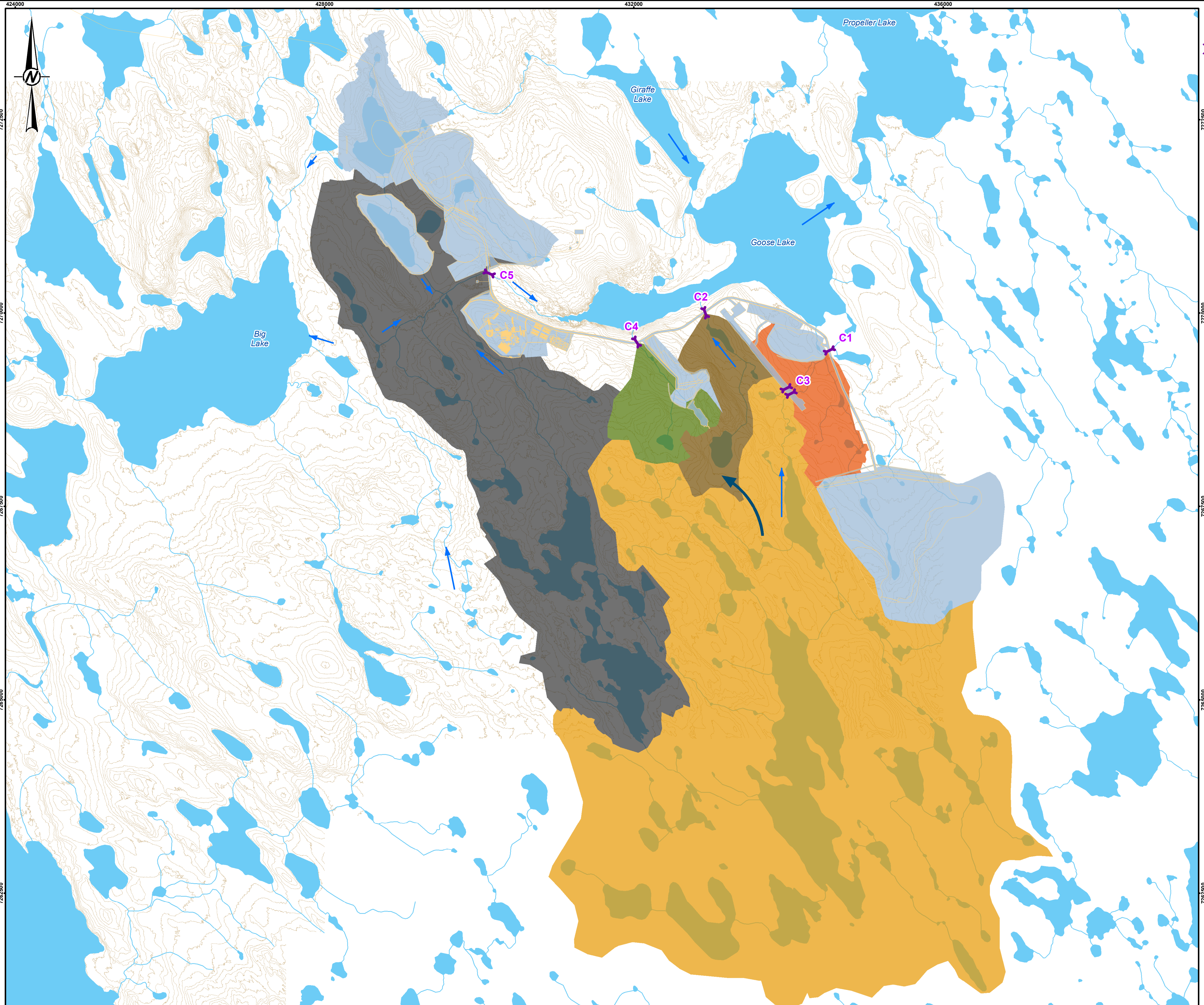
Sabina's response includes flow characteristics reportedly extracted from Appendix F-1 of the WMP which reviewers were unable to locate. We request that this reference be located and a copy provided for review.

Sabina Supplemental Response:

1. Sabina stated that an amended Figure A-01 of the Water Management Plan (171005 2AM-BRP----SD05-WaterMgmtPlan_IMLE) to show watershed areas draining to proposed culverts would be provided prior to the Technical Meeting. For clarity purposes, Sabina elected to not update Figure A-01, but instead provide an entirely new figure with the requested information; please see the attached Figure A-34). This figure will be included in the next revision of the Water Management Plan.

Supplemental Attachment:

Figure A-34. Goose Property Culverts Catchments



LEGEND

- CONTOUR (2 m)
- CULVERT
- FLOW DIRECTION
- SITE INFRASTRUCTURE
- WATERCOURSE
- C1 - CULVERT C1 CATCHMENT (SEE NOTE 1 AND 2)
- C2 - CULVERT C2 CATCHMENT (SEE NOTE 2)
- C3 - CULVERT C3 CATCHMENT (SEE NOTE 2)
- C4 - CULVERT C4 CATCHMENT
- C5 - CULVERT C5 CATCHMENT
- PROJECT INFRASTRUCTURE AREA
- WATERBODY
- WATERSHED SPILL

0 1,000 2,000

1:50,000 METRES

NOTE(S)

1. TOTAL CATCHMENT TO CULVERT C1 IS EQUAL TO C1 + C3
2. WATERSHED SPILL ACCOUNTED IN THE DESIGN OF CULVERT C2, C3 AND C1.

REFERENCE(S)

FOOTPRINT OBTAINED FROM CLIENT. HYDROGRAPHY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
PROJECTION: UTM ZONE 13N DATUM: NAD 83

YYYY-MM-DD	2018-04-24
DESIGNED	PC
PREPARED	SK
REVIEWED	PC
APPROVED	PC

CLIENT: Sabina GOLD & SILVER CORP.

CONSULTANT: GOLDER

PROJECT
SABINA BACK RIVER PROJECT, WATER LICENCE PHASE, NUNAVUT CANADA

TITLE
GOOSE PROPERTY CULVERTS CATCHMENTS

PROJECT NO.	FIGURE	REV.
1776921	A-34	0

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25mm 0

PATH: I:\2017\1776921\Mapping\MXD\Hydrology\Finalized\1776921_Culvert_Catchments_Rev0.mxd PRINTED ON: 2018-04-24 AT: 8:51:58 AM

Interested Party:	CIRNA	TC No.:	WT-INAC-TRC-7
Subject/Topic:	Saline Soil Management		

Reference to Type A:

- Water Management Plan
- Section 8.3.8: Saline Water Pond Closure

Detailed Review Comment:

A diffusion model has been used to predict pore water concentrations within the soil underlying the Saline Water Pond. It is unclear if this is the appropriate methodology for predicting pore water quality in sediment overlain by highly saline water (up to 30,000 mg/L Chloride).

Given the transient deposition of water within the Saline Water Pond and the density difference between the pond water and pore water the application of an advective model which considers density dependent transport may be more appropriate.

The outputs of an advective model would likely result in more appropriate but perhaps higher chloride concentrations than are currently being predicted by the diffusion model. This would have implications for current impact predictions and proposed mitigation measures.

Recommendation/Request:

1. INAC requests that the chloride diffusion model used by Sabina be provided as well as the rationale for its use and the underlying assumptions used.

2. INAC recommends that Sabina provide a robust justification for the use of a diffusion model rather than other alternatives to evaluate predicted chloride concentrations in pore water within the soil underlying the Saline Water Pond.

3. INAC requests that a sensitivity analysis be performed on downgradient TSF water quality for various soil quantities and saline concentrations for soil originating from the Saline Water Pond.

Sabina Response:

Sabina acknowledges CIRNA's technical comment and commits to providing additional information prior to the Technical Meeting and looks forward to additional discussion on this issue.

Attachment:

N/A

Supplemental Request:

INAC requests that Sabina provide the model sufficiently far in advance of the meeting in order to allow a full review.

Sabina Supplemental Response:

There are three components associated with chloride release and the Saline Water Pond (SWP). The first is associated with saline water replacing porewater in the soils underlying the SWP during Operations. The second component associated with chloride release is related to the sediment removal from the base of the SWP and placement of this removed sediment in Goose Main TF. The third method of chloride release is associated with porewater in the remaining sediments within the footprint of the decommissioned SWP; this third component is where the diffusion model was employed.

Sabina clarifies that a chloride diffusion model was not used to calculate the concentration of chloride in the porewater underlying the SWP. Due to density differences, it was assumed the ponded saline water would 100% displace the freshwater in the underlying pores at a chloride concentration equal to 14,000 mg/L, which is the average predicted concentration in the SWP; this 100% displacement assumption is very conservative.

The second method of chloride release is associated with the sediment removal from the base of the Saline Water Pond and placement in the Goose Main TF. Previous field characterization programs have confirmed that the basin of the SWP has a 7-m thick layer of overburden. Decommissioning of the pond will include the removal of the top 2 m of overburden from the SWP footprint and the relocation to the Goose Main TF. The chloride released from this sediment was not calculated using a diffusion model. The water and load balance model (171005 2AM-BRP----MAD App E-2_WaterLoadBalanceRpt-IMLE) assumes that 100% of the chloride loading within the removed sediment is released within the first year of placement in the Goose Main TF.

The third method of chloride release is associated with porewater in the remaining sediment within the footprint of the decommissioned SWP. After the containment dams have been breached, the original Umwelt Lake will reform, which will cover a portion of the remaining sediment in water. The diffusion model was performed in Hydrus™ software to calculate annual chloride mass released from the sediments below the newly reclaimed Umwelt Lake. Based on this diffusion model, 50% of the total chloride mass in the Umwelt Lake footprint is released in the first year, followed by 10% in the second year, and eventually 1% by Year 20 (Post-Closure Phase). The sediment in the area outside of the reclaimed Umwelt Lake but within the footprint of the decommissioned SWP was assumed to release 100% of all chloride within the first year, without a diffusion model.

A diffusion-based model was selected due to density differences between the saline water in the pores and the freshwater ponding above the sediment, which would keep the saline water from flowing upwards by advection. Other mechanisms, including wind and thermal mixing, could result in a faster release of chloride. A sensitivity analysis was also performed through the water and load balance model to test the effect at PN04 of releasing 100% of the total chloride mass (863,000 kg) into the reclaimed pond in the first year post-excavation of the SWP.

Mitigation measures to reduce the risk of chloride concentration exceedances during the initial flushing of the SWP soils could include removing more sediment from the pond footprint; mitigation measures were included in Sabina Technical Comment Response, WT-ECCC-TC-2. Sabina will consider monitoring that could be implemented during Operations and during decommissioning to characterize the chloride concentrations through the sediment column to target the excavation depth for sediment removal from the SWP basin and subsequent placement in the Goose Main TF.

Supplemental Attachment:

N/A

The BACK RIVER PROJECT

Technical Comment Responses

Environment and Climate Change Canada

Interested Party:	ECCC	**TC No.:**	**WT-ECCC-TC-3**
Subject/Topic:	Nitrite		

Reference to Type A:

- MAD Appendix F7 Technical Review of Water, Waste Rock, and Tailings Management/Design
- MAD Appendix E-2 Water and Load Balance
- Julio A. Camargo and Álvaro Alonso. 2006. Ecological and toxicological effects of inorganic nitrogen pollution in aquatic ecosystems: A global assessment. Environment International 32: 831–849

Detailed Review Comment:

ECCC has concerns with the predicted exceedances of nitrite Canadian Council of the Ministers of the Environment (CCME) guidelines in surface waters, including in Goose Lake. Figure A2-2 in the Main Application Document (MAD) Appendix F7 illustrates CCME guideline exceedances for nitrite, most notably at PN-06 (up to 0.4 mg/L, previously predicted to be 0.36 mgN/L) and to a lesser degree at PN-03 (previously 0.18 mgN/L) and PN-09 (previously 0.11 mgN/L). The text on Page 7 states that there is an additional nitrite CCME guideline exceedance at PN04, but this is not reflected on the graph. Also, the CCME Short-term guideline for Nitrite is shown as 0.08 mg/L, rather than 0.06 mg/L NO3-N. Furthermore, Table 7-8 MAD Appendix E-2 shows maximum NO2-N of 0.31 mg/L in Goose Lake, while the updated predictions in Appendix A of the MAD App F-7 shows it at 0.32 mg/L maximum. In either case, the whole lake average nitrite concentration in Goose Lake is predicted to reach maximums, which are in the range of acute toxicity to salmonid fry documented in the literature (Carmago & Alonso, 2006).

Sources of nitrite entering surface waters are explained as follows in Section 7.4 of Appendix E-2: "*…the rise in nitrite concentrations is associated with ANFO residual from roads and pads. The first spike in 2017 (Year -2) are from the initial construction of the roads. The spike in 2028 (Year 10) is from the Echo WRSA pond draining to PN09 and the final spike in 2036 (Year 18) is from the Goose Main TF overflow to PN06.*"

The primary source of the nitrite loadings is the use of explosives. Section 9.8 of the Water Management Plan has an ammonia management plan, which describes handling and storage of blasting products. While the elevated chloride levels will be a toxicity-modifying factor and reduce nitrite toxicity to some degree, it is important that source loadings be reduced to levels, which will not be deleterious to fish-bearing aquatic ecosystems.

In addition, Appendix C of MAD Appendix E-2 shows 0.000 as the nitrite input value for the stockpile and unfrozen waste rock pile (as well as pit walls, tailings and industrial pads), which contradicts Section 4.2.7 of the Water and Load Balance which states loadings were included. If those sources have not been accounted for, the model would substantially underestimate nitrite. ECCC also notes that the model inputs for nitrite for treated camp sewage were erroneously based on effluent concentrations of 30 mgN/L (Table 4-6 MAD Appendix E-2) rather than the actual treatment target of 0.5 mgN/L, which may overstate predicted nitrite concentrations. Review and revision of the model inputs and an update of the nitrite model is recommended.

Recommendation/Request:

ECCC recommends that the Proponent

- Update the Water and Load Balance model with the revised nitrite numbers for camp wastewater contributions and
- Confirm model inputs for nitrite sources.

Sabina Response:

Sabina is currently in the process of updating the Water and Load Balance Model as described in WTKIA-NWB-03. This update includes revisions to the nitrite input value as outlined in the Type A Water Licence Information Request response, ECCC-IR-6. Sabina will provide the results of the Water and Load Balance Model update prior to the Technical Meeting.

Sabina can confirm, as stated in the response to ECCC-IR-6, the following concentrations for nitrogen species in the sewage treatment plant effluent will be used in the updated Water and Load Balance Model:

- Nitrate – 22 mg-N/L
- Nitrite – 0.5 mg-N/L
- Ammonia – 8 mg-N/L
- Total Kjeldahl Nitrogen – 12 mg-N/L

Attachment:

N/A

Supplemental Request:

N/A

Sabina Supplemental Response:

Sabina stated that the results of the Water and Load Balance Model update would be provided prior to the Technical Meeting. Sabina directs the reviewer to Appendix A Technical Memorandum for the Load Balance Update in Support of the Type A Water Licence.

As documented in the technical memorandum prepared by Golder (Appendix A), updated nitrite predictions were compared to the CCME Water Quality Guidelines (WQG) of 0.06 mg/L. This is a fixed CCME guideline and is not dependent on any toxicity modifying factors. Nitrite concentrations during Closure (Year 10 to Year 18) were predicted to be below the CCME WQG of 0.06 mg/L.

Supplemental Attachment:

N/A

Interested Party:	ECCC	**TC No.:**	**WT-ECCC-TC-4**
Subject/Topic:	Arsenic		

Reference to Type A:

- MAD Appendix F7 Technical Review of Water, Waste Rock, and Tailings Management/Design
- MAD Appendix E-1 SSWQO Arsenic

Detailed Review Comment:

MAD Appendix E-1 Site-Specific Water Quality Objective (SSWQO) Arsenic, page 1, states:

> *"During the final NIRB hearing in June 2017, Sabina confirmed the intent to use an arsenic SSWQO value of 0.01 mg/L for the Project (NIRB 2017), which is well below the calculated 0.025 mg/L SSWQO."*

Revised modelling work has resulted in higher arsenic levels being predicted for several waterbodies. For example, in Figure A2-3 of MAD Appendix F7, arsenic at PN06 (0.023 mg/L in Year 17) is substantially higher than the 0.010 mg/L committed to by the Proponent, although it remains below the SSWQO of 0.025 mg/L. Other exceedances are predicted for PN04 (0.11 mg/L), PN10 (0.022 mg/L maximum, 0.016 mg/L long-term, and 0.018 mg/L maximum at closure) and Goose Lake (0.015 mg/L maximum).

Recommendation/Request:

ECCC recommends that the Proponent clarify the likelihood that the stated arsenic objective of 0.010 mg/L will be maintained and whether additional contingency mitigation measures are being considered.

Sabina Response:

An arsenic site-specific water quality objective (SSWQO) of 0.01 mg/L was proposed for Goose Lake as part of the Final Environmental Impact Statement (FEIS) for the Project as confirmed at the final NIRB hearing in June 2017 by Sabina. In response to information requests and technical comments on the SSWQO proposed as part of the FEIS, a revised SSWQO was subsequently derived using standard methods as required for submission with the Type A Water Licence Application for the Project (171005 2AM-BRP----MAD App E-1_SSWQOArsenic-IMLE). The revised SSWQO also considered relevant toxicity information and data available up to 2017.

The revised SSWQO for arsenic was developed in general accordance with standard methods provided for the development of a long-term guideline for freshwater environments by the Canadian Council of Ministers of the Environment (CCME) in the guidance document "*A Protocol for the Derivation of Water Quality Guidelines for the Protection of Aquatic Life 2007*" (CCME 2007). Consistent with this guidance and in consideration of the available toxicity data, the revised SSWQO was statistically derived using a species sensitivity distribution (SSD) of the available and acceptable toxicity data. A review of the data confirmed that the minimum data requirements of this approach had been met. In total, chronic toxicity data for 27 aquatic species were included in the long-term SSD that supported the derivation of a SSWQO of 25 µg/L.

As stated in Technical Comment response WT-KIA-NWB-3, Sabina is currently updating the water and load balance and will provide additional clarification on the likelihood that the stated arsenic SSWQO of 0.01 mg/L will be maintained and whether contingency mitigation measures should be considered prior to or at the Technical Meeting.

References:

CCME. 2007. A protocol for the derivation of water quality guidelines for the protection of aquatic life 2007. In: Canadian environmental quality guidelines, 1999, Canadian Council of Ministers of the Environment, 1999, Winnipeg.

Attachment:

N/A

Supplemental Request:

N/A

Sabina Supplemental Response:

Sabina stated that additional clarification on the likelihood that the stated arsenic SSWQO of 0.010 mg/L will be maintained, and that Sabina would comment on whether contingency mitigation measures should be considered.

In the updated water and load balance model, total and dissolved arsenic concentrations predicted at several receiving environment assessment nodes are above the arsenic SSWQO of 0.010 mg/L; this is discussed in the technical memorandum provided by Golder (Appendix A). Sabina has committed to meet this SSWQO for the Back River Project. Sabina highlights that additional analysis completed during the FEIS Addendum indicated that concentrations below 0.025 mg/L are considered to be conservatively protective of aquatic life in the receiving environment. Nevertheless, Sabina will consider additional contingency mitigation measures to meet the SSWQO of 0.010 mg/L, if needed.

Supplemental Attachment:

N/A

Interested Party:	ECCC	**TC No.:**	**WT-ECCC-TC-5**
Subject/Topic:	Dissolved versus Total Fractions of Metals		

Reference to Type A:

- MAD Appendix F7 Technical Review of Water, Waste Rock, and Tailings Management/Design
- MAD Appendix E-2 Water and Load Balance
- SDO5 Water Management Plan

Detailed Review Comment:

As noted in KIA-IR-12, comparisons are made of modeled dissolved metals to guidelines for total metals and this is not necessarily a valid comparison. The justification for doing this is based on model source terms being derived using data for dissolved metals and the assumption that there will be a negligible particulate component.

In Section 6.3 Page 8 of the MAD Appendix F7, the statement is made that "*Golder does not consider it necessary to provide total metal concentrations as there is limited potential for concentrations to exceed available guidelines as the constituent concentrations in process water are not expected to exceed guidelines.*" This circular argument does not address concerns with comparing dissolved fractions of parameters to guidelines for the total metals. Dissolved metals do not account for any metals associated with particulate matter and may underestimate metal concentrations (to the detriment of the environment).

The Proponent has indicated in their response to KIA-IR-12 that this approach will be re-evaluated in the context of information collected since the submission of the Type A Water Licence Application, specifically for new tailings geochemical test results. The commitment is made in this response that water quality predictions will be updated to include dissolved and particulate fractions. Further commitments were made in Section 6.1.5 of the Water Management Plan to modelling of total metal concentrations as may be required, to establish appropriate discharge criteria and to predict downstream compliance.

ECCC concurs with updating predictions to include the total metals concentrations and requests details on the approach that will be used to estimate total metals for the source terms/model inputs.

Recommendation/Request:

ECCC recommends that the Proponent provide details on the approach that will be used to derive total concentrations.

Sabina Response:

Sabina confirms that the Water and Load Balance Model is currently being updated to meet Sabina's commitments for the FEIS and FEIS Addendum Project Certificate (170601-12MN036-FHA EX 45-Recommended PC Terms and Conditions Committments-IA2E), item INAC-C-1. The objective of this update is to evaluate the effect of total suspended solids (TSS) of an assumed composition on the total parameter concentrations in mine discharges during Operations, Closure, and Post-Closure. Total loads will be calculated for all mine facilities (pads, roads, waste rock storage area, tailings management facilities).

Total metal concentrations for Project discharges will be estimated by adding a calculated particulate fraction to the existing model predictions of dissolved concentrations. Particulate fractions for the relevant parameters were developed as follows:

- The relative proportions of each waste rock lithology produced at each pit are calculated based on the total tonnage of waste volume presented in Table 2-2 of the Geochemical Characterization Report (171005 2AM-BRP----MAD App E-3_GeochemCharactRpt-IMLE). Lower greywacke (LGW) and deep iron formation (DIF) proportions are combined to reflect the distribution of samples as summarized in Table 5-1 of the Geochemical Characterization Report.
- The available results of solid phase geochemical analysis of each rock type at each deposit was reviewed. The input for modeled constituents was defined using the average of samples collected for each rock type at each deposit, as presented in Appendix E2 of the Geochemical Characterization Report. In the absence of data for a specific lithology at a given deposit, the overall average, calculated based on all samples of that rock type collected at the Goose Property, was used to define its elemental composition.
- Using the solid phase geochemistry data and the relative proportions of each rock-type, the weighted average was calculated to define the chemical composition of the TSS associated with waste rock produced by each pit. For pads and roads, the weighted average was calculated using the relative proportion of each rock type for the entire Goose Property and the overall average composition for each rock type based on all samples of that rock type collected at the Goose Property. Tailings were defined by using the average of the solid phase geochemistry results for the composite samples used to develop the tailings source terms, specifically samples KM4030-147 TAILS, BR-TAIL-02, and BR-TAIL-03 as described in the Geochemical Characterization Report.
- The product of the weighted average (expressed as µg/g) and the TSS concentration discharge limit, set to 15 mg/L (per the Metal Mining Effluent Regulations, 2013), defined the concentration of each modeled constituent associated to the TSS load. The TSS load was then added to the dissolved fraction load to estimate metal concentrations for the fraction.

Sabina will provide the results of the Water and Load Balance Model update prior to the Technical Meeting.

Attachment:

N/A

Supplemental Request:

N/A

Sabina Supplemental Response:

Sabina stated that the results of the Water and Load Balance Model update would be provided prior to the Technical Meeting. Sabina directs the reviewer to Appendix A Technical Memorandum for the Load Balance Update in Support of the Type A Water Licence.

Supplemental Attachment:

N/A

Interested Party:	ECCC	TC No.:	WT-ECCC-TC-9
Subject/Topic:	Aquatics Effects Management Plan		

Reference to Type A:

- SD21 Aquatic Effects Management Plan (AEMP)
- Type A Water Licence Response to Information Requests – Feb. 5, 2018, ECCC-IR8 to ECCC-IR24 (inclusive)

Detailed Review Comment:

ECCC provided technical review comments on the AEMP in the conformity review submitted to the Nunavut Water Board January 22, 2018. The Proponent provided their responses in the Type A Water Licence Response to Information Requests document submitted to the Nunavut Water Board on February 5, 2018, but many of the comments raised are still outstanding. The Proponent has initiated meetings with ECCC to discuss and resolve concerns related to the AEMP and develop a path forward for the AEMP. Meeting minutes from these meetings have been uploaded to the NWB registry. Work is underway by the Proponent to assess data collected in 2017, to identify data gaps and any limitations for the study design and to address questions raised by reviewers. ECCC anticipates that technical meetings with the Proponent in advance of the NWB Technical Meetings (scheduled May 1-3, 2018) will be constructive in resolving or tabling concerns prior to public hearings.

Recommendation/Request:

ECCC recommends continued development of the Aquatics Effects Management Plan by the Proponent so that questions and concerns can be addressed in preparation for the Nunavut Water Board Technical Meetings.

Sabina Response:

Sabina acknowledges ECCC's recommendation and anticipates further conversation related to the Aquatic Effects Management Plan (171005 2AM-BRP----SD21-AEMP-IMLE) with ECCC prior to the Technical Meeting. Sabina confirms that the meeting minutes from the meeting referred to by ECCC were submitted to the NWB on April 7, 2018 for upload to the Nunavut Water Board Public Registry.

Attachment:

N/A

Supplemental Request:

N/A

Sabina Supplemental Response:

Sabina met with ECCC on April 20, 2018 to address ECCC's remaining comments and concerns related to the Aquatic Effects Monitoring Program (AEMP). A summary of the AEMP discussions undertaken to date are provided in the attachment below, along with a compilation of agreed changes to the AEMP which will be incorporated on next revision which is anticipated to be post issuance of a Water Licence. This attachment has been reviewed by ECCC, who has confirmed satisfaction with both the discussion summary and the AEMP changes. Sabina thanks ECCC for their input into the development of the AEMP and is pleased that, for the purposes of the Water Licensing process, ECCC is now satisfied with the AEMP Program. Sabina looks forward to future discussions with ECCC of this program following the collection and compilation of the 2018 baseline data.

Supplemental Attachment:

Table 1. AEMP Discussions and Agreed Changes

Revisions to be incorporated into next AEMP
Correct the description of the trigger for EEM (ECCC-IR-8)
More description of site water management and in particular effluent discharge from water and load balance (to be provided in First Study Design) (ECCC-IR-10). Indicate that the methodology for the plume delineation study will be discussed further with ECCC to ensure the MMER requirements are met in the First Study Design.
Clarification that that water quality, sediment quality, and benthic invertebrate samples will be collected from specific stations, while fish samples will be collected from broader areas.
Editorial updates to Tables 4.3-2 and 4.3-3 for consistency in lake trout sampling area (ECCC-IR-14)
Include water quality analytical detection limit table - see response to ECCC-IR-15
Update Table 5.1-1 to include field turbidity, laboratory pH, total dissolved solids (measured and calculated), and fluoride (ECCC-IR-17)
Outline approach for development of water and sediment quality benchmarks as per response to ECCC-IR-18.
Addition of Total Phosphorus in Sediment quality analyses (ECCC-IR-19)
Identify that sediment sampling be specific to top 1-2 cm of sediment (ECCC-IR-19)
Specify particle size methodology - see response to ECCC-IR-19; in 2017 the method used was Pipette removal OM & CO3 (Burt 2009). Historical data files do not have the laboratory certificate of analysis so unable to confirm historical method at this time. However, historical samples were analyzed at ALS and can be confirmed.
Indicate that subsample benthos variability will be characterized in one of the five replicate samples (each consisting of 3 sub-samples) per sampling area lake by not physically pooling the sub-samples for that replicate (ECCC-IR-21)
Align sampling frequency at BR-33 with that at BR-31; periodically review monitoring data and evaluate whether the frequency of water quality sampling is appropriate.
If slimy sculpin habitat is available at BR-33, relocate slimy sculpin tissue sampling effort from one of the locations in Propeller Lake to BR-33
Unless otherwise triggered under the MMER or a fish-tissue related effect is observed, reduce frequency of slimy sculpin sampling to once every 6 years to minimize impacts of this sampling
Include details of benthic invertebrate statistical tests described in response to ECCC-IR-22
Include details of statistical tests, as described in response to ECCC IR 18
Sabina will update the QA/QC Plan (171005 2AM-BRP----SD24-QAQCPlan-IMLE) to include a discussion on data quality objectives (e.g., steps to review and validate data from duplicates, blanks, and samples) (ECCC-IR-27)
Indicate that biological sampling (including fish) will commence a year after the initiation of discharge (i.e., year one of the First Biological Monitoring Study) if in alignment with MMER requirements, to harmonize MMER requirements with KIA request

Greyed cells are summaries of discussions which occurred post submission of IR responses

IR No	Reference to Type A	Detailed Review Comment	Recommendation/Request	Sabina Response	Updated Attachment	ECCC Response to Sabina Response (Mar 26th 2018)	Sabina Follow-up Response (Apr 19th 2018)	Further discussion ECCC/Sabina (Apr 20th 2018)	Conclusion
ECCC-IR-9	AEMP Section 4.1	The description of the trigger for Environmental Effects Monitoring (EEM) requirements should read "and" not "and/or" as stated in the first section. See Section 2(1) of the Metal Mining Effluent Regulations (MMER): 2 (1) These Regulations apply in respect of mines and recognized closed mines that (a) at any time after June 6, 2002, exceed an effluent flow rate of 50 m3 per day, based on effluent deposited from all the final discharge points of the mine; and (b) deposit a deleterious substance in any water or place referred to in subsection 36(3) of the Act.	ECCC recommends that the Proponent correct the description of the trigger for EEM.	Sabina will update the description of the trigger for EEM in the next iteration of the AEMP. Sabina is committed to working in conjunction with the ECCC, and KIA prior to the technical meeting associated with the NWB Type A Water Licence review process to revise the AEMP and set an appropriate timeline for revision.		OK			Resolved. See addition to AEMP Revision Tracker
ECCC-IR-10	AEMP Section 4.3.1	The Proponent should provide more detail on the effluent discharge (description of how the effluent will mix in exposure area, estimated effluent concentration in near-, mid- and far-field areas) to support the selection of exposure sampling areas. There was very little site characterization information for the sampling areas. The report indicates that reference and exposure areas are similar, however supporting information should be provided or referenced.	recommends that the Proponent provide details on effluent discharge and site characterization information.	Effluent (site water collected during the dewatering of Llama and Umwelt lakes) will be released to Goose Lake during the Construction Phase. Umwelt Lake will be fully dewatered during Year-3. Llama Lake will be partially dewatered during Year-3, used as a contact water pond in Year-3 to Year-1, and then fully dewatered in Year-1 (Main Application Document, Section 5.3.4.2; 171002 2AM-BRP----MainApplicationDocument_IMLE). Dewatering discharge will occur during the open season only and water will be treated for TSS and arsenic (Water Management Plan; Section 7.4.2; 171002 2AM-BRP----SD05-WaterMgmtPlan_IMLE). Details of the effluent pipeline are provided in the Water Management Plan (Appendix A, Figure A-19). After Year-1, all site water will be contained and recirculated (Main Application Document; Section 5.3.4.3; 171002 2AM-BRP----MainApplicationDocument_IMLE). There will be no discharge to Goose Lake through the effluent discharge pipe after Year-1. The water and load balance model evaluated water demands and predicted water quality for the Project, and the water quality predictions were evaluated assuming completely mixed systems. The selection of the near-field exposure study area is appropriate as it is based on the location of the discharge pipe, the quantity and quality of effluent to be released during the Construction Phase, and the predicted mixing of effluent in Goose Lake. Supplemental baseline data were collected in 2017 to specifically select reference stations that are similar to the exposure stations (i.e., similar water depths and habitat types). A factual report on the 2017 data is being prepared and will be provided prior to the technical review stage.		This information was requested to help evaluate the selected exposure area monitoring location. Plume behaviour has not been predicted, and I didn't see information on the diffuser's expected mixing zone. In response to ECCC-IR-23 Sabina states the plume delineation will be done before the first EEM study design, but this would be after exposure sites needed to be confirmed. There was very little information provided on characteristics of the sampling areas to indicate reference and exposure would be similar, but some of this may be in the 2017 report which has not been fully reviewed yet.	Golder is currently updating aspects of the water quality modelling and load balance. A fish population study will be a component of the AEMP regardless of whether the MMER trigger for one is met. The baseline report to be drafted following the 2018 sampling will include more detailed information regarding the exposure and reference areas and their compatibility.	Discussion of the Plume methodology needs and options.	No further action needed prior to the NWB WL hearing. The methodology for the plume delineation study will be discussed further with ECCC to ensure the MMER requirements are met in the First Study Design.
ECCC-IR-11	AEMP Section 4.3 Study Design Overview	The statistical study design is proposed to be a Before-After-Control-Impact (BACI) for water quality, sediment quality, and Benthic Invertebrate Community monitoring and Control-Impact (CI) for fish. The BACI model works best when timing of sampling is the same in the before and after periods (e.g. see Smith, E.P., D.R. Orvos, and J. Cairns, Jr. 1993. Impact Assessment Using the Before-After-Control-Impact model: Concerns and Comments. CJFAS 50: 627 – 637.) as unbalancing of the data may cause variances to be larger in the period where sample collection is more comprehensive and can affect detection of differences. It is important to have the "after" as similar to the "before" sampling as possible. Baseline data: There was a commitment by Sabina to collect additional freshet and fall water quality data prior to construction (KIA-C-8): *The Proponent commits to collect additional baseline water quality data from the lakes in the project area during freshet and fall as confirmed by measurements of higher flow prior to construction. The Proponent commits to use this data to update the water and load balance model.* ECCC had previously recommended that the revised AEMP should include details of how the baseline dataset is to be added to prior to construction and identify any gaps. For example, there has been inconsistent sampling of the same sites over the years (subsets of the lakes and streams have been done in various years). There are only 3 years of April data (2011 – 2013), and zooplankton was only monitored in 2011 and 2012 in Giraffe, Goose, and Propeller Lakes. Where baseline data is not robust enough to support the BACI analyses, further monitoring may be warranted.	ECCC recommends that the Proponent ▫ Identify additional monitoring which has been done to improve the gaps in the baseline dataset for water quality, sediment quality, benthic invertebrate community and fish, and ▫ Provide a discussion of the suitability of the available pre-development data to support the monitoring study design for water quality, sediment quality, benthic invertebrate community and fish.	Additional data for water quality, sediment quality, and benthic invertebrate community were collected in 2017 from Goose Lake, the Reference Lake, and some tributaries in the Goose area. These data are in the process of being reviewed and will be provided prior to the technical review phase. No additional monitoring has been completed for fish. A discussion on the suitability of all pre-development data can be provided once all data have been collated and reviewed.		ECCC agreed with the response that there could be a discussion on the suitability of all pre-development data once all data have been collated and reviewed.			resolved. Further discussion planned post 2018 baseline data collection and collation.
ECCC-IR-12	AEMP Section 4.3.2 Sampling Structure	The AEMP states that Slimy Sculpin will be collected from four areas: the near-field exposure area (Goose Lake), two far-field exposure areas (both in Propeller Lake), and a reference area (Reference Lake B). Rationale for the selection of these sampling sites is not provided. Because sculpin are not a migratory species, it would be more useful to have sampling focused closer to the effluent discharge and other mine sources of runoff/aerial deposition. ECCC believes that sampling only at BRP-31 in Goose Lake would not necessarily pick up effects from mining activities at the Goose Pit site, which is adjacent to BRP-33. It is not clear why only one nearfield station has been proposed. Additional near-field stations, including sampling at BRP-33, would improve detection of effects from mining activities.	ECCC recommends that the Proponent clarify rationale for proposed sculpin sampling locations and ensure that there are enough near-field sampling stations capable of measuring effects from mining activities at the Goose Pit site.	A single nearfield site for small-bodied fish (i.e., Slimy Sculpin) is anticipated to be sufficient to monitor for potential impacts within Goose Lake. This approach is consistent with MMER EEM technical guidance that states at least one near-field station should be as near as possible to the effluent discharge point. As such, near-field sampling is planned to occur at BRP-31, immediately downstream of the effluent diffuser. The two far-field stations in Propeller Lake are intended monitor the spatial extent of potential impacts. A single near-field area is in alignment with the quantity and quality of discharge.		Sabina proposes in this slide to look at sampling sculpin near BRP-33 when the mine moves into closure. ECCC recommends fish sampling be done at this site prior to construction, as well as on the recommended reduces frequency, which can be discussed further with respect to a start time which lines up with MMER EEM timing.	We are currently reviewing baseline information to confirm sculpin habitat in Goose and Propeller Lakes. Additional comment will be provided following that review but prior to the technical meeting. Sabina would like to confirm with ECCC that EEM-related biological sampling could occur in year one of the 3 year cycle. This would be to accommodate a request by the KIA that sampling occur as close to the discharge period as possible (KIA-TC-7).		Prior to the Technical Meeting, Sabina will confirm whether slimy sculpin habitat has been evaluated near BR-33 to date. ECCC confirmed that it is possible that EEM fish sampling may commence a year after the initiation of discharge (i.e. year one of the First Biological Monitoring Study) to harmonize EEM requirements with KIA request (see AEMP Revisions Tracker) however, the timing would be subject to conditions outlined in the MMER.
ECCC-IR-13	AEMP Section 4.3.3 Sampling Frequency	This section states that the water quality monitoring schedule could be reduced in the near-field and reference areas to just open-water, only during periods of time where there is no direct discharge to surface water (i.e., Operations to Closure phases). ECCC believes that April sampling should be done on an ongoing basis for the purpose of maintaining a balanced dataset for BACI analysis. Even if there is no discharge, ongoing monitoring of conditions will be important to track changes that could be attributed to site activities (such as surface disturbances, air emissions) or natural variability (reference lake).	ECCC recommends that sampling be consistent across seasons to track changes and to support a balanced data set.	The current AEMP was designed with consideration of Construction (dewatering discharge only) and early Operations (no effluent discharge to the receiving environment). Sabina has proposed in the AEMP that program frequency and sampling areas be re-adjusted after the Construction Phase (i.e., during the phase where there is no discharge to Goose Lake) based on observed water quality trends. At that time, Sabina will reconsider continuing the under-ice portion of the program. Sabina highlights that study design for water quality sampling in lakes considers the requirements of MMER, is aligned with other components when possible, and is consistent with other monitoring programs in Nunavut and Northwest Territories; it is also reflective of the discharge schedule for the Project and the sampling effort provides appropriate statistical power.		Does not address concern with changing (reducing) sampling frequency in operations but acknowledges MMER-EEM sampling.	The AEMP was initially designed around the framework of the EEM recognizing the requirement to collect samples four times per year during discharge. When discharge is not occurring, collection of samples at specific locations (e.g., effluent, exposure area) may not be required. The same consideration was applied to water quality monitoring frequency in other areas (e.g., in Goose Lake near the Goose Main Pit). There will be no point source discharge to Goose Lake during late Construction and through to Post-Closure and the only influences to surface water quality in Goose Lake will be from indirect sources (e.g., deposition of dust). At this time in the mine life cycle it may be appropriate to reduce sampling frequency. A change in study design to a reduced monitoring frequency would take into account observed water quality in Goose Lake up to that point, current site activities, and site activities planned for the near-future. If trends in water quality suggest that there is an effect of the on the receiving environment, a reduction in monitoring frequency would not be made	ECCC stressed that reduction in monitoring frequency at locations nearest the Project should only be done when confident that there are no non-point source effects observed. Sabina agreed	Resolved
ECCC-IR-14	AEMP Table 4.3-3 Overview of the Aquatic Effects Management Plan Sampling Design by Component and Season	1. The lake trout non-lethal survey is to be done in July, and will be conducted away from the near-field exposure area. Table 4.3-3 shows trout being sampled at BRP-32, while Table 4.3-2 shows at BRP-31 – the location should be clarified. As the exposure area should be selected to ensure that the fish collected have been exposed to the effluent, sampling should be done as close to the effluent discharge point as is practical (i.e. BRP-31). Water sampling is not proposed to be done in conjunction with this sampling, and should be. 2. Each lake sampling area has 5 stations, and the number of samples per station is shown as 1 for benthic invertebrate samples. Section 5.3.3 states that three sub-samples will be collected and composited.	ECCC recommends that the Proponent clarify the trout sampling location and identify supporting water quality sampling. ECCC recommends benthic invertebrate sampling be consistent with guidance provided for the MMER-EEM program; three field subsamples should be collected and analyzed separately.	Due to the relatively large home range of Lake Trout (i.e., Lake Trout are anticipated to move freely throughout Goose Lake), non-lethal sampling is anticipated to occur throughout Goose Lake, while focusing effort in suitable habitat as close to the effluent diffuser as reasonable. As a consequence, the specificity of the BRP-31 and BRP-32 locations for fish sampling may be misleading, as sampling is anticipated to cover a broader spatial area to achieve target sample sizes. Tables 4.3-2 and 4.3-3 in the AEMP will updated in the next iteration of the AEMP design plan to highlight that water quality, sediment quality, and benthic invertebrate samples will be collected from specific stations, while fish samples will be collected from areas near the BRP-31 and BRP-32 locations. Water sampling has been proposed biannually in April and August at BRP-32 and BRP-33, as well as four times per year at BRP-31. Sabina confirms that at least one of those four sampling periods is anticipated to coincide with the July fish sampling program. MMER/ EEM Technical Guidance (ECCC 2012) for metal mines indicates that for the purposes of statistical analysis, each replicate station consists of a number of pooled field sub-samples. Section 4.3.3 in the 2012 guidance document discussed pooling of field sub-samples and indicates that "The pooling of field sub-sample data can occur at several points in the monitoring program. The point at which pooling occurs will depend on several factors". The guidance goes on to note that "once this physical pooling is done, the potential information from individual sub-samples is lost. In regards to factor 3, if there is a need for additional information to address study design issues (e.g., to examine species area curves or field sub-sampling precision), field sub-samples may be preserved and processed separately. The resulting unpooled data are then available to address the study design issues and can subsequently be pooled electronically for the appropriate statistical analyses." In consideration of this guidance, Sabina decided to physically pool the sub-samples in the field. However, as suggested in the response to ECCC-IR 21, Sabina could document variability in one replicate per sampling area by not physically pooling the sub-samples for that replicate. *Reference:* *ECCC (Environment and Climate Change Canada) 2012. Metal Mining Technical Guidance for Environmental Effects Monitoring. http://www.ec.gc.ca/esee-eem/AEC7C481-D66F-4B9B-BA08-A5DC960CDE5E/COM-1434---Tec-Guide-for-Metal-Mining-Env-Effects-Monitoring_En_02[1].pdf*					Resolved. See additions to AEMP Revision Tracker.

IR No	Reference to Type A	Detailed Review Comment	Recommendation/Request	Sabina Response	Updated Attachment	ECCC Response to Sabina Response (Mar 26th 2018)	Sabina Follow-up Response (Apr 19th 2018)	Further discussion ECCC/Sabina (Apr 20th 2018)	Conclusion
ECCC-IR-15	AEMP Section 5.1 Water Quality	The report notes that water quality samples will be analyzed at detection limits less than aquatic life and drinking water guidelines, and that detection limits will be specified once analytical laboratory is selected. ECCC believes the revised plan should include water quality analytical methods and detection limits, and ensure methods are sensitive enough to accurately measure contaminants of concern. ECCC notes that this was raised by the Kitikmeot Inuit Association (Technical Comment F-KIA-TC-22) and Proponent's response to that was to state their commitment to including analytical detection limits in the AEMP for the water licence.	ECCC recommends that the Proponent provide detection limits for sample analysis, and identify water quality analytical methods.	Sabina agrees and commits that the next iteration of the AEMP design plan will include detection limits for water quality sample laboratory analysis and identify water quality laboratory analytical methods. Sabina notes that during the 2017 field season, the analytical detection limits used can be found in Table ECCC-IR-15-1 (Attachment A.10). Note, this list will be updated with the next iteration of the AEMP design plan to reflect response to ECCC-IR-17. Sabina is committed to working in conjunction with the ECCC, and KIA prior to the technical meeting associated with the NWB Type A Water Licence review process to revise the AEMP and set an appropriate timeline for revision.	Attachment A.10 - Table ECCC-IR-15-1. Detection Limits and Analytical Methods used in the 2017 Field Program				Resolved. See addition to AEMP Revision Tracker.
ECCC-IR-16	AEMP Section 5.1.2 Study Design and Schedule	It is unclear to ECCC if the timing of the water quality sampling is sufficient to develop an appropriate "Normal range". Additional sampling should be conducted in each calendar quarter, with timing selected to characterize the range of natural variability to the fullest extent. Supporting baseline data should also be collected for these times. This will be supportive of the development of the "normal range" to be used in connection with the Response Framework.	ECCC recommends that the Proponent identify further sampling needed to define the "Normal range", and clarify timing of water quality sampling.	Natural variability and normal range will be defined by existing baseline data collected from Goose Lake, Propeller Lake, and the Reference Lake, as well as on-site data collected during the Construction Phase from Reference Lake. As per the AEMP (171002 2AM-BRP----SD21-AEMP-IMLE) proposed schedule, Reference Lake will be sampled four times per year during the 2018 baseline period and the Construction Phase of the Project. This iteration of the AEMP design plan applies to the Construction Phase and will be updated as necessary to accommodate future phases of the Project (i.e., Operations, Closure, and Post-Closure).		Sabina stated in Slide 14 of the AEMP Workshop Meeting that these would be compiled following completion of the 2018 baseline program and Sabina would consult with ECCC in early 2019. ECCC wanted confirmation that there was enough data to develop the "Normal Range"	It is anticipated that there will be sufficient data to calculate normal ranges but this will be confirmed once the baseline data set has been compiled and undergone analysis as part of the baseline reporting in 2018/2019.	ECCC will recommend to NWB that Sabina be required to provide a baseline report post completion of 2018 sampling	No further action needed prior to the NWB WL hearing. Sabina will prepare a baseline report in late 2018/early 2019
ECCC-IR-17	AEMP Table 5.1-1. Water Quality Parameters	Table 5.1-1 presents a list of water quality parameters that will be considered in the AEMP	ECCC recommends that the Proponent revise the parameter list and provide rationale for any omissions as follows 1. Field: Consider adding field turbidity for receiving environment samples, particularly for near-shore sites. 2. Conventional: Laboratory pH in addition to field measurements of receiving environment samples. Confirm whether Total Dissolved Solids (TDS) will be calculated or measured. 3. Major ions: add fluoride for effluent and receiving environment. 4. Nutrients: add Total Organic Carbon (TOC) to receiving environment analyses.	Sabina agrees with the recommendation. Field turbidity, laboratory pH, total dissolved solids (measured and calculated), and fluoride will be added to the water quality suite of constituents. Table 5.1-1 will be updated accordingly in the next iteration of the AEMP design plan.		OK			Resolved. See addition to AEMP Revision Tracker
ECCC-IR-18	AEMP Section 5.1.4 Data Analysis and Interpretation and Section 5.2.4 Data Analysis and Interpretation	This section states that benchmarks are to be developed for the project, and that statistical methods will be used to evaluate potential differences. The tests to be used should be identified.	ECCC recommends that the Proponent provide details of statistical tests to be used to evaluate potential differences.	Water quality and sediment quality benchmarks will be developed for the Project using the set of existing baseline data and standard guidelines (CCME 1999, 2001; Health Canada 2012). Sabina will continue to collect supplemental data in 2018 and potentially beyond. Benchmarks will be developed for water and sediment quality constituents by comparing the baseline data to the guidelines. Where baseline concentrations are less than the generic guidelines, the benchmark may be the guideline value or a percentile of the guideline value. Where baseline concentrations are greater than the generic guidelines, the benchmark will be reflective of background concentrations. Once the benchmarks are set, data collected during the active phase of the AEMP will be compared to the benchmark values. Data from the exposure areas will be compared to reference areas to determine if there are statistical differences between the data. *References:* *CCME. 1999. Canadian Environmental Quali+J64ty Guidelines. 1999, with updates to 2017. Winnipeg, MB, Canada.* *CCME. 2001. Canadian Sediment Quality Guidelines for the Protection of Aquatic Life 1999, with updates to 2017. Canadian Environmental Quality Guidelines, Winnipeg, MB, Canada.* *Health Canada. 2012. Summary of Guidelines for Canadian Drinking Water Quality (CDWQ) Prepared by the Federal-Provincial Subcommittee on Drinking Water of the Federal-Provincial-Territorial Committee on Environmental and Occupational Health.*		Approach outlined in response; should be included in future iteration of AEMP.	OK		Resolved. See addition to AEMP Revision Tracker.
ECCC-IR-19	AEMP Section 5.2 Sediment Quality	To meet the stated objective of evaluating the accuracy of the FEIS predictions and measuring the effects of Project activities on sediment quality, sampling for metals should be done for the surficial sediments, given the low deposition rates in the area lakes. Methods should be consistent with baseline data collection to the extent possible, and if necessary, further baseline samples may need to be collected which analyze the top 1-2 cm only. Combining deeper sediments will mask changes at the surface. In addition, total phosphorus should be monitored in sediments.	ECCC recommends sediment chemistry sample depth be revised to the top 1-2 cm. ECCC recommends that the Proponent identify which Particle Size Analysis method will be used, and confirm comparability of baseline data. ECCC recommends that the Proponent add total phosphorus to sediment chemistry analysis.	Sabina will further evaluate the collection of sediment samples via sediment coring methods that would be necessary to sub-sample the top 1-2 cm of lake sediments, with respect to feasibility and the comparability to baseline data previously collected for the Project. Sabina identifies that the particle size method to be used is Pipette removal OM & CO3 (Burt 2009). In further review, Sabina will confirm comparability with data previously collected for the Project. Sabina confirms that total phosphorus will be added to sediment chemistry in the next iteration of the AEMP. *Reference:* *Burt, R. 2009. Soil Survey Field and Laboratory Methods Manual. Soil Survey Investigations Report No. 5. Method 3.2.1.2.2. United States, Department of Agriculture, Natural Resources Conservation Service.*		OK			Resolved. See addition to AEMP Revision Tracker. Golder to see if a more appropriate commercially available method of sediment phosphate analysis is available.
ECCC-IR-20	AEMP Table 5.2-1 Sediment Quality Parameters	The methodology for Particle Size Analysis should be specified, and comparability of baseline data checked. Nutrients should include total phosphorus (TP), to evaluate potential for changes in TP that may be released to the overlying waters during periods of low dissolved oxygen.	ECCC recommends that the Proponent provide requested details on particle size analysis. ECCC recommends total phosphorus analysis for sediments be included in nutrient analysis.	Sabina identifies that the particle size method to be used is Pipette removal OM & CO3 (Burt 2009). In further review, Sabina will confirm comparability with data previously collected for the Project. Sabina confirms that total phosphorus will be added to the nutrient analysis of sediments in the next iteration of the AEMP. *Reference:* *Burt, R. 2009. Soil Survey Field and Laboratory Methods Manual. Soil Survey Investigations Report No. 5. Method 3.2.1.2.2. United States, Department of Agriculture, Natural Resources Conservation Service.*		OK			Resolved. See addition to AEMP Revision Tracker.
ECCC-IR-21	AEMP Section 5.3.2	This section states that each of the replicate sediment sampling stations will be sampled, with one composite sample taken at each station. ECCC notes that by keeping the sub-samples as discrete rather than compositing, a better understanding of the heterogeneity of the benthic invertebrate community can be gained.	ECCC recommends that the Proponent maintain field sub-samples as separate samples rather than compositing.	Compositing of benthic field sub-samples is practiced in many Northern Canadian mining operations, as stated in their respective AEMPs. By taking field-samples and then compositing them for each station, a wider spatial area is sampled that is more representative of spatial variability in the benthic community, as opposed to that captured in a single grab sample. In order to document and understand variability between sub-samples, the sub-samples from one station per sampling area could be processed separately and data presented for each individual sub-sample as well as for the combined station sample (i.e., composite).		OK	Sabina would like to propose that sub-sampling of one replicate sample in each lake would be sufficient to characterize the subsample variability given the small size of these lakes.	ECCC found this proposal acceptable	Resolved. See addition to AEMP Revision Tracker
ECCC-IR-22	AEMP Section 5.3.4	Benthic invertebrate statistical methods should be described in more detail.	ECCC recommends that the Proponent provide details of benthic invertebrate statistical tests to be used.	Benthic invertebrate endpoints will be evaluated using statistical (quantitative) and visual (qualitative) methods to evaluate potential differences in benthic community structure between areas. The approach to data analysis will be designed to address the key question(s) for benthic invertebrates and will be consistent with MMER technical guidance provided by ECCC (2012). The approach will consider both univariate and multivariate statistical analysis techniques. It is anticipated that univariate parametric tests, such as analysis of variance (ANOVA), will be used to evaluate potential differences between the near-field, mid-field, far-field, and reference areas, providing the data meets test assumptions. If these assumptions are not met, then an appropriate non-parametric tests will be considered. With respect to multivariate analysis, non-metric multidimensional scaling (NMDS) will be considered to further evaluate potential differences between the near-field, mid-field, far-field, and reference areas. Relationships between habitat variables and benthic invertebrate metrics will be evaluated using tools such as calculating Spearman rank correlation coefficients and examining scatter plots. Habitat variables that are significantly correlated with summary variables could be considered in the subsequent statistical analyses as potential covariates, where appropriate. *Reference:* *ECCC (Environment and Climate Change Canada). 2012. Metal Mining Technical Guidance for Environmental Effects Monitoring. http://www.ec.gc.ca/esee-eem/AEC7C481-D66F-4B9B-BA08-A5DC960CDE5E/COM-1434---Tec-Guide-for-Metal-Mining-Env-Effects-Monitoring_En_02[1].pdf*		OK			Resolved. See addition to AEMP Revision Tracker

IR No	Reference to Type A	Detailed Review Comment	Recommendation/Request	Sabina Response	Updated Attachment	ECCC Response to Sabina Response (Mar 26th 2018)	Sabina Follow-up Response (Apr 19th 2018)	Further discussion ECCC/Sabina (Apr 20th 2018)	Conclusion
ECCC-IR-23	AEMP Section 5.4.2 Fish	This section states that the proposed sample size for slimy sculpin is 20 males/females/juveniles. It is important to note that this is the minimum recommended by the EEM technical guidance. The proponent should conduct power analyses after each study to determine if n=20 provides sufficient power to detect differences in effect endpoints between exposure and reference areas (as stated in Section 5.4.4). The non-lethal survey for lake trout indicates a target sample size of 100 juvenile and adult fish. Note that any young-of-the-year (YOY) fish should also be enumerated, but do not count towards the target sample size of 100. Fish tissue testing is required under the MMER if effluent contains greater than 0.10 ug/L of total mercury. In the water and load balance modeling, input data for mercury had very low contributions (0.000006 to 0.00005 mg/L) from the components associated with the local geology or tailings. Predictions for mercury in the exposure area were 0.00001 mg/L, which is the background surface water concentration. Sediments in area lakes had mean mercury concentrations of 0.052 mg/kg (ppm), so there could be some potential for effluent from dewatering to contain mercury. Tissues studies every 3 years may or may not be required under the MMER. To support determination of whether a fish population study is required, a plume delineation study will be needed. Under the MMER, the mine is required to conduct a study of the fish population if the concentration of effluent in the exposure area is greater than 1% in the area located within 250 metres (m) of a final discharge point (MMER, Schedule 5, s. 9(b)). In the event that a fish survey and tissue monitoring are not required under the MMER EEM program, it is recommended that the frequency of fish sampling be changed to 5 years, to minimize effects of sampling on fish populations.	ECCC recommends that the Proponent provide rationale and frequency for sampling of fish tissue if not required under the MMER EEM. ECCC recommends that the Proponent provide details of the plume delineation study.	The proposed frequency of fish tissue sampling is intended to address the toxicological impairment hypothesis and meet sampling commitments under the FEIS. These obligations require fish tissue sampling every three years, while fish tissue sampling will likely not be required under the MMER environmental effects monitoring (EEM) (i.e., is triggered for mercury only if effluent mercury concentration exceeds 0.1 microgram/L). Sabina confirms that a plume delineation study will be completed before the first EEM study design is submitted to ECCC. Information from the plume delineation study will be used to update the site characterization section of the AEMP design plan and the EEM study design.		(In the March 19th AEMP workshop, Sabina suggested a reduction in slimy sculpin fish tissue sampling to once every 6 years unless the MMER trigger was reached. ECCC agreed with this approach)		Further technical discussion of plume delineation study and methodological options.	No further action needed prior to the NWB WL hearing. Concluded details of this study would need to be developed prior to discharge.
ECCC-IR-24	AEMP Section 6. Response Framework	An example has been provided for the approach to setting Action Levels in Table 6.3-1 Proposed Action Levels for Toxicological Impairment and Nutrient Enrichment Hypotheses ECCC notes several concerns with the examples provided: a) Changes for Water Quality parameters are triggered for concentrations that are lower than the normal range. This would not be applicable for parameters such as dissolved oxygen, which should not be reduced. The focus should be on the parameters being outside their normal range rather than lower than their normal range. b) For the column "Benthic Community" the response is only to a decline in any of the benthic metrics; if there is a nutrient enrichment occurring there could be increases in the benthic community endpoints. To capture potential nutrient enrichments, the low action levels should be tied to differences that are statistically significant for comparisons to baseline and/or reference sites. c) The "Fish Health" column has the low action level being triggered by difference in endpoints of condition or gonadosomatic or hepatosomatic indices, or fish tissue chemistry beyond the normal range. Triggering the low action level is contingent on these changes being tied to impairment of fish health. These are not necessarily clear levels of change which would indicate impairment, and it may be more appropriate to use comparisons to reference lake fishes, or statistically significant differences from baseline. d) There was no action level indicated for sediment quality.	ECCC recommends that the Proponent ▫ Provide an estimate of the timeline for development of Action Levels and identification of the "Normal Range" for Toxicological Impairment, Sediment Quality and Nutrient Enrichment Hypotheses. ▫ Consult with ECCC and other relevant stakeholders in the development of both of Action Levels and the "Normal Range".	Benchmarks and action levels will be developed once all 2018 supplemental baseline data have been reviewed, consolidated, and analyzed (e.g., statistical distributions). Please see response to ECCC-IR-11 for compilation and review of the baseline dataset. Sabina commits to consulting with ECCC and other relevant stakeholders in the development of Action Levels and the "Normal Range".		OK			Resolved. Response framework to be developed post 2018 baseline data compilation/development of natural ranges.
ECCC-IR-27	QA/QC Plan Section 8. Data and Reporting Requirements	The QA/QC Plan should include a discussion of data quality objectives under Section 8.2 Data Verification.	ECCC recommends that the Proponent provide data quality objectives for the QA/QC plan.	Sabina will update the QA/QC Plan (171002 2AM-BRP----SD24-QAQCPlan-IMLE) to include a discussion on data quality objectives (e.g., steps to review and validate data from duplicates, blanks, and samples). This updated plan will be provided in response to Technical Comments.					Resolved. See addition to AEMP Revision Tracker

Appendix A. Load Balance Update to Support the Type A Water Licence

GOLDER

TECHNICAL MEMORANDUM

DATE April 27, 2018 1776921_030_TM_WO-006_Rev0

TO Merle Keefe
Sabina Gold & Silver Corp.

CC Catherine Paul

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LOAD BALANCE UPDATE IN SUPPORT OF THE TYPE A WATER LICENCE; BACK RIVER PROJECT

1.0 INTRODUCTION

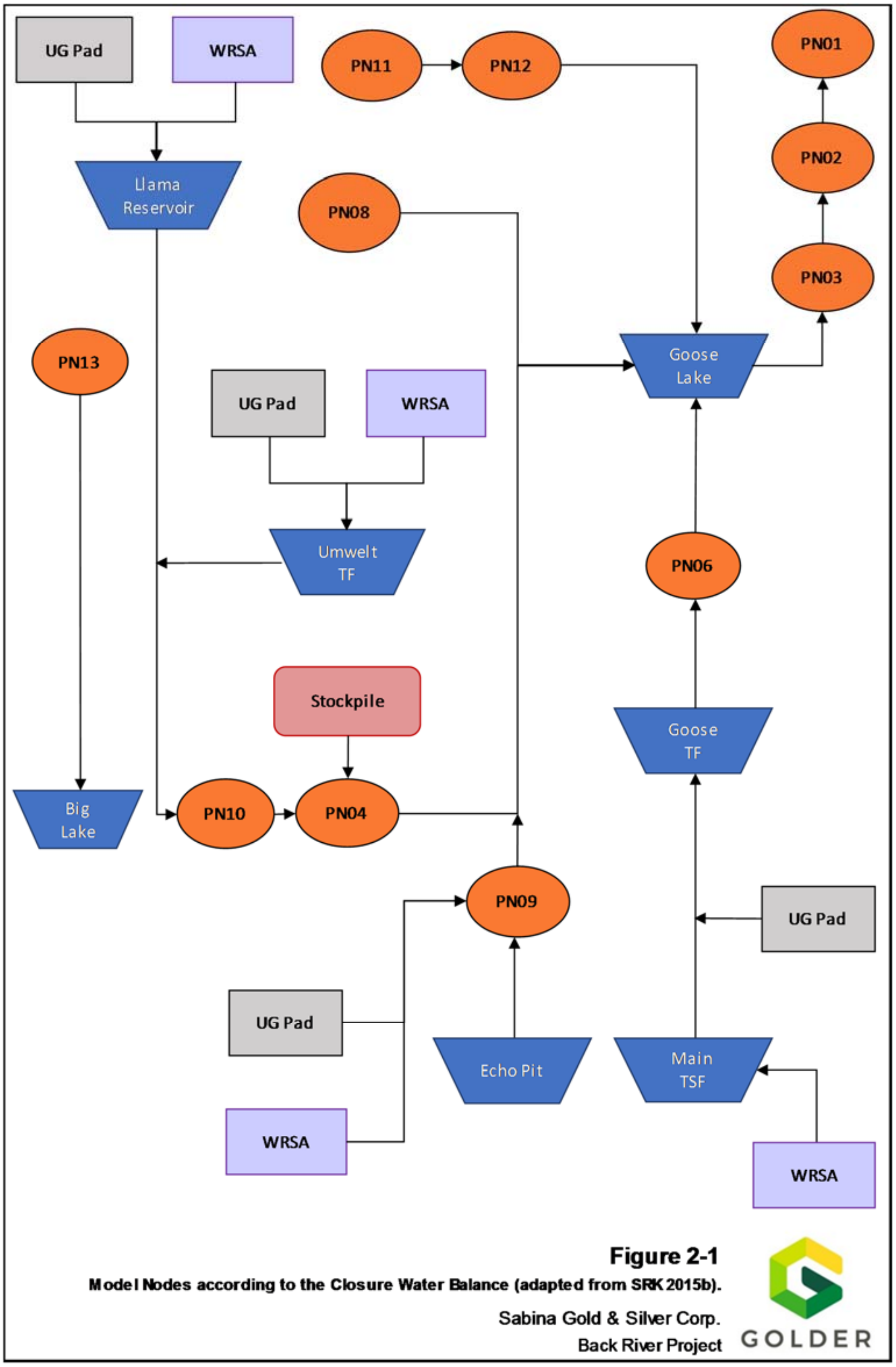
At the request of Sabina Gold & Silver Corp. (Sabina), Golder Associates Ltd. (Golder) completed an update of the Load Balance Model (model) for the Back River Project (Project). The model update is a requirement of the Final Environmental Impact Statement (FEIS) and FEIS Addendum Project Certificate (170601-12MN036-FHA EX 45-Recommended PC Terms and Conditions Committments-IA2E), item INAC-C-1. Sabina committed to working with Crown-Indigenous Relations and Northern Affairs Canada (CIRNA), Environment and Climate Change Canada (ECCC), and the Kitikmeot Inuit Association (KIA) prior to the Nunavut Water Board Type A Water Licence review meeting to revise the water and load balance. Updates were made to the Load Balance that was presented in Appendix F-7 of the Type A Water Licence Application for the Project (Golder 2017; 171005 2AM-BRP----MAD App F-7_TechReview-IMLE) to address information requests outlined in Appendix 1 of this memorandum.

This Technical Memorandum includes an overview of the existing water and load balance model, a summary of model updates, methods, and key results. Model limitations and a discussion of results are also provided.

2.0 OVERVIEW OF BACK RIVER PROJECT WATER AND LOAD BALANCE

Golder was provided a copy of the Water and Load Balance model prepared for the Back River Project FEIS (SRK 2015a). The Water and Load Balance Report (SRK 2015b; 171005 2AM-BRP----MAD App E-2_WaterLoadBalanceRpt-IMLE) presents a detailed description of the water and load balance model, which was developed to optimize the water management strategy, optimize the tailings deposition schedule, and evaluate water treatment goals for the Project to meet water quality guidelines. The objective of the load balance model (the model) is to predict water quality at the Goose Property and the effect to downstream receptors. The model is based on mass balance principles, and incorporated available data for hydrology, mining and production schedules, water management plans, water chemistry and source load inputs. Water quality predictions were developed for all open pits, tailings facilities, and specific locations downstream of the Goose Property (Figure 2-1).

Figure 2-1: Model Nodes according to the Closure Water Balance (adapted from SRK 2015b)



The water balance tracks all inputs, outputs, and storage at the key Project facilities. Water inputs include groundwater inflows from taliks within the Llama underground development and Llama open pit, Umwelt underground development, and Goose Main underground development; and precipitation. Outflows include Project discharges, including treated effluent, pit overflows to downstream receptors, and seepage as well as evaporation. The model accounts for water storage within the open pit and underground developments, and voids in tailings and waste rock.

Loading rates were calculated in the load balance for each inflow in the water balance. Loadings and concentrations were calculated for each mine component, either as a direct loading from a defined source term or a linked loading from a reservoir (e.g., open pit or lake) reporting from another facility. The main source terms include background surface water quality; groundwater inflows; geochemical source terms for waste rock and tailings contact water developed using a combination of humidity cell test data, geochemical modelling, and existing data from nearby similar mine sites; process water effluent; and sewage treatment plant (STP) treated effluent water. Geochemical source terms were derived based on average hydrological conditions.

The model accounts for the effect of release of nitrogen species from blasting residuals. Cryoconcentration (exclusion of parameters from ice) is conservatively assumed to occur during the winter months. Lastly, degradation rates of cyanide species were also accounted for in the model using data from an analogous Northern mine.

The water and load balance model was run on a daily time step from Year -2 to Year 42, which allowed for the development and evaluation of steady-state conditions in pits and downstream receptors. The water balance was run as a Monte Carlo simulation (i.e., stochastic model) using probability distribution functions developed for the Project. Water quality predictions were generated from the load balance using deterministic model runs and average hydrological conditions, for consistency with geochemical source terms that were also generated assuming average hydrological conditions.

Load balance model results were compared to the Metal Mining Effluent Regulations (MMER 2017) (EC 2012), Canadian Council of Minsters for the Environment (CCME) water quality guidelines, and site-specific water quality objectives (SSWQOs) developed for arsenic (As) and copper (Cu). The model results were also used to evaluate water treatment requirements. The proposed water treatment plan during construction included treatment of contact water stored in Llama Lake will require treatment for total suspended solids (TSS) and As prior to discharge during the open season (Year -2, W3), and saline underground water stored in Umwelt Lake will require treatment for TSS prior to discharge to Goose Lake during the open water season (Year -2, Q3). During Operations, water from the Goose Main Tailings Facility (TF) will be treated all year to reduce TSS, As, and Cu concentrations (Year 7, Q4 to Year 10, Q2). At Closure, water from the Goose Main TF will be treated during the open water season for TSS, As and Cu (Year 10, Q2 to Year 16, Q1). Water treatment during Construction will involve clarification and ferric chloride addition; treated water will be pumped to Goose Lake. During Operations and Closure, treatment will include oxidation of cyanide using hydrogen peroxide, and ferric chloride addition. Treated water will be pumped back to the Goose Main TF.

2.1 Third Party Review

Golder (2017) completed a third party review of the Water and Load Balance as part of the Type A Water Licence application submission. During this review, Golder identified inconsistencies between the GoldSim model (SRK 2015b) and supporting documentation which were addressed through an update to the load balance. These updates resulted in minor changes to the key load balance results presented in SRK (2015a), with effectively no impact on the Project-wide water management strategy and sizing of water management infrastructure. Results of the update completed as part of the review are presented in Golder (2017).

As part of this review, Golder noted that source concentrations developed for Project contact waters represent dissolved metal concentrations and, as stated in SRK (2015a), do not account for additional loading that may result from total suspended sediments (particularly for aluminum (Al) and iron (Fe)). Many of the source inputs are expected to have negligible particulate associated with them (e.g., groundwater flows and runoff from pit walls and waste rock) or will have limited potential for particulate to reach the receiving environment due to Project design features (e.g., planned active water treatment, passive water treatment in sediment ponds, limited potential for sediment resuspension in pits and tailings facilities).

3.0 LOAD BALANCE MODEL

3.1 Model Overview

The Type A Water Licence load balance model updates were made using the Version 11 of the GoldSim model[1] (Golder 2017), which is an updated version of the model discussed in Appendix E-2 of the Type A Water Licence Application for the Project (SRK 2015a; SRK 2015b).

3.2 Model Updates

Based on the information requests presented in Appendix 1, the following updates were made to the load balance model:

- Incorporation of the total metals fraction to evaluate the effect of suspended solids on the total parameter concentrations in mine discharges during Operations, Closure, and Post-Closure.
- Incorporation of total metal concentrations for downstream water quality using baseline water quality results (Sabina 2015), to evaluate total metal concentrations in receiving environment during Operations, Closure, and Post-Closure.
- Nitrogen species concentrations were updated in sewage treatment plant effluent to the following values:
  - Nitrate (NO_3) = 22 mg-N/L
  - Nitrite (NO_2) = 0.5 mg-N/L
  - Ammonia (NH_3) = 8 mg-N/L

Additional refinements to the model included the following:

- Lower bound limits equivalent to background water quality inputs were applied to water quality predictions when these were lower than the background water quality.
- Total dissolved solids concentrations (C_{TDS}) in milligrams/litre (mg/L) were estimated from the sum of all modelled major ion concentrations as per Equation 1.

$$C_{TDS} = C_{Ca} + C_{Mg} + C_K + C_{Na} + \left(\frac{C_{Alkalinity}}{50}\right) \cdot 61 + C_{SO_4} + C_{NO_3} + C_{Cl} \qquad (1)$$

Where: C= concentration, Ca = Calcium, Mg = magnesium, K = potassium, Na = sodium, SO_4 = sulphate, Cl = chloride

[1] FEIS_Goose_Rev17G_spb_kpw_SAB_withresults - WQ_UPDATE_Original.gsm

- Hardness was calculated based on predicted calcium and magnesium predicted concentrations, as per Equation 2.

$$C_{Hardness} = 2.5C_{Ca} + 4.11\ C_{Mg} \qquad (2)$$

No other changes to the mine plan or water balance were made to the load balance as part of this model update. Further, source term inputs for waste rock, overburden, and tailings presented in SRK (2015a) were used without any modifications or updates.

3.2.1 Estimation of Total Metals Concentrations

Total metal concentrations for Project discharges were estimated by adding a calculated particulate fraction to the dissolved concentration results from the model. Total loads were calculated for contact water for all mine facilities (pads, roads, waste rock piles, tailings storage facilities), assuming that the discharge from each facility will meet the MMER TSS discharge limit (15 mg/L). The particulate concentration of each element was developed as follows:

- The relative proportions of each waste rock lithology produced at each pit were calculated based on the total tonnage of waste volume presented in Table 2-2 of SRK 2015c. Lower greywacke (LGW) and deep iron formation (DIF) proportions were combined to reflect the distribution of samples as summarized in Table 5-1 of SRK (2015c).
- The water balance was reviewed to identify the source of runoff at each facility, as seepage water will not be a significant source of particulate. When tailings runoff was a key source of TSS, the solid phase composition of tailings was used to assign the chemical composition of TSS. When waste rock was a key source of TSS, the solid phase composition of waste rock was used to assign the chemical composition of TSS.
- The available data on solid phase geochemistry of each rock type at each deposit were reviewed. The input for modeled constituents was defined using the average of samples collected for each rock type at each deposit, as presented in Appendix E2 of SRK (2015c). In the absence of data for a specific lithology at a given deposit, the overall average calculated based on all samples of that rock type collected at the Goose Property was used to define its elemental composition.
- Using the solid phase geochemistry data and the relative proportions of each rock-type, the weighted average was calculated to define the chemical composition of the TSS associated with waste rock produced by each Pit. For pads and roads, the weighted average was calculated using the relative proportion of each rock type for the entire Goose Property and the overall average composition for each rock type based on all samples of that rock type collected at the Goose Property.
- Tailings were defined by using the average of the solid phase geochemistry results for the composite samples used to develop the tailings source terms (SRK 2015c), specifically KM4030-147 TAILS, BR-TAIL-02, and BR-TAIL-03.
- The product of the weighted average (expressed as micrograms/gram or ug/g) and the TSS concentration discharge limit (set to 15 mg/L (MMER 2017)), defined the concentration of each modeled constituent associated to the TSS load. The TSS load was then added to the dissolved fraction load to estimate metal concentrations for the fraction.

3.2.2 Incorporation of 2017 Monitoring Data

In Technical Comment WT-KIA-NWB-27 (see Appendix 1), KIA requested that Sabina incorporate the 2017 monitoring dataset to evaluate fall and freshet conditions. This data has not been incorporated into the surface water quality inputs. It is understood that Sabina will collect additional surface water baseline data in 2018, including data to further characterize seasonal variability. Sabina has committed to updating the Water and Load Balance Model using all available baseline data, including data that will be collected in 2018, prior to the initiation of dewatering to ensure the water quality criteria for discharge are appropriate.

The existing surface water inputs to the load balance model are considered appropriate. The background water quality dataset used to develop the model inputs consists of data collected at the Project between 1993 and 2013. As outlined in SRK 2015b, seasonal water quality trends were evaluated for select parameters, including alkalinity, As, cadmium (Cd), calcium (ca), chloride (Cl), copper (Cu), iron (Fe), nickel (Ni), sulphate (SO4) and zinc. Seasonal variation was not identified for any of the parameters; therefore, annual water quality medians were used for inputs to the load balance model (SRK 2015).

3.3 Screening Criteria

The results of the load balance were compared against three applicable guidelines outlined in Table 3-1. The complete analyte list and comparison criteria for the water quality results are provided in Appendix 2, Attachment 1A and 1B. The water quality screening criteria listed in Table 3-1 are referred to as the “reference criteria” in this memorandum.

Table 3-1: Water Quality Screening Criteria

Water Quality Criteria	Guideline Description
Canadian Council of Ministers of the Environment (CCME 1999)	Water Quality Guidelines for the Protection of Aquatic Life, Freshwater, Long-Term (Chronic)
Metal Mining Effluent Regulations (MMER 2017)	Schedule 4, Column 2 – Maximum Authorized Monthly Mean Concentrations
Site-Specific Water Quality Objectives	Numerical concentrations set out for Site conditions

MMER were applied to Goose Property model nodes, and MMER, CCME / SSWQO were used to screen water quality model results for receiving environment model nodes. In review of the results presented in SRK (2015b), it was noted that some MMER and CCME criteria were presented inaccurately. These criteria have been addressed in this memorandum. Table 3-2 summarizes the parameters that were subject to revision. Site-specific guidelines remained the same and are not included in the table below.

Table 3-2: Summary of updates to Water Quality Screening Criteria

Parameter [mg/L]	SRK (2015b)	This Memorandum	SRK (2015b)	This Memorandum
	CCME		MMER	
Cyanide	-	**0.0050**	1.0	1.0
Ammonia	-	**4.3[a]**	6.0	-
Nitrite	**0.08**	**0.060**	-	-
Arsenic	0.0050	0.0050	**0.050**	**0.50**
Chromium	-	0.0010	-	-
Silver	**0.00010**	**0.00025**	-	-

a Ammonia guideline is pH and temperature dependent; to be conservative this guideline was based on a field pH (7.5) and water temperature of 4.0°C.

Bolded and underlined values indicate a change in criterion for the identified parameter.

4.0 RESULTS

Monthly average water quality predictions were completed for dissolved and total metal concentrations at all open pits, tailings facility and downstream prediction points. The model nodes are presented in Figure 2-1, which presents the Closure water management strategy for simplification. The objective of this section is to identify the constituents of potential concern (COPC) for each modeling node. Parameters are identified as a COPC when predicted concentrations are greater than the applicable water quality criteria.

Appendix 2, Attachment 1A and 1B present a statistical summary of the absolute monthly maximum concentrations, long-term monthly average, and Closure maximum monthly concentrations for both dissolved and total metal concentrations in order to understand the extent of change in concentration with the addition of total suspended solids. Appendix 2, Attachment 2 presents concentration trends of COPCs by location.

4.1 Receiving Environment

Based on the current model update, the water quality results in the receiving environment can be characterized as follows:

- No model modeled parameters at the receiving environment nodes exceeded the MMER criteria.
- Prediction nodes PN08, PN11, PN12, and PN13 are unaffected by project infrastructure and predictions are identical to the background source water quality. The results for these nodes are grouped as one statistical summary in Appendix 2, Attachment 1A.
- Concentration inputs for mercury (Hg) are based on the analytical detection limit. Therefore, predicted Hg concentrations reflect the analytical detection limit. For consistency, Hg is highlighted as exceeding the CCME criteria in Appendix 2; however, it is unlikely to be a COPC.
- The addition of the particulate fraction did not produce any substantial change from the dissolved concentrations for most parameters, with exception of aluminum (Al) and iron (Fe). Arsenic, chromium (Cr), Cu, phosphorous (P), vanadium (V) and titanium (Ti) also had a small overall increase in concentration owing to the addition of the particulate fraction. Calcium (Ca) and magnesium (Mg) also comprise an important part

of the suspended solids chemical composition, but the contribution from the particulate fraction is negligible in comparison to the dissolved concentration of these parameters.

4.1.1 Goose Lake and Downstream Model Nodes

Receiving environment model nodes downstream of Goose Lake include PN03, PN02, and PN01. Model results for these nodes are summarized in Appendix 2, Attachment 1A. Figures presenting concentration trends of key COPCs for these nodes are presented in Appendix 2, Attachment 2.

Goose Lake

Figure 2-1 summarizes the key inflows to, and outflows from, Goose Lake. Parameters that exceed the reference criteria in Goose Lake include:

- NO_2
- Total Al
- Dissolved and total As
- Dissolved and total Cd
- Total Cr
- Dissolved and total Cu
- Total Fe

Total and dissolved As, Cd and Cu only surpass the applicable guidelines following the overflow of the Goose Main TF into the receiving environment. This overflow commences in the Closure period (Year 18 of the mine life). Total Al, total Cr and total Fe exceed the reference criteria for the duration of the Post-Closure period.

PN03

As outlined in Figure 2-1, PN03 is located further downstream of the Goose Lake assessment node. The projected concentration trends at these locations are similar, the only difference being a flow rate of 0 m^3/s at PN03 during the winter months, during which no water quality predictions were derived. Parameters that exceed the reference criteria at PN03 include:

- Total Al
- Total Fe

Similar to Goose Lake, the exceedances at PN03 begin after Year 18, following the overflow of the Goose Main TF. Dissolved As and Cu exceed CCME criteria, but do not exceed the SSWQO in Post-Closure.

PN02

PN02 is located downstream of assessment location PN03. The projected concentrations trends are similar to PN03; however, predicted concentrations decrease relative to PN03 as a result of an increase in the relative proportion of natural runoff. Parameters that exceed the reference criteria at PN02 include:

- Total Al

The exceedance at PN02 begins after Year 18, and exceed the reference criteria for the duration of the Post-Closure Phase.

PN01

PN01 is located downstream of assessment location PN02 and is the farthest downstream node from the Project. Water quality modeling results suggest that at PN01 a large assimilative capacity occurs. In addition, no COPC's were flagged at this location. Therefore, effects from the Project discharge are expected to be minimal on water quality at this node.

4.1.2 Model Nodes Upstream of Goose Lake

Model nodes upstream of Goose Lake include PN10, PN04, PN09 and PN06. Model results for these nodes are summarized in Appendix 2, Attachment 1A. Figures presenting concentration trends of key COPCs at these nodes are presented in Appendix 2, Attachment 2.

PN10

The PN10 assessment node is located upstream of Goose Lake. Natural runoff is the primary incoming flow to this node during the Operations Phase. During the Closure (after Year 13) and Post-Closure periods (after year 18), PN10 also receives water from the Llama Reservoir, the Umwelt TF and the Saline Water Pond. The combined flow from these facilities contributes to the overall increase of simulated concentrations and ultimately causes several parameters to screen above the applicable water quality criteria. Parameters that exceed the reference criteria at PN10 include:

- Cl
- Total Al
- Dissolved and total As
- Dissolved and total Cd
- Total Cr
- Dissolved and total Cu
- Dissolved and total Fe

The exceedances at PN10 begin after Year 13, during the Closure and Post-Closure periods. Discharge from the Llama reservoir and Saline Water Ponds effect Cl concentrations. Total Al, total Cr and dissolved and total Fe exceed the CCME criteria, and dissolved and total As exceeds the SSWQO for the duration of the Post-Closure period.

PN04

PN04 is located downstream of assessment location PN10 and flows to Goose Lake. During the Operations Phase, the primary contributing flow to this location consists of a combination of runoff flows from roads, and undisturbed areas. At Closure and throughout Post-Closure stages, PN04 also receives flow from the ore stockpile, the Llama Reservoir, the Umwelt TF and the Saline Water Pond. The relative flow contribution from these facilities to the total incoming flow at PN04 is lower in comparison to PN10. Parameters that exceed the reference criteria at PN04 include:

- Cl
- NO_2
- Total Al
- Dissolved and total As
- Dissolved and total Cd
- Total Fe

With the exception of Cl and NO_2, exceedances at PN04 begin in the Closure (after Year 13) and Post-Closure periods (after year 18) periods. Chloride concentrations are a function of flow from PN10, which receives water from the Llama reservoir and Saline Water Pond. Total Al and Fe exceed the reference criteria for the Post-Closure period. Total and dissolved As exceed the SSWQO during the initial Closure period, but are less than the SSWQO during Post-Closure.

PN09

PN09 is located downstream of the Echo Pit. During the Operations Phase, the main contributing flows to this node consist of a combination of runoff from roads with natural runoff from undisturbed areas. At Closure and Post-Closure, this location also receives direct discharge from the Echo Pit and the Echo WRSA, both contributing to the overall increase of simulated concentrations. Parameters that exceed the reference criteria at PN09 include:

- NO_2
- Total Al
- Dissolved and total As
- Total Cr
- Total Fe

With the exception of NO_2, exceedances at PN09 begin in the Closure (after Year 10) and Post-Closure periods (after Year 18) periods. Dissolved and total As exceeds the SSWQO between Year 9 and Year 14, and decreases to concentrations less than the SSWQO in the Post-Closure period. Total and dissolved Cu do not exceed the SSWQO. Total Al, Cr, and Fe exceed the CCME criteria during the Post-Closure period.

PN06

Main incoming flows to this location consist of natural runoff and road runoff during Operations, and additional discharge from the Goose Main TF and discharge from the Tailings Storage Facility (TSF) during Closure and Post-Closure. Parameters that exceed the reference criteria at PN06 include:

- NO_2
- Dissolved Al
- Dissolved and total As

- Dissolved and total Cd
- Total Cr
- Dissolved and total Cu
- Total Fe
- Dissolved and total Se
- Dissolved and total Ag

Exceedances at this location begin at Year 18, following the overflow of the Goose Main TF. Dissolved As and Cu concentrations exceed the SSWQO at the time of the initial discharge, and decrease to long-term concentrations less than the SSWQO. Total Al, dissolved and total Cd, total Cr and total Fe exceed the reference criteria for the duration of the Post-Closure period.

4.2 Goose Property Modelling Nodes

Goose Property model nodes include the Umwelt TF, Llama Reservoir, Goose Main TF, Echo Pit, and the Tailings Storage Facility. Model results for these nodes are summarized in Appendix 2, Attachment 1B. Select results are presented in Appendix 2, Attachment 2. Water quality model results were compared to MMER discharge criteria.

Umwelt Open Pit and Tailings Facility

The Umwelt open pit will be mined between Year -2 and Year 2, and underground mining will take place between Year 2 and Year 10.

The contact water collected in Umwelt open pit will be dewatered to Llama Lake until milling begins (Year -1), when water will then be pumped to the TSF. After the completion of open pit mining in Year 2, the open pit will become the Umwelt TF and will be used for mine water storage from the Llama open pit, and tailings deposition. Water will be reclaimed to the Goose Process Plant. Tailings will be deposited until the solids are at an elevation 5 meters below the discharge elevation over a period of approximately 4 years (through Year 6). After the completion of the Goose Main open pit, excess water from the Umwelt TF will be transferred to the Goose Main TF. A 5-m water cover will be maintained in the Umwelt TF at Closure.

Some exceedances of MMER criteria were noted during Operations, but at this stage water will be not be discharged prior to treatment. Water in the Umwelt TF meets the MMER criteria during the Closure and Post Closure stages.

Llama Open Pit and Reservoir Facility

The Llama open pit will be developed and mined between Year 1 and Year 3, and underground mining will take place concurrently between Year 1 and Year 4. The open pit will be developed in an open talik; groundwater inflows will be encountered during mining. Groundwater dewatered from the Llama open pit and underground will be pumped to the TSF until Year 2, when water will be pumped to the Umwelt TF.

Following the completion of open pit mining, the Llama open pit will become the Llama Reservoir, and will be used for storage of site-wide contact water and hypersaline water. Hydrodynamic modelling of the Llama Reservoir confirmed that meromixis will occur (SRK 2015b); however, for the purpose of the load balance model, the reservoir was conservatively assumed to be completely mixed. At Closure, excess water from Llama Reservoir will be routed to Goose Lake.

Water in the Llama Reservoir meets the MMER criteria at all stages of the Project.

Goose Main Open Pit and Tailings Facility (Goose Main TF)

The Goose Main open pit will be mined between Year 2 and Year 6, and underground mining will take place between Year 5 and Year 9. After Year 6, the open pit will become the Goose Main TF. Inflows to Goose Main Pit will be pumped to the TSF until Year 2, followed by the Umwelt TF. The Goose Main TF will also serve as storage for process water and site-wide contact water. During Operations and Closure, water from the Goose Main TF will be treated and re-circulated back to Goose Main TF until discharge criteria are met.

Water in the Goose Main TF meets the MMER criteria at all stages of the Project.

Echo Pit

The Echo open pit will be developed and mined between Year 4 and 5 ; underground mining will take place between Year 6 and 9. The Echo pit will be continuously dewatered, allowing for the recovery of the crown pillar. During Operations, water will be pumped from the Echo Pit to the Umwelt TF until Year 6, followed by the Goose Main TF until the end of mining. When underground mining is complete (Year 9), the Echo open pit will be allowed to reflood.

Water in the Echo Pit meets the MMER criteria at all stages of the Project.

Tailings Storage Facility (TSF)

The TSF will be active between Year -1 and Year 2. The TSF will also be used to store site-wide contact water, mill process water and saline water from the Llama open pit. Supernatant water from the TSF will be continuously reclaimed to the Goose Process Plant following tailings deposition.

At Closure, the TSF will be covered with waste rock and converted to a WRSA (TSF WRSA). A portion of the TSF footprint will be used for contact water storage until the start of Closure (TSF WRSA Pond).

No parameters exceed the MMER concentrations at Closure or during Post-Closure.

5.0 MODEL LIMITATIONS

The model results presented in this Technical Memorandum are based on the general assumptions listed in SRK (2015c), including the mine plan, water management plan and input data. Given the complex interplay of climate, the geochemical nature of the rock materials, and the physical characteristics of the mine facilities, several simplifying and conservative assumptions were included in the load balance model. The water quality predictions presented in this report reflect these assumptions. While it is believed that the modelling approach and resulting water quality predictions presented herein are consistent with industry practices and appropriate for evaluating potential impacts associated with the Project, actual contact water quality during Construction, Operations, Closure, and Post-Closure may differ from the predictions presented.

Actual water quality will largely depend on the mine plan and management practices followed during mining, and on-site conditions related to water movement and chemical loading. In that respect, the extent to which actual dissolution of rock particles in waste rock storages areas, and the subsequent release of chemical constituents into drainage water will affect water quality, will depend on the volume of water infiltrating into the waste rock storage areas, the contact surface between water and rock, the dissolution kinetics under site conditions, and the internal characteristics of the WRSAs themselves (e.g., temperature, degree of saturation, presence of ice). This, in turn, will depend largely on climate; particularly the amount of precipitation and evaporation, and the ambient air temperature. In wet years, for example, larger volumes of water may enter waste rock storage areas and result in the mobilization of greater volumes of mineral dissolution products than in drier years. Likewise, the presence of permafrost and/or ice within the rock voids may inhibit water movement and the mobilization of dissolution products in drainage reporting from these facilities. The use of drilling brines or underground development and saline groundwater production could require different handling procedures for drainage.

Specific to TSS, high levels of TSS are often correlated with discrete events that occur over shorter intervals. Depending on site-specific hydrological conditions and controls, and the resultant TSS load, total concentrations at specific points of interest could be higher or lower than the results presented here. Furthermore, this model does not include factors that will mitigate TSS, such as settling times.

Given the above, the mine site contact water flow volumes and quality will need to be monitored throughout the mine life, and the management of contact water will need to be adaptive.

6.0 CONCLUSIONS

Water quality predictions were updated to address information requests from KIA, CIRNA, and ECCC during the FEIS and Type A Water Licence Review (Appendix 1). The FEIS load balance model served as the basis for the prediction update (SRK 2015a; Golder 2017). Water quality predictions were evaluated in all open pits, tailings facilities, and predefined locations downstream of the Goose Property. Results were compared to MMER (Goose Property), and CCME and SSWQOs (receiving environment) guidelines.

Overall, the updates performed to the water and load balance model resulted in minor changes to the key water balance results presented in the FEIS, with effectively no impact on Project-wide water management strategy and sizing of water management infrastructure. Post-Closure water quality estimates for the Llama Reservoir, Umwelt TF, Goose Main TF and Echo Open Pit overflows at Closure are expected to meet the MMER guidelines. Water quality predictions do not indicate exceedances of the SSWQO for As or Cu in Goose Lake during the long-term, but do exceed during the initial stages of the Post-Closure period, when the Goose Main TF begins to discharge to Goose Lake.

7.0 CLOSURE

We trust that this Technical Memorandum meets your current needs. Should you have any questions, please do not hesitate to contact the undersigned.

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https://golderassociates.sharepoint.com/sites/11269g/wo006_wl_regulatory_support/g006_load_balance/tm/rev a/1776921_030_tm_loadbalanceupdate-typea_rev0.docx

Attachments: Appendix 1. Information Requests
Appendix 2. Complete Analyte List and Comparison Criteria for the Water Quality Results

References

CCME (Canadian Council of Ministers of the Environment). 1999. Canadian Water Quality Guidelines for the Protection of Aquatic Life. Available online at: http://st-ts.ccme.ca/.

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SRK. 2015b. Back River Project Water and Load Balance Report, dated October 2015.

SRK. 2015c. Geochemical Characterization in Support of the Final Environmental Impact Statement (FEIS) for the Back River Project, Nunavut, dated November 2015.

APPENDIX 1

Information Requests

IR No.	Source	Review Comment	Sabina Response
INAC-C-1			
¡ KIA-IR12:		¡ Provide further clarification as to the observed inconsistent use of the terms dissolved versus total in the above referenced documents.	The water quality model described in the Water and Load Balance Report (App E-2 of the MAD; 171002 2AM-BRP----MAD App E-2_WaterLoadBalanceRpt-IMLE) relied on load balance source terms calculated using the results of groundwater quality monitoring, surface water quality monitoring, and geochemical assessment.
		¡ If source terms are derived primarily from dissolved metal concentrations, comment on whether 'upper bound source concentrations' (noted in Section 7.3 of the Geochemical Characterization Report - App E-3 of the MAD) were used in a sensitivity analysis to capture the potential underestimation of additional loading (which was noted in Section 7.1 of the Geochemical Characterization Report – App E-3 of the MAD).	The model inputs were derived using dissolved concentrations. The model results (i.e., dissolved concentrations) were compared to CCME and MMER total concentration guidelines. This approach assumes that the predicted water quality has a negligible particulate component (i.e., total suspended sediments). Dissolved concentrations do not account for additional loading that may result from total suspended sediments, particularly for aluminum and iron.
		¡ Indicate how new monitoring results will be used to update model predictions.	
			Using the dissolved concentration inputs to the water quality model, there is limited potential for concentrations to exceed available guidelines as the constituent concentrations in process water are not expected to exceed guidelines. Many of the source inputs are expected to have negligible particulate (e.g., groundwater flows and runoff from pit walls and waste rock). Furthermore, there is limited potential for particulate to reach the receiving environment due to Project design features (e.g., planned active water treatment, passive water treatment in sediment ponds, limited potential for sediment resuspension in pits and tailings facilities).
			As outlined in Section 9.1 of App E-2 of the MAD (171002 2AM-BRP----MAD App E-2_WaterLoadBalanceRpt-IMLE), the base case source terms formed the basis of the water quality predictions. Sensitivity analyses were performed by modifying arsenic input concentrations (multiplying base case concentrations by factors of 2 and 0.5), runoff coefficients, and groundwater inputs. "Upper bound source concentrations" (Section 7.3 of the Geochemical Characterization Report - App E-3 of the MAD; 171002 2AM-BRP----MAD App E-3_GeochemCharactRpt-IMLE) were not used in a sensitivity analysis.
			As part of the final engineering design phase, water quality predictions will be updated to reflect the final Project design. Water quality source terms derived using groundwater and surface water quality monitoring data will be re-evaluated in the context of information collected since the submission of the Type A Water Licence Application. Geochemical source terms will be considered in the context of additional tailings geochemical test results. Lastly, the water quality predictions will be updated to include dissolved and particulate fractions.
			Sabina is committed to working in conjunction with the ECCC, INAC, and KIA prior to the technical meeting associated with the NWB Type A Water Licence review process to revise the water and load balance and set an appropriate timeline for revision.
¡ ECCC-IR-6:		¡ *ECCC recommends that the Proponent confirm whether the treatment effluent water quality model predictions used the erroneous input values for nitrite.*	Sabina confirms that the erroneous concentration of 30 mg/L of Nitrite was used in the water and load balance and Sabina commits to revising parameter concentration in next revision of the water and load balance. Sabina is committed to working in conjunction with the ECCC, INAC, and KIA prior to the technical meeting associated with the NWB Type A Water Licence review process to revise the water and load balance and set an appropriate timeline for revision.
WT-KIA-NWB-27		We again request the proponent commit to collect additional baseline water quality data from the lakes in the Project area during freshet and fall as confirmed by measurements of higher flow, prior to construction. Sabina should commit to use this data to update the water and load balance model. The Proponent will ensure sampling is an appropriate and accurate representation of at least one (1) full year of seasonal data.	At KIA's request, Sabina undertook additional seasonal baseline water quality characterization in 2017 and plans further baseline data collection in 2018. In advance of 2017 sampling, on July 30, 2017, the KIA was provided with an outline of the intended seasonal water quality baseline sampling for review and comment. Supplementary baseline sampling included both lake and stream sampling in August and September (i.e., fall) and included both Goose Lake and Goose Outflow. A summary of the locations and dates sampled, as well as the data to be collected, were included with this submission.
		The occurrence of freshet should be confirmed with on-site meteorological and flow measurements. If the results diverge from those presented in the 2015 Water and Load balance report, we request that Sabina provide additional water treatment options as necessary.	In 2018, Sabina will collect additional baseline data at proposed AEMP sites, including data to further characterize seasonal variability. Goose Lake, as well as the Reference Lake B, will be sampled in April (i.e., winter), as well as monthly during the open water season in July, August, and September (i.e., fall). Goose Outflow and the reference outflow will also be sampled monthly during the stream open water season; namely, June (i.e., freshet), July, August, and September.
		We further request that Sabina present monthly outputs for Goose Lake water quality and prediction nodes (PN) 01 through 13 to assist reviewers in determining when site water quality will comply with CCME water quality objectives for the protection of aquatic life and when Goose Lake will return to the baseline trophic level. Monthly outputs should be provided using the updated dataset.	To clarify, although streams can be sampled during freshet (June), representative lake water quality samples cannot be collected during freshet due to the difference in melt timing of the streams and lakes. In the Back River region, freshet (defined as peak stream flows) occurs in June, as the streams receive snow meltwater and progressively become ice free. During this month, lakes still remain covered by ice, with initial meltwater being deposited on the ice surface and eventually into the lakes as the shorelines melt; this seasonal melt usually begins near the point of entry of inflow drainages. During this time, lakes are not accessible; the ice surface is variably thinning, weakening, separating from shore, and progressively breaking apart preventing safe access. In contrast to streams, lakes generally only become ice-free in mid-July, at which time lake water sampling is again possible.
			Sabina commits to updating the Water and Load Balance Model using all available baseline data, including data that will be that collected in 2018, prior to the initiation of dewatering to ensure the water quality criteria for discharge are appropriate.
			Sabina highlights current model results for monthly outputs for Goose Lake water quality and prediction nodes (PN) 01 through 13 were provided in the Type A Water Licence Application. These results are provided in Appendix G of the Water and Load Balance Report (171002 2AM-BRP----MAD App E-2_WaterLoadBalanceRpt-IMLE) and updated results in Attachment 2 of the Technical Review of Water, Waste Rock, and Tailings Management/Design (171002 2AM-BRP----MAD App F-7_TechReview-IMLE).

Prepared:
Reviewed:
Approved:

APPENDIX 2

Complete Analyte List and Comparison Criteria for the Water Quality Results

Attachment 1A
Water Quality Results - Prediction Nodes

	Unit	Guidelines			Goose Background Source	PN01					
		CCME Freshwater (Chronic)	Site Specific	MMER		Dissolved Metals			Total Metals		
						Absolute Maximum	Long-Term Average	Max at Closure	Absolute Maximum	Long-Term Average	Max at Closure
Conventional Parameters											
Hardness, as $CaCO_3$	mg/L	-	-	-	11	11	11	11	11	11	11
Total alkalinity, as $CaCO_3$	mg/L	-	-	-	2.0	2.2	2.0	2.2	2.2	2.0	2.2
Total dissolved solids	mg/L	-	-	-	23	16	12	16	16	12	16
Total suspended solids	mg/L	-	-	-	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Total organic carbon	mg/L	-	-	-	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Major Ions											
Chloride	mg/L	120	-	-	1.0	1.8	1.0	1.7	1.8	1.0	1.7
Cyanide	mg/L	0.0050	-	1.0	0.00054	0.00054	0.00054	0.00054	0.00054	0.00054	0.00054
Sulphate	mg/L	-	-	-	4.1	5.3	4.2	5.3	5.3	4.2	5.3
Free cyanide	mg/l	-	-	-	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Cyanide - wad	mg/l	-	-	-	0.0010	0.0011	0.0010	0.0011	0.0011	0.0010	0.0011
Nutrients											
Nitrate	mg-N/L	2.9	-	-	0.0065	0.017	0.0065	0.015	0.017	0.0065	0.015
Nitrite	mg-N/L	0.060	-	-	0.0010	0.0015	0.0010	0.0015	0.0015	0.0010	0.0015
Total ammonia	mg-N/L	4.3[(a)]	-	-	0.0050	0.0068	0.0050	0.0050	0.0068	0.0050	0.0050
Metals											
Aluminum	mg/L	0.10[(b, c)]	-	-	0.011	0.012	0.011	0.012	0.014	0.014	0.014
Antimony	mg/L	-	-	-	0.000050	0.00015	0.000051	0.00015	0.00015	0.000051	0.00015
Arsenic	mg/L	0.0050	0.010	0.50	0.00020	0.00034	0.00026	0.00034	0.00035	0.00027	0.00035
Barium	mg/L	-	-	-	0.0051	0.0057	0.0051	0.0055	0.0057	0.0051	0.0055
Beryllium	mg/L	-	-	-	0.00020	0.00020	0.00020	0.00020	0.00020	0.00020	0.00020
Bismuth	mg/L	-	-	-	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050
Boron	mg/L	1.5	-	-	0.0050	0.0054	0.0050	0.0052	0.0054	0.0050	0.0052
Cadmium	mg/L	0.000040[(d)]	-	-	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010
Calcium	mg/L	-	-	-	2.1	3.9	2.2	3.3	3.9	2.2	3.3
Chromium	mg/L	0.0010	-	-	0.00015	0.00015	0.00015	0.00015	0.00016	0.00016	0.00016
Cobalt	mg/L	-	-	-	0.00012	0.00019	0.00012	0.00019	0.00019	0.00012	0.00019
Copper	mg/L	0.0020[(d)]	0.0046	0.30	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014
Iron	mg/L	0.30	-	-	0.014	0.015	0.014	0.015	0.023	0.021	0.023
Lead	mg/L	0.0010[(d)]	-	0.20	0.000050	0.000051	0.000050	0.000051	0.000051	0.000050	0.000051
Lithium	mg/L	-	-	-	0.0050	0.0057	0.0050	0.0054	0.0057	0.0050	0.0054
Magnesium	mg/L	-	-	-	1.3	1.4	1.3	1.4	1.4	1.3	1.4
Manganese	mg/L	-	-	-	0.0019	0.0022	0.0019	0.0022	0.0022	0.0020	0.0022
Mercury	mg/L	0.000026	-	-	0.000010	0.000010	0.000010	0.000010	0.000011	0.000010	0.000011
Molybdenum	mg/L	0.073	-	-	0.000050	0.00022	0.000053	0.00022	0.00022	0.000053	0.00022
Nickel	mg/L	0.025[(d)]	-	0.50	0.0033	0.0034	0.0033	0.0034	0.0034	0.0033	0.0034
Phosphorus	mg/L	-	-	-	0.0039	0.0042	0.0039	0.0042	0.0043	0.0039	0.0043
Potassium	mg/L	-	-	-	0.34	0.39	0.34	0.39	0.39	0.34	0.39
Selenium	mg/L	0.0010	-	-	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010
Silicon	mg/L	-	-	-	0.28	0.28	0.28	0.28	0.28	0.28	0.28
Silver	mg/L	0.00025	-	-	0.000010	0.000011	0.000010	0.000011	0.000011	0.000010	0.000011
Sodium	mg/L	-	-	-	0.66	1.4	0.69	1.2	1.4	0.69	1.2
Strontium	mg/L	-	-	-	0.0094	0.045	0.011	0.031	0.045	0.011	0.031
Tellurium	mg/L	-	-	-	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020
Thallium	mg/L	0.00080	-	-	0.000050	0.000050	0.000050	0.000050	0.000050	0.000050	0.000050
Tin	mg/L	-	-	-	0.00010	0.00010	0.000100	0.00010	0.00010	0.000100	0.00010
Titanium	mg/L	-	-	-	0.010	0.010	0.010	0.010	0.010	0.010	0.010
Uranium	mg/L	0.015	-	-	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010
Vanadium	mg/L	-	-	-	0.000053	0.000059	0.000053	0.000059	0.000064	0.000057	0.000064
Zinc	mg/L	0.030	-	0.50	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030
Zirconium	mg/L	-	-	-	0.00040	0.00040	0.00040	0.00040	0.00040	0.00040	0.00040

Notes:

[(a)] = the ammonia guideline is pH and temperature dependent. The guideline that results in the minimum ammonia guideline (4.3208 mg-N/L) is based on the combination of field pH (7.5) and water temperature (4.0°C). Guidelines calculated with temperature and pH values falling outside the defined range (i.e., pH 6.0 to 10.0 and temperature 0°C to 30°C) should be used with caution, as the WQG does not necessarily accurately reflect toxic effects at the low and high pH and

[(b)] = guideline is pH dependent. The guideline range shown is based on the pH observed in the dataset (7.5). The guideline is calculated based on the individual pH for each sample.

[(c)] = guideline is pH dependent: 0.005 mg/L at pH < 6.5 and 0.1 mg/L at pH ≥ 6.5.

[(d)] = guideline is hardness dependent. The guideline range shown is based on the hardness observed in the dataset (11 mg/L). The guideline is calculated based on the individual hardness

[(C)] = concentration is higher than the chronic aquatic life CCME guideline or outside the recommended pH, DO or total alkalinity range.

[(S)] = concentration is higher than the site-specific guideline guideline.

[(M)] = concentration is higher than the metal mining effluent regulations (MMER, 2017) guideline.

Bolded concentrations are higher than water quality guidelines.

Water quality data and guidelines shown in this table were rounded to reflect laboratory or field instrument precision after comparisons to guidelines. Therefore, values slightly above guidelines may be displayed as being equal to the guidelines and identified as exceedances. Concentrations equal to the guideline values were not identified as exceedances.

- = no guideline or no data.

Prepared: TL
Reviewed: KS
Approved: KS

	Unit	Guidelines			Goose Background Source	PN02					
		CCME Freshwater (Chronic)	Site Specific	MMER		Dissolved Metals			Total Metals		
						Absolute Maximum	Long-Term Average	Max at Closure	Absolute Maximum	Long-Term Average	Max at Closure
Conventional Parameters											
Hardness, as $CaCO_3$	mg/L	-	-	-	11	11	11	11	11	11	11
Total alkalinity, as $CaCO_3$	mg/L	-	-	-	2.0	8.6	4.4	8.6	8.6	4.4	8.6
Total dissolved solids	mg/L	-	-	-	23	134	28	134	134	28	134
Total suspended solids	mg/L	-	-	-	3.0	3.3	3.1	3.2	3.3	3.1	3.2
Total organic carbon	mg/L	-	-	-	4.0	4.4	4.1	4.3	4.4	4.1	4.3
Major Ions											
Chloride	mg/L	120	-	-	1.0	28	2.4	24	28	2.4	24
Cyanide	mg/L	0.0050	-	1.0	0.00054	0.00059	0.00054	0.00054	0.00059	0.00054	0.00054
Sulphate	mg/L	-	-	-	4.1	41	10	41	41	10	41
Free cyanide	mg/l	-	-	-	0.0010	0.0011	0.0010	0.0011	0.0011	0.0010	0.0011
Cyanide - wad	mg/l	-	-	-	0.0010	0.0048	0.0010	0.0048	0.0048	0.0010	0.0048
Nutrients											
Nitrate	mg-N/L	2.9	-	-	0.0065	0.33	0.0090	0.28	0.33	0.0090	0.28
Nitrite	mg-N/L	0.060	-	-	0.0010	0.017	0.0011	0.017	0.017	0.0011	0.017
Total ammonia	mg-N/L	4.3[a]	-	-	0.0050	0.066	0.0050	0.0050	0.066	0.0050	0.0050
Metals											
Aluminum	mg/L	0.10[b, c]	-	-	0.011	0.031	0.020	0.031	**0.11**[C]	0.089	**0.11**[C]
Antimony	mg/L	-	-	-	0.000050	0.0029	0.00011	0.0029	0.0029	0.00011	0.0029
Arsenic	mg/L	0.0050	0.010	0.50	0.00020	0.0046	0.0023	0.0046	0.0049	0.0025	0.0049
Barium	mg/L	-	-	-	0.0051	0.027	0.0061	0.018	0.027	0.0065	0.018
Beryllium	mg/L	-	-	-	0.00020	0.00022	0.00020	0.00022	0.00023	0.00021	0.00023
Bismuth	mg/L	-	-	-	0.00050	0.00070	0.00051	0.00061	0.00070	0.00051	0.00061
Boron	mg/L	1.5	-	-	0.0050	0.019	0.0057	0.014	0.019	0.0057	0.014
Cadmium	mg/L	0.000040[d]	-	-	0.000010	0.000019	0.000013	0.000019	0.000019	0.000013	0.000019
Calcium	mg/L	-	-	-	2.1	59	6.4	39	59	6.4	39
Chromium	mg/L	0.0010	-	-	0.00015	0.00021	0.00015	0.00021	0.00052	0.00042	0.00052
Cobalt	mg/L	-	-	-	0.00012	0.0023	0.00015	0.0023	0.0023	0.00019	0.0023
Copper	mg/L	0.0020[d]	0.0046	0.30	0.0014	**0.0021**[C]	0.0016	**0.0021**[C]	**0.0022**[C]	0.0017	**0.0022**[C]
Iron	mg/L	0.30	-	-	0.014	0.057	0.025	0.057	0.29	0.23	0.29
Lead	mg/L	0.0010[d]	-	0.20	0.000050	0.000093	0.000051	0.000093	0.00011	0.000068	0.00011
Lithium	mg/L	-	-	-	0.0050	0.030	0.0062	0.019	0.030	0.0062	0.019
Magnesium	mg/L	-	-	-	1.3	5.0	1.7	4.1	5.0	1.7	4.1
Manganese	mg/L	-	-	-	0.0019	0.013	0.0041	0.012	0.013	0.0050	0.012
Mercury	mg/L	0.000026	-	-	0.000010	0.000013	0.000011	0.000013	**0.000036**[C]	**0.000030**[C]	**0.000036**[C]
Molybdenum	mg/L	0.073	-	-	0.000050	0.0051	0.00018	0.0051	0.0051	0.00018	0.0051
Nickel	mg/L	0.025[d]	-	0.50	0.0033	0.0065	0.0047	0.0065	0.0065	0.0048	0.0065
Phosphorus	mg/L	-	-	-	0.0039	0.016	0.0045	0.016	0.018	0.0062	0.018
Potassium	mg/L	-	-	-	0.34	2.2	0.38	2.2	2.2	0.40	2.2
Selenium	mg/L	0.0010	-	-	0.00010	0.00027	0.00014	0.00027	0.00027	0.00014	0.00027
Silicon	mg/L	-	-	-	0.28	0.32	0.28	0.32	0.32	0.28	0.32
Silver	mg/L	0.00025	-	-	0.000010	0.000047	0.000011	0.000047	0.000047	0.000011	0.000047
Sodium	mg/L	-	-	-	0.66	24	1.8	18	24	1.8	18
Strontium	mg/L	-	-	-	0.0094	1.1	0.065	0.65	1.1	0.065	0.65
Tellurium	mg/L	-	-	-	0.0020	0.0022	0.0020	0.0022	0.0022	0.0020	0.0022
Thallium	mg/L	0.00080	-	-	0.000050	0.000070	0.000051	0.000061	0.000070	0.000051	0.000062
Tin	mg/L	-	-	-	0.00010	0.00014	0.00010	0.00014	0.00014	0.00010	0.00014
Titanium	mg/L	-	-	-	0.010	0.011	0.010	0.011	0.015	0.013	0.015
Uranium	mg/L	0.015	-	-	0.000010	0.000014	0.000010	0.000012	0.000016	0.000014	0.000016
Vanadium	mg/L	-	-	-	0.000053	0.00025	0.000059	0.00025	0.00040	0.00019	0.00040
Zinc	mg/L	0.030	-	0.50	0.0030	0.0045	0.0034	0.0044	0.0045	0.0035	0.0045
Zirconium	mg/L	-	-	-	0.00040	0.00044	0.00041	0.00044	0.00044	0.00041	0.00044

Notes:

[a] = the ammonia guideline is pH and temperature dependent. The guideline that results in the minimum ammonia guideline (4.3208 mg-N/L) is based on the combination of field pH (7.5) and water temperature (4.0°C). Guidelines calculated with temperature and pH values falling outside the defined range (i.e., pH 6.0 to 10.0 and temperature 0°C to 30°C) should be used with caution, as the WQG does not necessarily accurately reflect toxic effects at the low and high pH and

[b] = guideline is pH dependent. The guideline range shown is based on the pH observed in the dataset (7.5). The guideline is calculated based on the individual pH for each sample.

[c] = guideline is pH dependent: 0.005 mg/L at pH < 6.5 and 0.1 mg/L at pH ≥ 6.5.

[d] = guideline is hardness dependent. The guideline range shown is based on the hardness observed in the dataset (11 mg/L). The guideline is calculated based on the individual hardness

[C] = concentration is higher than the chronic aquatic life CCME guideline or outside the recommended pH, DO or total alkalinity range.

[S] = concentration is higher than the site-specific guideline guideline.

[M] = concentration is higher than the metal mining effluent regulations (MMER, 2017) guideline.

Bolded concentrations are higher than water quality guidelines.

Water quality data and guidelines shown in this table were rounded to reflect laboratory or field instrument precision after comparisons to guidelines. Therefore, values slightly above guidelines may be displayed as being equal to the guidelines and identified as exceedances. Concentrations equal to the guideline values were not identified as exceedances.

- = no guideline or no data.

Prepared: TL
Reviewed: KS
Approved: KS

GOLDER

	Unit	Guidelines			Goose Background Source	PN03					
		CCME Freshwater (Chronic)	Site Specific	MMER		Dissolved Metals			Total Metals		
						Absolute Maximum	Long-Term Average	Max at Closure	Absolute Maximum	Long-Term Average	Max at Closure
Conventional Parameters											
Hardness, as $CaCO_3$	mg/L	-	-	-	11	11	11	11	11	11	11
Total alkalinity, as $CaCO_3$	mg/L	-	-	-	2.0	15	6.8	15	15	6.8	15
Total dissolved solids	mg/L	-	-	-	23	264	45	256	264	45	256
Total suspended solids	mg/L	-	-	-	3.0	3.9	3.1	3.5	3.9	3.1	3.5
Total organic carbon	mg/L	-	-	-	4.0	5.2	4.1	4.6	5.2	4.1	4.6
Major Ions											
Chloride	mg/L	120	-	-	1.0	57	3.9	47	57	3.9	47
Cyanide	mg/L	0.0050	-	1.0	0.00054	0.00070	0.00054	0.00054	0.00070	0.00054	0.00054
Sulphate	mg/L	-	-	-	4.1	78	16	78	78	16	78
Free cyanide	mg/l	-	-	-	0.0010	0.0013	0.0010	0.0012	0.0013	0.0010	0.0012
Cyanide - wad	mg/l	-	-	-	0.0010	0.0086	0.0011	0.0086	0.0086	0.0011	0.0086
Nutrients											
Nitrate	mg-N/L	2.9	-	-	0.0065	0.77	0.012	0.55	0.77	0.012	0.55
Nitrite	mg-N/L	0.060	-	-	0.0010	0.036	0.0013	0.032	0.036	0.0013	0.032
Total ammonia	mg-N/L	4.3[a]	-	-	0.0050	0.14	0.0050	0.0050	0.14	0.0050	0.0050
Metals											
Aluminum	mg/L	0.10[b, c]	-	-	0.011	0.050	0.029	0.050	**0.21**[C]	**0.17**[C]	**0.21**[C]
Antimony	mg/L	-	-	-	0.000050	0.0058	0.00018	0.0058	0.0058	0.00018	0.0058
Arsenic	mg/L	0.0050	0.010	0.50	0.00020	**0.0090**[C]	0.0044	**0.0090**[C]	**0.0095**[C]	0.0050	**0.0095**[C]
Barium	mg/L	-	-	-	0.0051	0.050	0.0072	0.030	0.050	0.0078	0.030
Beryllium	mg/L	-	-	-	0.00020	0.00026	0.00021	0.00023	0.00026	0.00022	0.00026
Bismuth	mg/L	-	-	-	0.00050	0.00091	0.00052	0.00073	0.00091	0.00052	0.00073
Boron	mg/L	1.5	-	-	0.0050	0.034	0.0063	0.023	0.034	0.0064	0.023
Cadmium	mg/L	0.000040[d]	-	-	0.000010	0.000028	0.000015	0.000028	0.000028	0.000015	0.000028
Calcium	mg/L	-	-	-	2.1	121	11	75	121	11	75
Chromium	mg/L	0.0010	-	-	0.00015	0.00027	0.00016	0.00027	0.00088	0.00069	0.00088
Cobalt	mg/L	-	-	-	0.00012	0.0045	0.00018	0.0045	0.0045	0.00027	0.0045
Copper	mg/L	0.0020[d]	0.0046	0.30	0.0014	**0.0028**[C]	0.0018	**0.0028**[C]	**0.0030**[C]	**0.0021**[C]	**0.0030**[C]
Iron	mg/L	0.30	-	-	0.014	0.099	0.036	0.099	**0.56**[C]	**0.45**[C]	**0.56**[C]
Lead	mg/L	0.0010[d]	-	0.20	0.000050	0.00014	0.000053	0.00014	0.00018	0.000087	0.00018
Lithium	mg/L	-	-	-	0.0050	0.057	0.0074	0.033	0.057	0.0074	0.033
Magnesium	mg/L	-	-	-	1.3	9.0	2.1	6.9	9.0	2.1	6.9
Manganese	mg/L	-	-	-	0.0019	0.025	0.0064	0.021	0.025	0.0082	0.023
Mercury	mg/L	0.000026	-	-	0.000010	0.000016	0.000012	0.000016	**0.000061**[C]	**0.000051**[C]	**0.000061**[C]
Molybdenum	mg/L	0.073	-	-	0.000050	0.010	0.00031	0.010	0.010	0.00031	0.010
Nickel	mg/L	0.025[d]	-	0.50	0.0033	0.0096	0.0062	0.0096	0.0096	0.0063	0.0096
Phosphorus	mg/L	-	-	-	0.0039	0.029	0.0051	0.028	0.032	0.0086	0.032
Potassium	mg/L	-	-	-	0.34	4.0	0.43	4.0	4.0	0.47	4.0
Selenium	mg/L	0.0010	-	-	0.00010	0.00043	0.00018	0.00043	0.00043	0.00018	0.00043
Silicon	mg/L	-	-	-	0.28	0.37	0.29	0.37	0.37	0.29	0.37
Silver	mg/L	0.00025	-	-	0.000010	0.000084	0.000012	0.000084	0.000084	0.000013	0.000084
Sodium	mg/L	-	-	-	0.66	50	3.1	36	50	3.1	36
Strontium	mg/L	-	-	-	0.0094	2.3	0.12	1.3	2.3	0.12	1.3
Tellurium	mg/L	-	-	-	0.0020	0.0026	0.0021	0.0023	0.0026	0.0021	0.0023
Thallium	mg/L	0.00080	-	-	0.000050	0.000091	0.000052	0.000072	0.000091	0.000053	0.000073
Tin	mg/L	-	-	-	0.00010	0.00018	0.00010	0.00017	0.00018	0.00010	0.00017
Titanium	mg/L	-	-	-	0.010	0.013	0.010	0.012	0.020	0.016	0.019
Uranium	mg/L	0.015	-	-	0.000010	0.000018	0.000010	0.000015	0.000022	0.000018	0.000022
Vanadium	mg/L	-	-	-	0.000053	0.00044	0.000065	0.00044	0.00074	0.00034	0.00074
Zinc	mg/L	0.030	-	0.50	0.0030	0.0061	0.0038	0.0058	0.0061	0.0041	0.0060
Zirconium	mg/L	-	-	-	0.00040	0.00052	0.00041	0.00047	0.00052	0.00041	0.00047

Notes:

[(a)] = the ammonia guideline is pH and temperature dependent. The guideline that results in the minimum ammonia guideline (4.3208 mg-N/L) is based on the combination of field pH (7.5) and water temperature (4.0°C). Guidelines calculated with temperature and pH values falling outside the defined range (i.e., pH 6.0 to 10.0 and temperature 0°C to 30°C) should be used with caution, as the WQG does not necessarily accurately reflect toxic effects at the low and high pH and

[(b)] = guideline is pH dependent. The guideline range shown is based on the pH observed in the dataset (7.5). The guideline is calculated based on the individual pH for each sample.

[(c)] = guideline is pH dependent: 0.005 mg/L at pH < 6.5 and 0.1 mg/L at pH ≥ 6.5.

[(d)] = guideline is hardness dependent. The guideline range shown is based on the hardness observed in the dataset (11 mg/L). The guideline is calculated based on the individual hardness

[(C)] = concentration is higher than the chronic aquatic life CCME guideline or outside the recommended pH, DO or total alkalinity range.

[(S)] = concentration is higher than the site-specific guideline guideline.

[(M)] = concentration is higher than the metal mining effluent regulations (MMER, 2017) guideline.

Bolded concentrations are higher than water quality guidelines.

Water quality data and guidelines shown in this table were rounded to reflect laboratory or field instrument precision after comparisons to guidelines. Therefore, values slightly above guidelines may be displayed as being equal to the guidelines and identified as exceedances. Concentrations equal to the guideline values were not identified as exceedances.

- = no guideline or no data.

	Unit	Guidelines			Goose Background Source	PN04					
		CCME Freshwater (Chronic)	Site Specific	MMER		Dissolved Metals			Total Metals		
						Absolute Maximum	Long-Term Average	Max at Closure	Absolute Maximum	Long-Term Average	Max at Closure
Conventional Parameters											
Hardness, as $CaCO_3$	mg/L	-	-	-	11	11	11	11	11	11	11
Total alkalinity, as $CaCO_3$	mg/L	-	-	-	2.0	12	11	12	12	11	12
Total dissolved solids	mg/L	-	-	-	23	1,053	94	404	1,053	94	404
Total suspended solids	mg/L	-	-	-	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Total organic carbon	mg/L	-	-	-	4.0	4.1	4.0	4.1	4.1	4.0	4.1
Major Ions											
Chloride	mg/L	120	-	-	1.0	**247[(C)]**	12	85	**247[(C)]**	12	85
Cyanide	mg/L	0.0050	-	1.0	0.00054	0.00054	0.00054	0.00054	0.00054	0.00054	0.00054
Sulphate	mg/L	-	-	-	4.1	62	26	34	62	26	34
Free cyanide	mg/l	-	-	-	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Cyanide - wad	mg/l	-	-	-	0.0010	0.0020	0.0010	0.0013	0.0020	0.0010	0.0013
Nutrients											
Nitrate	mg-N/L	2.9	-	-	0.0065	1.6	0.019	0.13	1.6	0.019	0.13
Nitrite	mg-N/L	0.060	-	-	0.0010	**0.081[(C)]**	0.0017	0.0083	**0.081[(C)]**	0.0017	0.0083
Total ammonia	mg-N/L	4.3[(a)]	-	-	0.0050	0.99	0.0050	0.0053	0.99	0.0050	0.0053
Metals											
Aluminum	mg/L	0.10[(b, c)]	-	-	0.011	0.049	0.044	0.048	**0.18[(C)]**	**0.17[(C)]**	**0.18[(C)]**
Antimony	mg/L	-	-	-	0.000050	0.0011	0.00029	0.00057	0.0011	0.00029	0.00058
Arsenic	mg/L	0.0050	0.010	0.50	0.00020	**0.011[(C, S)]**	**0.0083[(C)]**	**0.0095[(C)]**	**0.012[(C, S)]**	**0.0089[(C)]**	**0.010[(C)]**
Barium	mg/L	-	-	-	0.0051	0.20	0.013	0.072	0.20	0.013	0.074
Beryllium	mg/L	-	-	-	0.00020	0.00021	0.00020	0.00020	0.00024	0.00022	0.00023
Bismuth	mg/L	-	-	-	0.00050	0.0019	0.00053	0.00095	0.0019	0.00053	0.00096
Boron	mg/L	1.5	-	-	0.0050	0.13	0.0098	0.048	0.13	0.0098	0.049
Cadmium	mg/L	0.000040[(d)]	-	-	0.000010	**0.000042[(C)]**	0.000020	0.000028	**0.000042[(C)]**	0.000020	0.000028
Calcium	mg/L	-	-	-	2.1	522	29	187	522	29	189
Chromium	mg/L	0.0010	-	-	0.00015	0.00034	0.00015	0.00021	0.00082	0.00065	0.00073
Cobalt	mg/L	-	-	-	0.00012	0.0011	0.00022	0.00049	0.0011	0.00031	0.00059
Copper	mg/L	0.0020[(d)]	0.0046	0.30	0.0014	**0.0028[(C)]**	**0.0021[(C)]**	**0.0025[(C)]**	**0.0030[(C)]**	**0.0024[(C)]**	**0.0027[(C)]**
Iron	mg/L	0.30	-	-	0.014	0.17	0.060	0.10	**0.56[(C)]**	**0.44[(C)]**	**0.50[(C)]**
Lead	mg/L	0.0010[(d)]	-	0.20	0.000050	0.00020	0.000054	0.000099	0.00021	0.000086	0.00013
Lithium	mg/L	-	-	-	0.0050	0.23	0.014	0.083	0.23	0.014	0.083
Magnesium	mg/L	-	-	-	1.3	34	3.4	13	34	3.4	13
Manganese	mg/L	-	-	-	0.0019	0.096	0.012	0.039	0.096	0.014	0.042
Mercury	mg/L	0.000026	-	-	0.000010	0.000013	0.000013	0.000013	**0.000052[(C)]**	**0.000049[(C)]**	**0.000052[(C)]**
Molybdenum	mg/L	0.073	-	-	0.000050	0.0029	0.00054	0.0013	0.0029	0.00054	0.0014
Nickel	mg/L	0.025[(d)]	-	0.50	0.0033	0.0095	0.0088	0.0093	0.0096	0.0089	0.0094
Phosphorus	mg/L	-	-	-	0.0039	0.11	0.0081	0.041	0.11	0.012	0.045
Potassium	mg/L	-	-	-	0.34	8.5	0.65	3.2	8.5	0.69	3.2
Selenium	mg/L	0.0010	-	-	0.00010	0.00044	0.00025	0.00034	0.00044	0.00025	0.00034
Silicon	mg/L	-	-	-	0.28	0.28	0.28	0.28	0.28	0.28	0.28
Silver	mg/L	0.00025	-	-	0.000010	0.000048	0.000014	0.000025	0.000048	0.000014	0.000026
Sodium	mg/L	-	-	-	0.66	217	9.6	76	217	9.6	77
Strontium	mg/L	-	-	-	0.0094	10	0.44	3.6	10	0.44	3.7
Tellurium	mg/L	-	-	-	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020
Thallium	mg/L	0.00080	-	-	0.000050	0.00019	0.000053	0.000095	0.00019	0.000054	0.000097
Tin	mg/L	-	-	-	0.00010	0.00038	0.00011	0.00019	0.00038	0.00011	0.00019
Titanium	mg/L	-	-	-	0.010	0.013	0.010	0.010	0.018	0.016	0.017
Uranium	mg/L	0.015	-	-	0.000010	0.000037	0.000011	0.000019	0.000041	0.000018	0.000026
Vanadium	mg/L	-	-	-	0.000053	0.0011	0.000095	0.00043	0.0013	0.00034	0.00069
Zinc	mg/L	0.030	-	0.50	0.0030	0.013	0.0046	0.0074	0.013	0.0049	0.0077
Zirconium	mg/L	-	-	-	0.00040	0.00041	0.00040	0.00041	0.00041	0.00040	0.00041

Notes:

[(a)] = the ammonia guideline is pH and temperature dependent. The guideline that results in the minimum ammonia guideline (4.3208 mg-N/L) is based on the combination of field pH (7.5) and water temperature (4.0°C). Guidelines calculated with temperature and pH values falling outside the defined range (i.e., pH 6.0 to 10.0 and temperature 0°C to 30°C) should be used with caution, as the WQG does not necessarily accurately reflect toxic effects at the low and high pH and

[(b)] = guideline is pH dependent. The guideline range shown is based on the pH observed in the dataset (7.5). The guideline is calculated based on the individual pH for each sample.

[(c)] = guideline is pH dependent: 0.005 mg/L at pH < 6.5 and 0.1 mg/L at pH ≥ 6.5.

[(d)] = guideline is hardness dependent. The guideline range shown is based on the hardness observed in the dataset (11 mg/L). The guideline is calculated based on the individual hardness

[(C)] = concentration is higher than the chronic aquatic life CCME guideline or outside the recommended pH, DO or total alkalinity range.

[(S)] = concentration is higher than the site-specific guideline guideline.

[(M)] = concentration is higher than the metal mining effluent regulations (MMER, 2017) guideline.

Bolded concentrations are higher than water quality guidelines.

Water quality data and guidelines shown in this table were rounded to reflect laboratory or field instrument precision after comparisons to guidelines. Therefore, values slightly above guidelines may be displayed as being equal to the guidelines and identified as exceedances. Concentrations equal to the guideline values were not identified as exceedances.

- = no guideline or no data.

	Unit	Guidelines			Goose Background Source	PN06					
		CCME Freshwater (Chronic)	Site Specific	MMER		Dissolved Metals			Total Metals		
						Absolute Maximum	Long-Term Average	Max at Closure	Absolute Maximum	Long-Term Average	Max at Closure
Conventional Parameters											
Hardness, as $CaCO_3$	mg/L	-	-	-	11	11	11	11	11	11	11
Total alkalinity, as $CaCO_3$	mg/L	-	-	-	2.0	42	8.6	38	42	8.6	38
Total dissolved solids	mg/L	-	-	-	23	564	42	492	564	42	492
Total suspended solids	mg/L	-	-	-	3.0	3.1	3.0	3.1	3.1	3.0	3.1
Total organic carbon	mg/L	-	-	-	4.0	4.2	4.1	4.2	4.2	4.1	4.2
Major Ions											
Chloride	mg/L	120	-	-	1.0	100	1.1	86	100	1.1	86
Cyanide	mg/L	0.0050	-	1.0	0.00054	0.00055	0.00054	0.00055	0.00055	0.00054	0.00055
Sulphate	mg/L	-	-	-	4.1	282	22	246	282	22	246
Free cyanide	mg/l	-	-	-	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Cyanide - wad	mg/l	-	-	-	0.0010	0.034	0.0010	0.029	0.034	0.0010	0.029
Nutrients											
Nitrate	mg-N/L	2.9	-	-	0.0065	2.2	0.0091	1.9	2.2	0.0091	1.9
Nitrite	mg-N/L	0.060	-	-	0.0010	**0.13**[(C)]	0.0011	**0.11**[(C)]	**0.13**[(C)]	0.0011	**0.11**[(C)]
Total ammonia	mg-N/L	4.3[(a)]	-	-	0.0050	0.24	0.0050	0.0072	0.24	0.0050	0.0072
Metals											
Aluminum	mg/L	0.10[(b, c)]	-	-	0.011	**0.11**[(C)]	0.033	0.099	**0.40**[(C)]	**0.32**[(C)]	**0.38**[(C)]
Antimony	mg/L	-	-	-	0.000050	0.025	0.00021	0.022	0.025	0.00021	0.022
Arsenic	mg/L	0.0050	0.010	0.50	0.00020	**0.023**[(C, S)]	**0.0057**[(C)]	**0.020**[(C, S)]	**0.024**[(C, S)]	**0.0070**[(C)]	**0.022**[(C, S)]
Barium	mg/L	-	-	-	0.0051	0.0090	0.0052	0.0085	0.010	0.0062	0.0099
Beryllium	mg/L	-	-	-	0.00020	0.00021	0.00020	0.00021	0.00023	0.00023	0.00023
Bismuth	mg/L	-	-	-	0.00050	0.00052	0.00051	0.00052	0.00052	0.00051	0.00052
Boron	mg/L	1.5	-	-	0.0050	0.015	0.0051	0.013	0.015	0.0051	0.014
Cadmium	mg/L	0.000040[(d)]	-	-	0.000010	**0.000051**[(C)]	0.000016	**0.000046**[(C)]	**0.000051**[(C)]	0.000016	**0.000048**[(C)]
Calcium	mg/L	-	-	-	2.1	50	6.2	44	50	6.2	45
Chromium	mg/L	0.0010	-	-	0.00015	0.00048	0.00015	0.00044	**0.0016**[(C)]	**0.0012**[(C)]	**0.0015**[(C)]
Cobalt	mg/L	-	-	-	0.00012	0.019	0.00018	0.016	0.019	0.00037	0.017
Copper	mg/L	0.0020[(d)]	0.0046	0.30	0.0014	**0.0044**[(C)]	0.0019	**0.0041**[(C)]	**0.0049**[(C, S)]	**0.0024**[(C)]	**0.0046**[(C)]
Iron	mg/L	0.30	-	-	0.014	0.24	0.039	0.21	**1.1**[(C)]	**0.87**[(C)]	**1.0**[(C)]
Lead	mg/L	0.0010[(d)]	-	0.20	0.000050	0.00033	0.000051	0.00029	0.00039	0.00012	0.00036
Lithium	mg/L	-	-	-	0.0050	0.0052	0.0051	0.0052	0.0052	0.0051	0.0052
Magnesium	mg/L	-	-	-	1.3	8.7	1.8	7.8	8.7	2.0	8.0
Manganese	mg/L	-	-	-	0.0019	0.033	0.0060	0.029	0.036	0.010	0.034
Mercury	mg/L	0.000026	-	-	0.000010	0.000024	0.000012	0.000022	**0.00010**[(C)]	**0.000090**[(C)]	**0.000099**[(C)]
Molybdenum	mg/L	0.073	-	-	0.000050	0.044	0.00037	0.038	0.044	0.00038	0.038
Nickel	mg/L	0.025[(d)]	-	0.50	0.0033	0.018	0.0067	0.016	0.018	0.0071	0.017
Phosphorus	mg/L	-	-	-	0.0039	0.061	0.0040	0.053	0.066	0.011	0.061
Potassium	mg/L	-	-	-	0.34	13	0.35	11	13	0.41	12
Selenium	mg/L	0.0010	-	-	0.00010	**0.0011**[(C)]	0.00021	0.00097	**0.0011**[(C)]	0.00021	0.00099
Silicon	mg/L	-	-	-	0.28	0.44	0.28	0.42	0.44	0.28	0.42
Silver	mg/L	0.00025	-	-	0.000010	**0.00031**[(C)]	0.000012	**0.00027**[(C)]	**0.00031**[(C)]	0.000013	**0.00028**[(C)]
Sodium	mg/L	-	-	-	0.66	56	0.71	49	56	0.71	50
Strontium	mg/L	-	-	-	0.0094	0.12	0.0096	0.11	0.12	0.0096	0.11
Tellurium	mg/L	-	-	-	0.0020	0.0021	0.0020	0.0021	0.0021	0.0020	0.0021
Thallium	mg/L	0.00080	-	-	0.000050	0.000052	0.000051	0.000052	0.000052	0.000051	0.000052
Tin	mg/L	-	-	-	0.00010	0.00021	0.00010	0.00020	0.00021	0.00010	0.00020
Titanium	mg/L	-	-	-	0.010	0.010	0.010	0.010	0.023	0.022	0.022
Uranium	mg/L	0.015	-	-	0.000010	0.000010	0.000010	0.000010	0.000025	0.000025	0.000025
Vanadium	mg/L	-	-	-	0.000053	0.0013	0.000054	0.0011	0.0018	0.00061	0.0017
Zinc	mg/L	0.030	-	0.50	0.0030	0.0059	0.0038	0.0056	0.0064	0.0044	0.0063
Zirconium	mg/L	-	-	-	0.00040	0.00042	0.00041	0.00042	0.00042	0.00041	0.00042

Notes:

[(a)] = the ammonia guideline is pH and temperature dependent. The guideline that results in the minimum ammonia guideline (4.3208 mg-N/L) is based on the combination of field pH (7.5) and water temperature (4.0°C). Guidelines calculated with temperature and pH values falling outside the defined range (i.e., pH 6.0 to 10.0 and temperature 0°C to 30°C) should be used with caution, as the WQG does not necessarily accurately reflect toxic effects at the low and high pH and

[(b)] = guideline is pH dependent. The guideline range shown is based on the pH observed in the dataset (7.5). The guideline is calculated based on the individual pH for each sample.

[(c)] = guideline is pH dependent: 0.005 mg/L at pH < 6.5 and 0.1 mg/L at pH ≥ 6.5.

[(d)] = guideline is hardness dependent. The guideline range shown is based on the hardness observed in the dataset (11 mg/L). The guideline is calculated based on the individual hardness

[(C)] = concentration is higher than the chronic aquatic life CCME guideline or outside the recommended pH, DO or total alkalinity range.

[(S)] = concentration is higher than the site-specific guideline guideline.

[(M)] = concentration is higher than the metal mining effluent regulations (MMER, 2017) guideline.

Bolded concentrations are higher than water quality guidelines.

Water quality data and guidelines shown in this table were rounded to reflect laboratory or field instrument precision after comparisons to guidelines. Therefore, values slightly above guidelines may be displayed as being equal to the guidelines and identified as exceedances. Concentrations equal to the guideline values were not identified as exceedances.

\- = no guideline or no data.

Attachment 1A
Water Quality Results - Prediction Nodes

	Unit	Guidelines			Goose Background Source	PN09					
		CCME Freshwater (Chronic)	Site Specific	MMER		Dissolved Metals			Total Metals		
						Absolute Maximum	Long-Term Average	Max at Closure	Absolute Maximum	Long-Term Average	Max at Closure
Conventional Parameters											
Hardness, as $CaCO_3$	mg/L	-	-	-	11	11	11	11	11	11	11
Total alkalinity, as $CaCO_3$	mg/L	-	-	-	2.0	7.5	6.0	6.5	7.5	6.0	6.5
Total dissolved solids	mg/L	-	-	-	23	41	28	30	41	28	30
Total suspended solids	mg/L	-	-	-	3.0	3.1	3.0	3.1	3.1	3.0	3.1
Total organic carbon	mg/L	-	-	-	4.0	4.1	4.0	4.1	4.1	4.0	4.1
Major Ions											
Chloride	mg/L	120	-	-	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Cyanide	mg/L	0.0050	-	1.0	0.00054	0.00055	0.00054	0.00055	0.00055	0.00054	0.00055
Sulphate	mg/L	-	-	-	4.1	20	12	13	20	12	13
Free cyanide	mg/l	-	-	-	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Cyanide - wad	mg/l	-	-	-	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Nutrients											
Nitrate	mg-N/L	2.9	-	-	0.0065	2.3	0.0075	0.073	2.3	0.0075	0.073
Nitrite	mg-N/L	0.060	-	-	0.0010	**0.11[C]**	0.0010	0.0043	**0.11[C]**	0.0010	0.0043
Total ammonia	mg-N/L	4.3[a]	-	-	0.0050	1.4	0.0056	0.046	1.4	0.0056	0.046
Metals											
Aluminum	mg/L	0.10[b, c]	-	-	0.011	0.049	0.036	0.040	**0.23[C]**	**0.22[C]**	**0.23[C]**
Antimony	mg/L	-	-	-	0.000050	0.00024	0.00018	0.00020	0.00024	0.00018	0.00020
Arsenic	mg/L	0.0050	0.010	0.50	0.00020	**0.010[C]**	**0.0057[C]**	**0.0065[C]**	**0.011[C, S]**	**0.0064[C]**	**0.0071[C]**
Barium	mg/L	-	-	-	0.0051	0.0053	0.0052	0.0053	0.0056	0.0055	0.0055
Beryllium	mg/L	-	-	-	0.00020	0.00021	0.00020	0.00021	0.00021	0.00021	0.00021
Bismuth	mg/L	-	-	-	0.00050	0.00051	0.00050	0.00051	0.00051	0.00050	0.00051
Boron	mg/L	1.5	-	-	0.0050	0.0051	0.0050	0.0051	0.0051	0.0050	0.0051
Cadmium	mg/L	0.000040[d]	-	-	0.000010	0.000025	0.000019	0.000020	0.000025	0.000020	0.000021
Calcium	mg/L	-	-	-	2.1	5.5	4.6	4.9	5.5	4.6	4.9
Chromium	mg/L	0.0010	-	-	0.00015	0.00015	0.00015	0.00015	**0.0011[C]**	**0.0011[C]**	**0.0011[C]**
Cobalt	mg/L	-	-	-	0.00012	0.00023	0.00019	0.00020	0.00037	0.00036	0.00036
Copper	mg/L	0.0020[d]	0.0046	0.30	0.0014	0.0018	0.0017	0.0018	**0.0022[C]**	**0.0021[C]**	**0.0022[C]**
Iron	mg/L	0.30	-	-	0.014	0.082	0.056	0.061	**0.47[C]**	**0.46[C]**	**0.47[C]**
Lead	mg/L	0.0010[d]	-	0.20	0.000050	0.000051	0.000050	0.000051	0.000099	0.000097	0.000099
Lithium	mg/L	-	-	-	0.0050	0.0051	0.0050	0.0051	0.0051	0.0050	0.0051
Magnesium	mg/L	-	-	-	1.3	1.9	1.7	1.8	1.9	1.8	1.9
Manganese	mg/L	-	-	-	0.0019	0.013	0.0089	0.0098	0.015	0.012	0.012
Mercury	mg/L	0.000026	-	-	0.000010	0.000011	0.000011	0.000011	**0.000068[C]**	**0.000066[C]**	**0.000068[C]**
Molybdenum	mg/L	0.073	-	-	0.000050	0.00025	0.00020	0.00022	0.00025	0.00022	0.00024
Nickel	mg/L	0.025[d]	-	0.50	0.0033	0.013	0.0090	0.0098	0.013	0.0095	0.010
Phosphorus	mg/L	-	-	-	0.0039	0.0040	0.0039	0.0040	0.0088	0.0086	0.0088
Potassium	mg/L	-	-	-	0.34	0.35	0.34	0.35	0.36	0.36	0.36
Selenium	mg/L	0.0010	-	-	0.00010	0.00017	0.00015	0.00016	0.00017	0.00016	0.00016
Silicon	mg/L	-	-	-	0.28	0.29	0.28	0.29	0.29	0.28	0.29
Silver	mg/L	0.00025	-	-	0.000010	0.000011	0.000011	0.000011	0.000012	0.000012	0.000012
Sodium	mg/L	-	-	-	0.66	0.68	0.67	0.68	0.68	0.67	0.68
Strontium	mg/L	-	-	-	0.0094	0.0097	0.0095	0.0097	0.0097	0.0095	0.0097
Tellurium	mg/L	-	-	-	0.0020	0.0021	0.0020	0.0021	0.0021	0.0020	0.0021
Thallium	mg/L	0.00080	-	-	0.000050	0.000051	0.000050	0.000051	0.000051	0.000050	0.000051
Tin	mg/L	-	-	-	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010
Titanium	mg/L	-	-	-	0.010	0.010	0.010	0.010	0.016	0.016	0.016
Uranium	mg/L	0.015	-	-	0.000010	0.000010	0.000010	0.000010	0.000021	0.000021	0.000021
Vanadium	mg/L	-	-	-	0.000053	0.000054	0.000053	0.000054	0.00042	0.00041	0.00042
Zinc	mg/L	0.030	-	0.50	0.0030	0.0050	0.0042	0.0044	0.0052	0.0048	0.0049
Zirconium	mg/L	-	-	-	0.00040	0.00041	0.00040	0.00041	0.00041	0.00040	0.00041

Notes:

[a] = the ammonia guideline is pH and temperature dependent. The guideline that results in the minimum ammonia guideline (4.3208 mg-N/L) is based on the combination of field pH (7.5) and water temperature (4.0°C). Guidelines calculated with temperature and pH values falling outside the defined range (i.e., pH 6.0 to 10.0 and temperature 0°C to 30°C) should be used with caution, as the WQG does not necessarily accurately reflect toxic effects at the low and high pH and

[b] = guideline is pH dependent. The guideline range shown is based on the pH observed in the dataset (7.5). The guideline is calculated based on the individual pH for each sample.

[c] = guideline is pH dependent: 0.005 mg/L at pH < 6.5 and 0.1 mg/L at pH ≥ 6.5.

[d] = guideline is hardness dependent. The guideline range shown is based on the hardness observed in the dataset (11 mg/L). The guideline is calculated based on the individual hardness

[C] = concentration is higher than the chronic aquatic life CCME guideline or outside the recommended pH, DO or total alkalinity range.

[S] = concentration is higher than the site-specific guideline guideline.

[M] = concentration is higher than the metal mining effluent regulations (MMER, 2017) guideline.

Bolded concentrations are higher than water quality guidelines.

Water quality data and guidelines shown in this table were rounded to reflect laboratory or field instrument precision after comparisons to guidelines. Therefore, values slightly above guidelines may be displayed as being equal to the guidelines and identified as exceedances. Concentrations equal to the guideline values were not identified as exceedances.

- = no guideline or no data.

Prepared: TL
Reviewed: KS
Approved: KS

GOLDER

	Unit	Guidelines			Goose Background Source	PN10					
		CCME Freshwater (Chronic)	Site Specific	MMER		Dissolved Metals			Total Metals		
						Absolute Maximum	Long-Term Average	Max at Closure	Absolute Maximum	Long-Term Average	Max at Closure
Conventional Parameters											
Hardness, as $CaCO_3$	mg/L	-	-	-	11	11	11	11	11	11	11
Total alkalinity, as $CaCO_3$	mg/L	-	-	-	2.0	23	21	22	23	21	22
Total dissolved solids	mg/L	-	-	-	23	2,968	198	1,016	2,968	198	1,016
Total suspended solids	mg/L	-	-	-	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Total organic carbon	mg/L	-	-	-	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Major Ions											
Chloride	mg/L	120	-	-	1.0	**2,957**[C]	27	**220**[C]	**2,957**[C]	27	**220**[C]
Cyanide	mg/L	0.0050	-	1.0	0.00054	0.00054	0.00054	0.00054	0.00054	0.00054	0.00054
Sulphate	mg/L	-	-	-	4.1	135	51	68	135	51	68
Free cyanide	mg/l	-	-	-	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Cyanide - wad	mg/l	-	-	-	0.0010	0.0038	0.0010	0.0018	0.0038	0.0010	0.0018
Nutrients											
Nitrate	mg-N/L	2.9	-	-	0.0065	0.85	0.037	0.32	0.85	0.037	0.32
Nitrite	mg-N/L	0.060	-	-	0.0010	0.049	0.0027	0.019	0.049	0.0027	0.019
Total ammonia	mg-N/L	4.3[a]	-	-	0.0050	0.024	0.0050	0.0053	0.024	0.0050	0.0053
Metals											
Aluminum	mg/L	0.10[b, c]	-	-	0.011	0.083	0.075	0.082	**0.37**[C]	**0.36**[C]	**0.37**[C]
Antimony	mg/L	-	-	-	0.000050	0.0027	0.00055	0.0012	0.0027	0.00055	0.0012
Arsenic	mg/L	0.0050	0.010	0.50	0.00020	**0.022**[C, S]	**0.016**[C, S]	**0.018**[C, S]	**0.024**[C, S]	**0.018**[C, S]	**0.020**[C, S]
Barium	mg/L	-	-	-	0.0051	0.53	0.024	0.18	0.53	0.025	0.18
Beryllium	mg/L	-	-	-	0.00020	0.00023	0.00020	0.00020	0.00032	0.00024	0.00027
Bismuth	mg/L	-	-	-	0.00050	0.0041	0.00057	0.0017	0.0041	0.00057	0.0017
Boron	mg/L	1.5	-	-	0.0050	0.34	0.017	0.12	0.34	0.017	0.12
Cadmium	mg/L	0.000040[d]	-	-	0.000010	**0.000088**[C]	0.000029	**0.000048**[C]	**0.000088**[C]	0.000029	**0.000048**[C]
Calcium	mg/L	-	-	-	2.1	1,399	65	480	1,399	65	480
Chromium	mg/L	0.0010	-	-	0.00015	0.00067	0.00016	0.00031	**0.0017**[C]	**0.0013**[C]	**0.0014**[C]
Cobalt	mg/L	-	-	-	0.00012	0.0026	0.00033	0.0010	0.0028	0.00052	0.0012
Copper	mg/L	0.0020[d]	0.0046	0.30	0.0014	**0.0045**[C]	**0.0030**[C]	**0.0037**[C]	**0.0051**[C, S]	**0.0035**[C]	**0.0042**[C]
Iron	mg/L	0.30	-	-	0.014	**0.40**[C]	0.099	0.20	**1.2**[C]	**0.97**[C]	**1.1**[C]
Lead	mg/L	0.0010[d]	-	0.20	0.000050	0.00044	0.000058	0.00018	0.00051	0.00013	0.00025
Lithium	mg/L	-	-	-	0.0050	0.61	0.026	0.21	0.61	0.026	0.21
Magnesium	mg/L	-	-	-	1.3	89	6.0	32	89	6.2	32
Manganese	mg/L	-	-	-	0.0019	0.25	0.023	0.094	0.25	0.027	0.098
Mercury	mg/L	0.000026	-	-	0.000010	0.000017	0.000016	0.000016	**0.00010**[C]	**0.000099**[C]	**0.00010**[C]
Molybdenum	mg/L	0.073	-	-	0.000050	0.0077	0.0011	0.0032	0.0077	0.0011	0.0032
Nickel	mg/L	0.025[d]	-	0.50	0.0033	0.014	0.013	0.014	0.015	0.014	0.014
Phosphorus	mg/L	-	-	-	0.0039	0.29	0.014	0.10	0.30	0.022	0.11
Potassium	mg/L	-	-	-	0.34	22	1.1	7.7	22	1.2	7.8
Selenium	mg/L	0.0010	-	-	0.00010	0.00091	0.00043	0.00061	0.00092	0.00043	0.00061
Silicon	mg/L	-	-	-	0.28	0.28	0.28	0.28	0.28	0.28	0.28
Silver	mg/L	0.00025	-	-	0.000010	0.00011	0.000018	0.000048	0.00011	0.000020	0.000049
Sodium	mg/L	-	-	-	0.66	583	22	196	583	22	196
Strontium	mg/L	-	-	-	0.0094	28	1.0	9.3	28	1.0	9.3
Tellurium	mg/L	-	-	-	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020
Thallium	mg/L	0.00080	-	-	0.000050	0.00041	0.000057	0.00017	0.00042	0.000059	0.00017
Tin	mg/L	-	-	-	0.00010	0.00084	0.00011	0.00034	0.00084	0.00012	0.00034
Titanium	mg/L	-	-	-	0.010	0.016	0.010	0.011	0.030	0.023	0.025
Uranium	mg/L	0.015	-	-	0.000010	0.000083	0.000011	0.000033	0.000098	0.000027	0.000049
Vanadium	mg/L	-	-	-	0.000053	0.0030	0.00015	0.0010	0.0035	0.00071	0.0016
Zinc	mg/L	0.030	-	0.50	0.0030	0.029	0.0061	0.013	0.029	0.0067	0.014
Zirconium	mg/L	-	-	-	0.00040	0.00040	0.00040	0.00040	0.00040	0.00040	0.00040

Notes:

[a] = the ammonia guideline is pH and temperature dependent. The guideline that results in the minimum ammonia guideline (4.3208 mg-N/L) is based on the combination of field pH (7.5) and water temperature (4.0°C). Guidelines calculated with temperature and pH values falling outside the defined range (i.e., pH 6.0 to 10.0 and temperature 0°C to 30°C) should be used with caution, as the WQG does not necessarily accurately reflect toxic effects at the low and high pH and

[b] = guideline is pH dependent. The guideline range shown is based on the pH observed in the dataset (7.5). The guideline is calculated based on the individual pH for each sample.

[c] = guideline is pH dependent: 0.005 mg/L at pH < 6.5 and 0.1 mg/L at pH ≥ 6.5.

[d] = guideline is hardness dependent. The guideline range shown is based on the hardness observed in the dataset (11 mg/L). The guideline is calculated based on the individual hardness

[C] = concentration is higher than the chronic aquatic life CCME guideline or outside the recommended pH, DO or total alkalinity range.

[S] = concentration is higher than the site-specific guideline guideline.

[M] = concentration is higher than the metal mining effluent regulations (MMER, 2017) guideline.

Bolded concentrations are higher than water quality guidelines.

Water quality data and guidelines shown in this table were rounded to reflect laboratory or field instrument precision after comparisons to guidelines. Therefore, values slightly above guidelines may be displayed as being equal to the guidelines and identified as exceedances. Concentrations equal to the guideline values were not identified as exceedances.

- = no guideline or no data.

	Unit	Guidelines			Goose Background Source	PN08, PN11, PN12 & PN13					
						Dissolved Metals			Total Metals		
		CCME Freshwater (Chronic)	Site Specific	MMER		Absolute Maximum	Long-Term Average	Max at Closure	Absolute Maximum	Long-Term Average	Max at Closure
Conventional Parameters											
Hardness, as $CaCO_3$	mg/L	-	-	-	11	11	11	11	11	11	11
Total alkalinity, as $CaCO_3$	mg/L	-	-	-	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Total dissolved solids	mg/L	-	-	-	23	23	23	23	23	23	23
Total suspended solids	mg/L	-	-	-	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Total organic carbon	mg/L	-	-	-	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Major Ions											
Chloride	mg/L	120	-	-	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Cyanide	mg/L	0.0050	-	1.0	0.00054	0.00054	0.00054	0.00054	0.00054	0.00054	0.00054
Sulphate	mg/L	-	-	-	4.1	4.1	4.1	4.1	4.1	4.1	4.1
Free cyanide	mg/l	-	-	-	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Cyanide - wad	mg/l	-	-	-	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Nutrients											
Nitrate	mg-N/L	2.9	-	-	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065	0.0065
Nitrite	mg-N/L	0.060	-	-	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Total ammonia	mg-N/L	4.3[(a)]	-	-	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050
Metals											
Aluminum	mg/L	0.10[(b, c)]	-	-	0.011	0.011	0.011	0.011	0.011	0.011	0.011
Antimony	mg/L	-	-	-	0.000050	0.000050	0.000050	0.000050	0.000050	0.000050	0.000050
Arsenic	mg/L	0.0050	0.010	0.50	0.00020	0.00020	0.00020	0.00020	0.00020	0.00020	0.00020
Barium	mg/L	-	-	-	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051	0.0051
Beryllium	mg/L	-	-	-	0.00020	0.00020	0.00020	0.00020	0.00020	0.00020	0.00020
Bismuth	mg/L	-	-	-	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050	0.00050
Boron	mg/L	1.5	-	-	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050
Cadmium	mg/L	0.000040[(d)]	-	-	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010
Calcium	mg/L	-	-	-	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Chromium	mg/L	0.0010	-	-	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015	0.00015
Cobalt	mg/L	-	-	-	0.00012	0.00012	0.00012	0.00012	0.00012	0.00012	0.00012
Copper	mg/L	0.0020[(d)]	0.0046	0.30	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014
Iron	mg/L	0.30	-	-	0.014	0.014	0.014	0.014	0.014	0.014	0.014
Lead	mg/L	0.0010[(d)]	-	0.20	0.000050	0.000050	0.000050	0.000050	0.000050	0.000050	0.000050
Lithium	mg/L	-	-	-	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050
Magnesium	mg/L	-	-	-	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Manganese	mg/L	-	-	-	0.0019	0.0019	0.0019	0.0019	0.0019	0.0019	0.0019
Mercury	mg/L	0.000026	-	-	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010
Molybdenum	mg/L	0.073	-	-	0.000050	0.000050	0.000050	0.000050	0.000050	0.000050	0.000050
Nickel	mg/L	0.025[(d)]	-	0.50	0.0033	0.0033	0.0033	0.0033	0.0033	0.0033	0.0033
Phosphorus	mg/L	-	-	-	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039
Potassium	mg/L	-	-	-	0.34	0.34	0.34	0.34	0.34	0.34	0.34
Selenium	mg/L	0.0010	-	-	0.00010	0.00010	0.000100	0.00010	0.00010	0.000100	0.00010
Silicon	mg/L	-	-	-	0.28	0.28	0.28	0.28	0.28	0.28	0.28
Silver	mg/L	0.00025	-	-	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010
Sodium	mg/L	-	-	-	0.66	0.66	0.66	0.66	0.66	0.66	0.66
Strontium	mg/L	-	-	-	0.0094	0.0094	0.0094	0.0094	0.0094	0.0094	0.0094
Tellurium	mg/L	-	-	-	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020
Thallium	mg/L	0.00080	-	-	0.000050	0.000050	0.000050	0.000050	0.000050	0.000050	0.000050
Tin	mg/L	-	-	-	0.00010	0.00010	0.000100	0.00010	0.00010	0.000100	0.00010
Titanium	mg/L	-	-	-	0.010	0.010	0.010	0.010	0.010	0.010	0.010
Uranium	mg/L	0.015	-	-	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010
Vanadium	mg/L	-	-	-	0.000053	0.000053	0.000053	0.000053	0.000053	0.000053	0.000053
Zinc	mg/L	0.030	-	0.50	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030	0.0030
Zirconium	mg/L	-	-	-	0.00040	0.00040	0.00040	0.00040	0.00040	0.00040	0.00040

Notes:

[(a)] = the ammonia guideline is pH and temperature dependent. The guideline that results in the minimum ammonia guideline (4.3208 mg-N/L) is based on the combination of field pH (7.5) and water temperature (4.0°C). Guidelines calculated with temperature and pH values falling outside the defined range (i.e., pH 6.0 to 10.0 and temperature 0°C to 30°C) should be used with caution, as the WQG does not necessarily accurately reflect toxic effects at the low and high pH and

[(b)] = guideline is pH dependent. The guideline range shown is based on the pH observed in the dataset (7.5). The guideline is calculated based on the individual pH for each sample.

[(c)] = guideline is pH dependent: 0.005 mg/L at pH < 6.5 and 0.1 mg/L at pH ≥ 6.5.

[(d)] = guideline is hardness dependent. The guideline range shown is based on the hardness observed in the dataset (11 mg/L). The guideline is calculated based on the individual hardness

[(C)] = concentration is higher than the chronic aquatic life CCME guideline or outside the recommended pH, DO or total alkalinity range.

[(S)] = concentration is higher than the site-specific guideline guideline.

[(M)] = concentration is higher than the metal mining effluent regulations (MMER, 2017) guideline.

Bolded concentrations are higher than water quality guidelines.

Water quality data and guidelines shown in this table were rounded to reflect laboratory or field instrument precision after comparisons to guidelines. Therefore, values slightly above guidelines may be displayed as being equal to the guidelines and identified as exceedances. Concentrations equal to the guideline values were not identified as exceedances.

\- = no guideline or no data.

	Unit	Guidelines			Goose Background Source	Goose Lake					
		CCME Freshwater (Chronic)	Site Specific	MMER		Dissolved Metals			Total Metals		
						Absolute Maximum	Long-Term Average	Max at Closure	Absolute Maximum	Long-Term Average	Max at Closure
Conventional Parameters											
Hardness, as $CaCO_3$	mg/L	-	-	-	11	11	11	11	11	11	11
Total alkalinity, as $CaCO_3$	mg/L	-	-	-	2.0	26	9.0	26	26	9.0	26
Total dissolved solids	mg/L	-	-	-	23	454	59	439	454	59	439
Total suspended solids	mg/L	-	-	-	3.0	6.7	4.0	6.0	6.7	4.0	6.0
Total organic carbon	mg/L	-	-	-	4.0	8.9	5.3	8.0	8.9	5.3	8.0
Major Ions											
Chloride	mg/L	120	-	-	1.0	98	5.1	80	98	5.1	80
Cyanide	mg/L	0.0050	-	1.0	0.00054	0.0012	0.00056	0.00068	0.0012	0.00056	0.00068
Sulphate	mg/L	-	-	-	4.1	135	22	135	135	22	135
Free cyanide	mg/l	-	-	-	0.0010	0.0022	0.0013	0.0020	0.0022	0.0013	0.0020
Cyanide - wad	mg/l	-	-	-	0.0010	0.015	0.0014	0.015	0.015	0.0014	0.015
Nutrients											
Nitrate	mg-N/L	2.9	-	-	0.0065	1.3	0.015	0.94	1.3	0.015	0.94
Nitrite	mg-N/L	0.060	-	-	0.0010	**0.062**[C]	0.0017	0.055	**0.062**[C]	0.0017	0.055
Total ammonia	mg-N/L	4.3[a]	-	-	0.0050	0.14	0.0050	0.0062	0.14	0.0050	0.0062
Metals											
Aluminum	mg/L	0.10[b, c]	-	-	0.011	0.086	0.038	0.086	**0.36**[C]	**0.22**[C]	**0.36**[C]
Antimony	mg/L	-	-	-	0.000050	0.0100	0.00024	0.0100	0.0100	0.00024	0.0100
Arsenic	mg/L	0.0050	0.010	0.50	0.00020	**0.015**[C, S]	**0.0058**[C]	**0.015**[C, S]	**0.016**[C, S]	**0.0065**[C]	**0.016**[C, S]
Barium	mg/L	-	-	-	0.0051	0.086	0.0094	0.044	0.086	0.010	0.045
Beryllium	mg/L	-	-	-	0.00020	0.00044	0.00027	0.00040	0.00045	0.00029	0.00045
Bismuth	mg/L	-	-	-	0.00050	0.0016	0.00068	0.0012	0.0016	0.00068	0.0012
Boron	mg/L	1.5	-	-	0.0050	0.059	0.0083	0.035	0.059	0.0084	0.035
Cadmium	mg/L	0.000040[d]	-	-	0.000010	**0.000048**[C]	0.000020	**0.000048**[C]	**0.000048**[C]	0.000020	**0.000048**[C]
Calcium	mg/L	-	-	-	2.1	208	14	114	208	14	114
Chromium	mg/L	0.0010	-	-	0.00015	0.00047	0.00020	0.00047	**0.0015**[C]	0.00091	**0.0015**[C]
Cobalt	mg/L	-	-	-	0.00012	0.0077	0.00023	0.0077	0.0078	0.00035	0.0078
Copper	mg/L	0.0020[d]	0.0046	0.30	0.0014	**0.0047**[C, S]	**0.0024**[C]	**0.0047**[C, S]	**0.0052**[C, S]	**0.0027**[C]	**0.0052**[C, S]
Iron	mg/L	0.30	-	-	0.014	0.17	0.048	0.17	**0.96**[C]	**0.59**[C]	**0.96**[C]
Lead	mg/L	0.0010[d]	-	0.20	0.000050	0.00023	0.000068	0.00023	0.00030	0.00012	0.00030
Lithium	mg/L	-	-	-	0.0050	0.097	0.0097	0.047	0.097	0.0097	0.047
Magnesium	mg/L	-	-	-	1.3	16	2.7	11	16	2.8	11
Manganese	mg/L	-	-	-	0.0019	0.043	0.0084	0.036	0.043	0.011	0.039
Mercury	mg/L	0.000026	-	-	0.000010	**0.000028**[C]	0.000016	**0.000028**[C]	**0.00010**[C]	**0.000067**[C]	**0.00010**[C]
Molybdenum	mg/L	0.073	-	-	0.000050	0.018	0.00040	0.018	0.018	0.00040	0.018
Nickel	mg/L	0.025[d]	-	0.50	0.0033	0.016	0.0082	0.016	0.016	0.0083	0.016
Phosphorus	mg/L	-	-	-	0.0039	0.050	0.0066	0.048	0.054	0.011	0.054
Potassium	mg/L	-	-	-	0.34	7.0	0.56	7.0	7.0	0.61	7.0
Selenium	mg/L	0.0010	-	-	0.00010	0.00074	0.00024	0.00074	0.00074	0.00024	0.00074
Silicon	mg/L	-	-	-	0.28	0.63	0.37	0.63	0.63	0.37	0.63
Silver	mg/L	0.00025	-	-	0.000010	0.00015	0.000016	0.00015	0.00015	0.000017	0.00015
Sodium	mg/L	-	-	-	0.66	86	4.0	59	86	4.0	59
Strontium	mg/L	-	-	-	0.0094	4.0	0.16	1.8	4.0	0.16	1.8
Tellurium	mg/L	-	-	-	0.0020	0.0044	0.0027	0.0040	0.0044	0.0027	0.0040
Thallium	mg/L	0.00080	-	-	0.000050	0.00016	0.000068	0.00012	0.00016	0.000069	0.00012
Tin	mg/L	-	-	-	0.00010	0.00031	0.00014	0.00029	0.00031	0.00014	0.00029
Titanium	mg/L	-	-	-	0.010	0.022	0.013	0.020	0.033	0.022	0.033
Uranium	mg/L	0.015	-	-	0.000010	0.000031	0.000014	0.000023	0.000038	0.000023	0.000038
Vanadium	mg/L	-	-	-	0.000053	0.00075	0.000085	0.00075	0.0013	0.00045	0.0013
Zinc	mg/L	0.030	-	0.50	0.0030	0.011	0.0050	0.0099	0.011	0.0054	0.010
Zirconium	mg/L	-	-	-	0.00040	0.00089	0.00053	0.00080	0.00089	0.00053	0.00080

Notes:

[a] = the ammonia guideline is pH and temperature dependent. The guideline that results in the minimum ammonia guideline (4.3208 mg-N/L) is based on the combination of field pH (7.5) and water temperature (4.0°C). Guidelines calculated with temperature and pH values falling outside the defined range (i.e., pH 6.0 to 10.0 and temperature 0°C to 30°C) should be used with caution, as the WQG does not necessarily accurately reflect toxic effects at the low and high pH and

[b] = guideline is pH dependent. The guideline range shown is based on the pH observed in the dataset (7.5). The guideline is calculated based on the individual pH for each sample.

[c] = guideline is pH dependent: 0.005 mg/L at pH < 6.5 and 0.1 mg/L at pH ≥ 6.5.

[d] = guideline is hardness dependent. The guideline range shown is based on the hardness observed in the dataset (11 mg/L). The guideline is calculated based on the individual hardness

[C] = concentration is higher than the chronic aquatic life CCME guideline or outside the recommended pH, DO or total alkalinity range.

[S] = concentration is higher than the site-specific guideline guideline.

[M] = concentration is higher than the metal mining effluent regulations (MMER, 2017) guideline.

Bolded concentrations are higher than water quality guidelines.

Water quality data and guidelines shown in this table were rounded to reflect laboratory or field instrument precision after comparisons to guidelines. Therefore, values slightly above guidelines may be displayed as being equal to the guidelines and identified as exceedances. Concentrations equal to the guideline values were not identified as exceedances.

- = no guideline or no data.

	Unit	MMER	Goose Background Source	Umwelt Tailings Facility			
				Dissolved Metals		Total Metals	
				Long-Term Average	Max at Closure	Long-Term Average	Max at Closure
Conventional Parameters							
Hardness, as $CaCO_3$	mg/L	-	11	11	11	11	11
Total alkalinity, as $CaCO_3$	mg/L	-	2.0	79	109	79	109
Total dissolved solids	mg/L	-	23	350	540	350	540
Total suspended solids	mg/L	-	3.0	3.0	3.0	3.0	3.0
Total organic carbon	mg/L	-	4.0	4.0	4.0	4.0	4.0
Major Ions							
Chloride	mg/L	-	1.0	1.0	1.0	1.0	1.0
Cyanide	mg/L	1.0	0.00054	0.00054	0.00054	0.00054	0.00054
Sulphate	mg/L	-	4.1	195	329	195	329
Free cyanide	mg/l	-	0.0010	0.0010	0.0010	0.0010	0.0010
Cyanide - wad	mg/l	-	0.0010	0.0010	0.0010	0.0010	0.0010
Nutrients							
Nitrate	mg-N/L	-	0.0065	0.018	0.60	0.018	0.60
Nitrite	mg-N/L	-	0.0010	0.0014	0.030	0.0014	0.030
Total ammonia	mg-N/L	-	0.0050	0.0050	0.013	0.0050	0.013
Metals							
Aluminum	mg/L	-	0.011	0.27	0.37	0.63	0.73
Antimony	mg/L	-	0.000050	0.0017	0.0023	0.0017	0.0023
Arsenic	mg/L	0.50	0.00020	0.065	0.094	0.069	0.097
Barium	mg/L	-	0.0051	0.0051	0.0051	0.0052	0.0057
Beryllium	mg/L	-	0.00020	0.00020	0.00020	0.00020	0.00020
Bismuth	mg/L	-	0.00050	0.00050	0.00050	0.00050	0.00050
Boron	mg/L	-	0.0050	0.0050	0.0050	0.0050	0.0050
Cadmium	mg/L	-	0.000010	0.000076	0.00010	0.000077	0.00011
Calcium	mg/L	-	2.1	49	67	49	67
Chromium	mg/L	-	0.00015	0.00015	0.00015	0.0016	0.0016
Cobalt	mg/L	-	0.00012	0.00061	0.00083	0.00086	0.0011
Copper	mg/L	0.30	0.0014	0.0079	0.011	0.0085	0.011
Iron	mg/L	-	0.014	0.31	0.42	1.2	1.4
Lead	mg/L	0.20	0.000050	0.000050	0.000050	0.00012	0.00013
Lithium	mg/L	-	0.0050	0.0050	0.0050	0.0050	0.0050
Magnesium	mg/L	-	1.3	7.8	11	8.0	11
Manganese	mg/L	-	0.0019	0.050	0.069	0.055	0.074
Mercury	mg/L	-	0.000010	0.000037	0.000051	0.00012	0.00013
Molybdenum	mg/L	-	0.000050	0.0034	0.0046	0.0034	0.0046
Nickel	mg/L	0.50	0.0033	0.043	0.060	0.044	0.060
Phosphorus	mg/L	-	0.0039	0.0039	0.0039	0.0094	0.010
Potassium	mg/L	-	0.34	0.34	0.34	0.34	0.36
Selenium	mg/L	-	0.00010	0.0013	0.0019	0.0014	0.0019
Silicon	mg/L	-	0.28	0.28	0.28	0.28	0.28
Silver	mg/L	-	0.000010	0.000031	0.000043	0.000034	0.000045
Sodium	mg/L	-	0.66	0.66	0.66	0.66	0.66
Strontium	mg/L	-	0.0094	0.0094	0.0094	0.0094	0.0094
Tellurium	mg/L	-	0.0020	0.0020	0.0020	0.0020	0.0020
Thallium	mg/L	-	0.000050	0.000050	0.000050	0.000050	0.000050
Tin	mg/L	-	0.00010	0.000100	0.00010	0.000100	0.00010
Titanium	mg/L	-	0.010	0.0100	0.010	0.020	0.022
Uranium	mg/L	-	0.000010	0.000010	0.000010	0.000026	0.000028
Vanadium	mg/L	-	0.000053	0.000053	0.000053	0.00070	0.00071
Zinc	mg/L	0.50	0.0030	0.013	0.017	0.013	0.018
Zirconium	mg/L	-	0.00040	0.00040	0.00040	0.00040	0.00040

Notes:

[a] = the ammonia guideline is pH and temperature dependent. The guideline that results in the minimum ammonia guideline (4.3208 mg-N/L) is based on the combination of field pH (7.5) and water temperature (4.0°C). Guidelines calculated with temperature and pH values falling outside the defined range (i.e., pH 6.0 to 10.0 and temperature 0°C to 30°C) should be used with caution, as the WQG does not necessarily accurately reflect toxic effects at the low and high pH and temperature extremes. The guideline is calculated based on the individual field pH and temperature measurements for each sample.

[b] = guideline is pH dependent. The guideline range shown is based on the pH observed in the dataset (7.5). The guideline is calculated based on the individual pH for each sample.

[c] = guideline is pH dependent: 0.005 mg/L at pH < 6.5 and 0.1 mg/L at pH ≥ 6.5.

[d] = guideline is hardness dependent. The guideline range shown is based on the hardness observed in the dataset (11 mg/L). The guideline is calculated based on the individual hardness value for each sample.

[M] = concentration is higher than the metal mining effluent regulations (MMER, 2017) guideline.
Bolded concentrations are higher than water quality guidelines.

Water quality data and guidelines shown in this table were rounded to reflect laboratory or field instrument precision after comparisons to guidelines. Therefore, values slightly above guidelines may be displayed as being equal to the guidelines and identified as exceedances. Concentrations equal to the guideline values were not identified as exceedances.

- = no guideline or no data.

	Unit	MMER	Goose Background Source	Llama Reservoir			
				Dissolved Metals		Total Metals	
				Long-Term Average	Max at Closure	Long-Term Average	Max at Closure
Conventional Parameters							
Hardness, as $CaCO_3$	mg/L	-	11	11	11	11	11
Total alkalinity, as $CaCO_3$	mg/L	-	2.0	13	13	13	13
Total dissolved solids	mg/L	-	23	212	1,409	212	1,409
Total suspended solids	mg/L	-	3.0	3.0	3.0	3.0	3.0
Total organic carbon	mg/L	-	4.0	4.0	4.0	4.0	4.0
Major Ions							
Chloride	mg/L	-	1.0	35	307	35	307
Cyanide	mg/L	1.0	0.00054	0.00054	0.00054	0.00054	0.00054
Sulphate	mg/L	-	4.1	34	41	34	41
Free cyanide	mg/l	-	0.0010	0.0010	0.0010	0.0010	0.0010
Cyanide - wad	mg/l	-	0.0010	0.0011	0.0023	0.0011	0.0023
Nutrients							
Nitrate	mg-N/L	-	0.0065	0.050	0.38	0.050	0.38
Nitrite	mg-N/L	-	0.0010	0.0036	0.024	0.0036	0.024
Total ammonia	mg-N/L	-	0.0050	0.0050	0.0050	0.0050	0.0050
Metals							
Aluminum	mg/L	-	0.011	0.051	0.051	0.38	0.38
Antimony	mg/L	-	0.000050	0.00044	0.0015	0.00044	0.0015
Arsenic	mg/L	0.50	0.00020	0.010	0.010	0.012	0.012
Barium	mg/L	-	0.0051	0.033	0.26	0.035	0.27
Beryllium	mg/L	-	0.00020	0.00020	0.00021	0.00030	0.00032
Bismuth	mg/L	-	0.00050	0.00066	0.0023	0.00066	0.0023
Boron	mg/L	-	0.0050	0.023	0.17	0.023	0.17
Cadmium	mg/L	-	0.000010	0.000024	0.000055	0.000025	0.000055
Calcium	mg/L	-	2.1	86	701	86	701
Chromium	mg/L	-	0.00015	0.00017	0.00040	0.0015	0.0017
Cobalt	mg/L	-	0.00012	0.00033	0.0014	0.00055	0.0016
Copper	mg/L	0.30	0.0014	0.0025	0.0035	0.0031	0.0041
Iron	mg/L	-	0.014	0.079	0.23	1.1	1.3
Lead	mg/L	0.20	0.000050	0.000067	0.00024	0.00016	0.00033
Lithium	mg/L	-	0.0050	0.038	0.30	0.038	0.30
Magnesium	mg/L	-	1.3	7.0	45	7.2	45
Manganese	mg/L	-	0.0019	0.023	0.13	0.027	0.13
Mercury	mg/L	-	0.000010	0.000014	0.000013	0.00012	0.00012
Molybdenum	mg/L	-	0.000050	0.00095	0.0041	0.00097	0.0041
Nickel	mg/L	0.50	0.0033	0.0094	0.0091	0.0100	0.0097
Phosphorus	mg/L	-	0.0039	0.019	0.15	0.030	0.16
Potassium	mg/L	-	0.34	1.5	11	1.6	11
Selenium	mg/L	-	0.00010	0.00032	0.00061	0.00033	0.00061
Silicon	mg/L	-	0.28	0.28	0.28	0.28	0.28
Silver	mg/L	-	0.000010	0.000018	0.000062	0.000020	0.000064
Sodium	mg/L	-	0.66	33	291	33	291
Strontium	mg/L	-	0.0094	1.5	14	1.5	14
Tellurium	mg/L	-	0.0020	0.0020	0.0020	0.0020	0.0020
Thallium	mg/L	-	0.000050	0.000066	0.00023	0.000069	0.00023
Tin	mg/L	-	0.00010	0.00013	0.00047	0.00013	0.00047
Titanium	mg/L	-	0.010	0.010	0.013	0.026	0.030
Uranium	mg/L	-	0.000010	0.000013	0.000046	0.000032	0.000065
Vanadium	mg/L	-	0.000053	0.00021	0.0015	0.00087	0.0022
Zinc	mg/L	0.50	0.0030	0.0058	0.017	0.0065	0.017
Zirconium	mg/L	-	0.00040	0.00040	0.00040	0.00040	0.00040

Notes:

[(a)] = the ammonia guideline is pH and temperature dependent. The guideline that results in the minimum ammonia guideline (4.3208 mg-N/L) is based on the combination of field pH (7.5) and water temperature (4.0°C). Guidelines calculated with temperature and pH values falling outside the defined range (i.e., pH 6.0 to 10.0 and temperature 0°C to 30°C) should be used with caution, as the WQG does not necessarily accurately reflect toxic effects at the low and high pH and temperature extremes. The guideline is calculated based on the individual field pH and temperature measurements for each sample.

[(b)] = guideline is pH dependent. The guideline range shown is based on the pH observed in the dataset (7.5). The guideline is calculated based on the individual pH for each sample.

[(c)] = guideline is pH dependent: 0.005 mg/L at pH < 6.5 and 0.1 mg/L at pH ≥ 6.5.

[(d)] = guideline is hardness dependent. The guideline range shown is based on the hardness observed in the dataset (11 mg/L). The guideline is calculated based on the individual hardness value for each sample.

[(M)] = concentration is higher than the metal mining effluent regulations (MMER, 2017) guideline.
Bolded concentrations are higher than water quality guidelines.

Water quality data and guidelines shown in this table were rounded to reflect laboratory or field instrument precision after comparisons to guidelines. Therefore, values slightly above guidelines may be displayed as being equal to the guidelines and identified as exceedances. Concentrations equal to the guideline values were not identified as exceedances.

\- = no guideline or no data.

	Unit	MMER	Goose Background Source	Goose Tailings Storage Facility			
				Dissolved Metals		Total Metals	
				Long-Term Average	Max at Closure	Long-Term Average	Max at Closure
Conventional Parameters							
Hardness, as $CaCO_3$	mg/L	-	11	11	11	11	11
Total alkalinity, as $CaCO_3$	mg/L	-	2.0	10	49	10	49
Total dissolved solids	mg/L	-	23	50	651	50	651
Total suspended solids	mg/L	-	3.0	3.0	3.0	3.0	3.0
Total organic carbon	mg/L	-	4.0	4.0	4.0	4.0	4.0
Major Ions							
Chloride	mg/L	-	1.0	1.1	114	1.1	114
Cyanide	mg/L	1.0	0.00054	0.00054	0.00054	0.00054	0.00054
Sulphate	mg/L	-	4.1	26	326	26	326
Free cyanide	mg/l	-	0.0010	0.0010	0.0010	0.0010	0.0010
Cyanide - wad	mg/l	-	0.0010	0.0010	0.039	0.0010	0.039
Nutrients							
Nitrate	mg-N/L	-	0.0065	0.0094	2.6	0.0094	2.6
Nitrite	mg-N/L	-	0.0010	0.0011	0.15	0.0011	0.15
Total ammonia	mg-N/L	-	0.0050	0.0050	0.0077	0.0050	0.0077
Metals							
Aluminum	mg/L	-	0.011	0.039	0.13	0.40	0.49
Antimony	mg/L	-	0.000050	0.00025	0.029	0.00025	0.029
Arsenic	mg/L	0.50	0.00020	0.0070	0.027	0.0087	0.029
Barium	mg/L	-	0.0051	0.0051	0.0097	0.0066	0.011
Beryllium	mg/L	-	0.00020	0.00020	0.00020	0.00024	0.00025
Bismuth	mg/L	-	0.00050	0.00050	0.00050	0.00050	0.00050
Boron	mg/L	-	0.0050	0.0050	0.016	0.0051	0.016
Cadmium	mg/L	-	0.000010	0.000017	0.000058	0.000018	0.000059
Calcium	mg/L	-	2.1	7.2	58	7.3	58
Chromium	mg/L	-	0.00015	0.00015	0.00054	0.0015	0.0019
Cobalt	mg/L	-	0.00012	0.00019	0.022	0.00043	0.022
Copper	mg/L	0.30	0.0014	0.0021	0.0050	0.0028	0.0057
Iron	mg/L	-	0.014	0.044	0.28	1.1	1.3
Lead	mg/L	0.20	0.000050	0.000050	0.00037	0.00014	0.00046
Lithium	mg/L	-	0.0050	0.0050	0.0050	0.0050	0.0050
Magnesium	mg/L	-	1.3	2.0	9.9	2.2	10
Manganese	mg/L	-	0.0019	0.0069	0.038	0.012	0.043
Mercury	mg/L	-	0.000010	0.000013	0.000026	0.00011	0.00012
Molybdenum	mg/L	-	0.000050	0.00045	0.050	0.00047	0.050
Nickel	mg/L	0.50	0.0033	0.0074	0.020	0.0081	0.021
Phosphorus	mg/L	-	0.0039	0.0039	0.069	0.013	0.078
Potassium	mg/L	-	0.34	0.34	15	0.43	15
Selenium	mg/L	-	0.00010	0.00024	0.0013	0.00024	0.0013
Silicon	mg/L	-	0.28	0.28	0.47	0.28	0.47
Silver	mg/L	-	0.000010	0.000013	0.00036	0.000014	0.00036
Sodium	mg/L	-	0.66	0.70	65	0.70	65
Strontium	mg/L	-	0.0094	0.0095	0.14	0.0096	0.14
Tellurium	mg/L	-	0.0020	0.0020	0.0020	0.0020	0.0020
Thallium	mg/L	-	0.000050	0.000050	0.000050	0.000051	0.000052
Tin	mg/L	-	0.00010	0.00010	0.00023	0.00010	0.00023
Titanium	mg/L	-	0.010	0.0100	0.010	0.026	0.026
Uranium	mg/L	-	0.000010	0.000010	0.000010	0.000028	0.000029
Vanadium	mg/L	-	0.000053	0.000054	0.0014	0.00075	0.0021
Zinc	mg/L	0.50	0.0030	0.0040	0.0065	0.0048	0.0073
Zirconium	mg/L	-	0.00040	0.00040	0.00040	0.00040	0.00040

Notes:

[(a)] = the ammonia guideline is pH and temperature dependent. The guideline that results in the minimum ammonia guideline (4.3208 mg-N/L) is based on the combination of field pH (7.5) and water temperature (4.0°C). Guidelines calculated with temperature and pH values falling outside the defined range (i.e., pH 6.0 to 10.0 and temperature 0°C to 30°C) should be used with caution, as the WQG does not necessarily accurately reflect toxic effects at the low and high pH and temperature extremes. The guideline is calculated based on the individual field pH and temperature measurements for each sample.

[(b)] = guideline is pH dependent. The guideline range shown is based on the pH observed in the dataset (7.5). The guideline is calculated based on the individual pH for each sample.

[(c)] = guideline is pH dependent: 0.005 mg/L at pH < 6.5 and 0.1 mg/L at pH ≥ 6.5.

[(d)] = guideline is hardness dependent. The guideline range shown is based on the hardness observed in the dataset (11 mg/L). The guideline is calculated based on the individual hardness value for each sample.

[(M)] = concentration is higher than the metal mining effluent regulations (MMER, 2017) guideline.
Bolded concentrations are higher than water quality guidelines.

Water quality data and guidelines shown in this table were rounded to reflect laboratory or field instrument precision after comparisons to guidelines. Therefore, values slightly above guidelines may be displayed as being equal to the guidelines and identified as exceedances. Concentrations equal to the guideline values were not identified as exceedances.

- = no guideline or no data.

	Unit	MMER	Goose Background Source	Echo Pit			
				Dissolved Metals		Total Metals	
				Long-Term Average	Max at Closure	Long-Term Average	Max at Closure
Conventional Parameters							
Hardness, as $CaCO_3$	mg/L	-	11	11	11	11	11
Total alkalinity, as $CaCO_3$	mg/L	-	2.0	2.1	2.4	2.1	2.4
Total dissolved solids	mg/L	-	23	13	15	13	15
Total suspended solids	mg/L	-	3.0	3.1	3.2	3.1	3.2
Total organic carbon	mg/L	-	4.0	4.1	4.3	4.1	4.3
Major Ions							
Chloride	mg/L	-	1.0	1.0	1.1	1.0	1.1
Cyanide	mg/L	1.0	0.00054	0.00055	0.00058	0.00055	0.00058
Sulphate	mg/L	-	4.1	4.7	5.5	4.7	5.5
Free cyanide	mg/l	-	0.0010	0.0010	0.0011	0.0010	0.0011
Cyanide - wad	mg/l	-	0.0010	0.0010	0.0011	0.0010	0.0011
Nutrients							
Nitrate	mg-N/L	-	0.0065	0.0066	0.0070	0.0066	0.0070
Nitrite	mg-N/L	-	0.0010	0.0010	0.0011	0.0010	0.0011
Total ammonia	mg-N/L	-	0.0050	0.0051	0.0054	0.0051	0.0054
Metals							
Aluminum	mg/L	-	0.011	0.014	0.018	0.32	0.32
Antimony	mg/L	-	0.000050	0.000055	0.000064	0.000055	0.000065
Arsenic	mg/L	0.50	0.00020	0.00052	0.0013	0.0015	0.0023
Barium	mg/L	-	0.0051	0.0052	0.0055	0.0059	0.0063
Beryllium	mg/L	-	0.00020	0.00020	0.00022	0.00022	0.00023
Bismuth	mg/L	-	0.00050	0.00051	0.00054	0.00051	0.00054
Boron	mg/L	-	0.0050	0.0051	0.0054	0.0053	0.0057
Cadmium	mg/L	-	0.000010	0.000011	0.000012	0.000012	0.000013
Calcium	mg/L	-	2.1	2.3	2.6	2.3	2.6
Chromium	mg/L	-	0.00015	0.00015	0.00016	0.0018	0.0018
Cobalt	mg/L	-	0.00012	0.00013	0.00014	0.00042	0.00043
Copper	mg/L	0.30	0.0014	0.0015	0.0017	0.0022	0.0024
Iron	mg/L	-	0.014	0.017	0.022	0.62	0.63
Lead	mg/L	0.20	0.000050	0.000051	0.000054	0.00013	0.00013
Lithium	mg/L	-	0.0050	0.0051	0.0054	0.0051	0.0054
Magnesium	mg/L	-	1.3	1.3	1.5	1.5	1.7
Manganese	mg/L	-	0.0019	0.0024	0.0031	0.0072	0.0079
Mercury	mg/L	-	0.000010	0.000010	0.000011	0.00010	0.00010
Molybdenum	mg/L	-	0.000050	0.000054	0.000064	0.000084	0.000094
Nickel	mg/L	0.50	0.0033	0.0038	0.0045	0.0047	0.0054
Phosphorus	mg/L	-	0.0039	0.0040	0.0042	0.012	0.012
Potassium	mg/L	-	0.34	0.34	0.36	0.38	0.41
Selenium	mg/L	-	0.00010	0.00011	0.00012	0.00011	0.00012
Silicon	mg/L	-	0.28	0.28	0.30	0.28	0.30
Silver	mg/L	-	0.000010	0.000010	0.000011	0.000012	0.000013
Sodium	mg/L	-	0.66	0.68	0.71	0.68	0.72
Strontium	mg/L	-	0.0094	0.0097	0.010	0.0097	0.010
Tellurium	mg/L	-	0.0020	0.0020	0.0022	0.0020	0.0022
Thallium	mg/L	-	0.000050	0.000051	0.000054	0.000052	0.000056
Tin	mg/L	-	0.00010	0.00010	0.00011	0.00010	0.00011
Titanium	mg/L	-	0.010	0.010	0.011	0.019	0.020
Uranium	mg/L	-	0.000010	0.000010	0.000011	0.000028	0.000029
Vanadium	mg/L	-	0.000053	0.000054	0.000057	0.00062	0.00062
Zinc	mg/L	0.50	0.0030	0.0032	0.0035	0.0041	0.0045
Zirconium	mg/L	-	0.00040	0.00041	0.00043	0.00041	0.00043

Notes:

[(a)] = the ammonia guideline is pH and temperature dependent. The guideline that results in the minimum ammonia guideline (4.3208 mg-N/L) is based on the combination of field pH (7.5) and water temperature (4.0°C). Guidelines calculated with temperature and pH values falling outside the defined range (i.e., pH 6.0 to 10.0 and temperature 0°C to 30°C) should be used with caution, as the WQG does not necessarily accurately reflect toxic effects at the low and high pH and temperature extremes. The guideline is calculated based on the individual field pH and temperature measurements for each sample.

[(b)] = guideline is pH dependent. The guideline range shown is based on the pH observed in the dataset (7.5). The guideline is calculated based on the individual pH for each sample.

[(c)] = guideline is pH dependent: 0.005 mg/L at pH < 6.5 and 0.1 mg/L at pH ≥ 6.5.

[(d)] = guideline is hardness dependent. The guideline range shown is based on the hardness observed in the dataset (11 mg/L). The guideline is calculated based on the individual hardness value for each sample.

[(M)] = concentration is higher than the metal mining effluent regulations (MMER, 2017) guideline.
Bolded concentrations are higher than water quality guidelines.

Water quality data and guidelines shown in this table were rounded to reflect laboratory or field instrument precision after comparisons to guidelines. Therefore, values slightly above guidelines may be displayed as being equal to the guidelines and identified as exceedances. Concentrations equal to the guideline values were not identified as exceedances.

- = no guideline or no data.

	Unit	MMER	Goose Background Source	Main Tailings Storage Facility			
				Dissolved Metals		Total Metals	
				Long-Term Average	Max at Closure	Long-Term Average	Max at Closure
Conventional Parameters							
Hardness, as $CaCO_3$	mg/L	-	11	11	11	11	11
Total alkalinity, as $CaCO_3$	mg/L	-	2.0	84	84	84	84
Total dissolved solids	mg/L	-	23	388	389	388	389
Total suspended solids	mg/L	-	3.0	3.0	3.0	3.0	3.0
Total organic carbon	mg/L	-	4.0	4.0	4.0	4.0	4.0
Major Ions							
Chloride	mg/L	-	1.0	1.0	1.0	1.0	1.0
Cyanide	mg/L	1.0	0.00054	0.00054	0.00054	0.00054	0.00054
Sulphate	mg/L	-	4.1	223	223	223	223
Free cyanide	mg/l	-	0.0010	0.0010	0.0010	0.0010	0.0010
Cyanide - wad	mg/l	-	0.0010	0.0010	0.0010	0.0010	0.0010
Nutrients							
Nitrate	mg-N/L	-	0.0065	0.010	0.37	0.010	0.37
Nitrite	mg-N/L	-	0.0010	0.0011	0.019	0.0011	0.019
Total ammonia	mg-N/L	-	0.0050	0.0071	0.23	0.0071	0.23
Metals							
Aluminum	mg/L	-	0.011	0.28	0.28	0.64	0.64
Antimony	mg/L	-	0.000050	0.0018	0.0018	0.0018	0.0018
Arsenic	mg/L	0.50	0.00020	0.067	0.067	0.069	0.069
Barium	mg/L	-	0.0051	0.0051	0.0051	0.0051	0.0051
Beryllium	mg/L	-	0.00020	0.00020	0.00020	0.00020	0.00020
Bismuth	mg/L	-	0.00050	0.00050	0.00050	0.00050	0.00050
Boron	mg/L	-	0.0050	0.0050	0.0050	0.0050	0.0050
Cadmium	mg/L	-	0.000010	0.000073	0.000073	0.000074	0.000074
Calcium	mg/L	-	2.1	52	52	52	52
Chromium	mg/L	-	0.00015	0.00015	0.00015	0.0014	0.0014
Cobalt	mg/L	-	0.00012	0.00057	0.00057	0.00082	0.00082
Copper	mg/L	0.30	0.0014	0.0081	0.0081	0.0088	0.0088
Iron	mg/L	-	0.014	0.30	0.30	1.3	1.3
Lead	mg/L	0.20	0.000050	0.000050	0.000050	0.00011	0.00011
Lithium	mg/L	-	0.0050	0.0050	0.0050	0.0050	0.0050
Magnesium	mg/L	-	1.3	8.0	8.0	8.2	8.2
Manganese	mg/L	-	0.0019	0.049	0.049	0.054	0.054
Mercury	mg/L	-	0.000010	0.000038	0.000038	0.00014	0.00014
Molybdenum	mg/L	-	0.000050	0.0036	0.0036	0.0036	0.0036
Nickel	mg/L	0.50	0.0033	0.042	0.042	0.042	0.042
Phosphorus	mg/L	-	0.0039	0.0039	0.0039	0.010	0.010
Potassium	mg/L	-	0.34	0.34	0.34	0.34	0.34
Selenium	mg/L	-	0.00010	0.0014	0.0014	0.0014	0.0014
Silicon	mg/L	-	0.28	0.28	0.28	0.28	0.28
Silver	mg/L	-	0.000010	0.000031	0.000031	0.000033	0.000033
Sodium	mg/L	-	0.66	0.66	0.66	0.66	0.66
Strontium	mg/L	-	0.0094	0.0094	0.0094	0.0094	0.0094
Tellurium	mg/L	-	0.0020	0.0020	0.0020	0.0020	0.0020
Thallium	mg/L	-	0.000050	0.000050	0.000050	0.000050	0.000050
Tin	mg/L	-	0.00010	0.000100	0.00010	0.000100	0.00010
Titanium	mg/L	-	0.010	0.0100	0.010	0.019	0.019
Uranium	mg/L	-	0.000010	0.000010	0.000010	0.000022	0.000022
Vanadium	mg/L	-	0.000053	0.000053	0.000053	0.00072	0.00072
Zinc	mg/L	0.50	0.0030	0.012	0.012	0.013	0.013
Zirconium	mg/L	-	0.00040	0.00040	0.00040	0.00040	0.00040

Notes:

(a) = the ammonia guideline is pH and temperature dependent. The guideline that results in the minimum ammonia guideline (4.3208 mg-N/L) is based on the combination of field pH (7.5) and water temperature (4.0°C). Guidelines calculated with temperature and pH values falling outside the defined range (i.e., pH 6.0 to 10.0 and temperature 0°C to 30°C) should be used with caution, as the WQG does not necessarily accurately reflect toxic effects at the low and high pH and temperature extremes. The guideline is calculated based on the individual field pH and temperature measurements for each sample.

(b) = guideline is pH dependent. The guideline range shown is based on the pH observed in the dataset (7.5). The guideline is calculated based on the individual pH for each sample.

(c) = guideline is pH dependent: 0.005 mg/L at pH < 6.5 and 0.1 mg/L at pH ≥ 6.5.

(d) = guideline is hardness dependent. The guideline range shown is based on the hardness observed in the dataset (11 mg/L). The guideline is calculated based on the individual hardness value for each sample.

(M) = concentration is higher than the metal mining effluent regulations (MMER, 2017) guideline.
Bolded concentrations are higher than water quality guidelines.

Water quality data and guidelines shown in this table were rounded to reflect laboratory or field instrument precision after comparisons to guidelines. Therefore, values slightly above guidelines may be displayed as being equal to the guidelines and identified as exceedances. Concentrations equal to the guideline values were not identified as exceedances.

- = no guideline or no data.

Prepared: TL
Reviewed: KS
Approved: KS

GOLDER

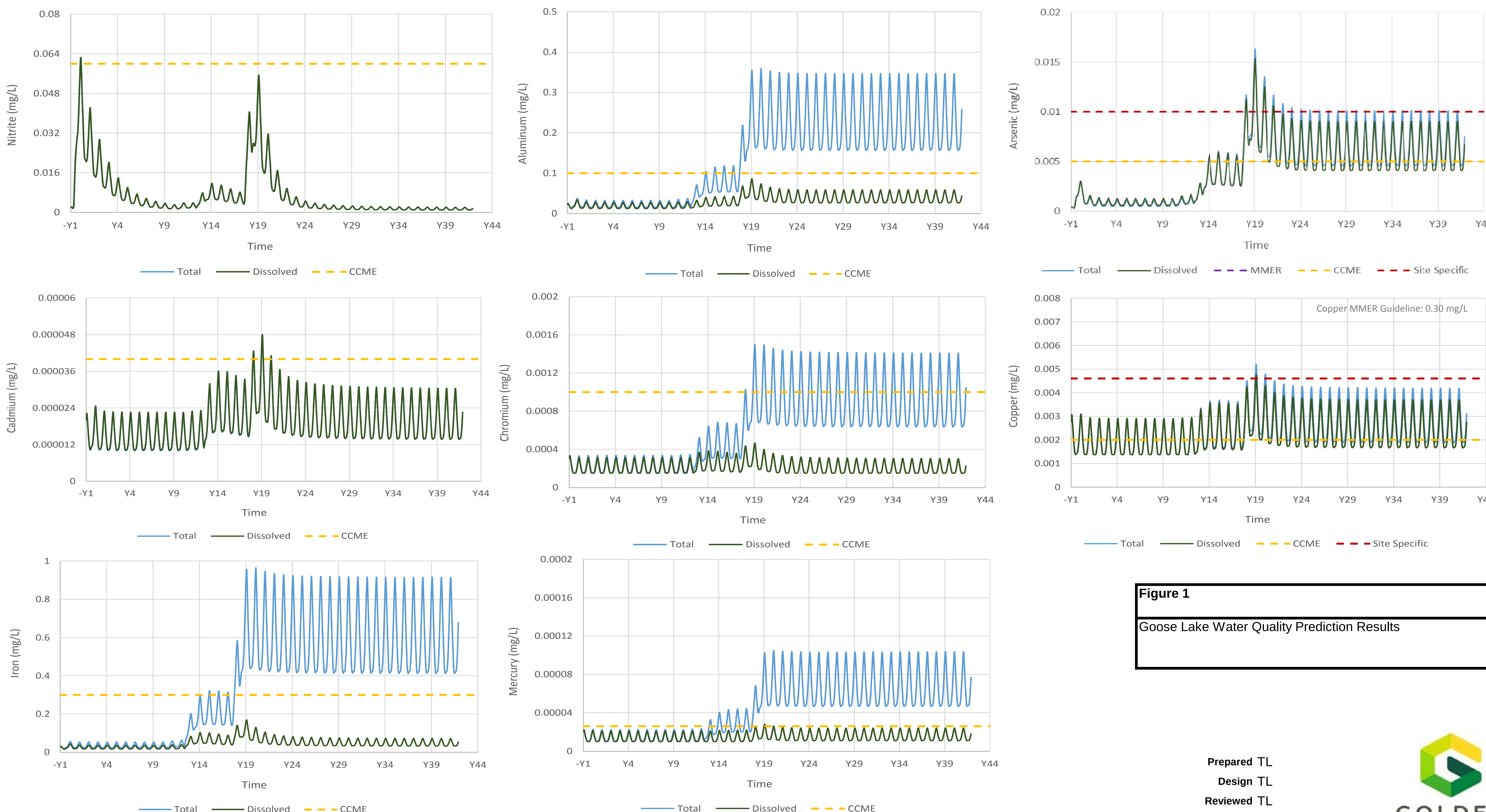


Figure 1

Goose Lake Water Quality Prediction Results

Prepared TL
Design TL
Reviewed TL
Approved SK

GOLDER

Attachment 2
Select Load Balance Model Results

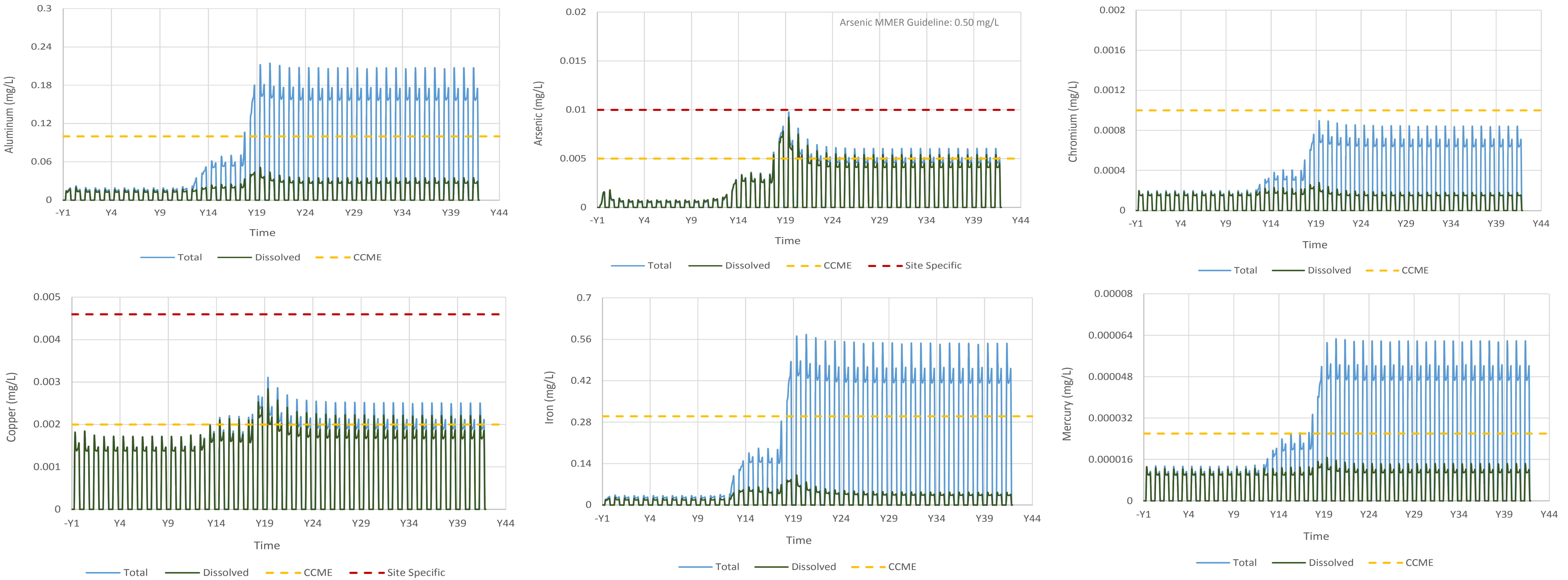
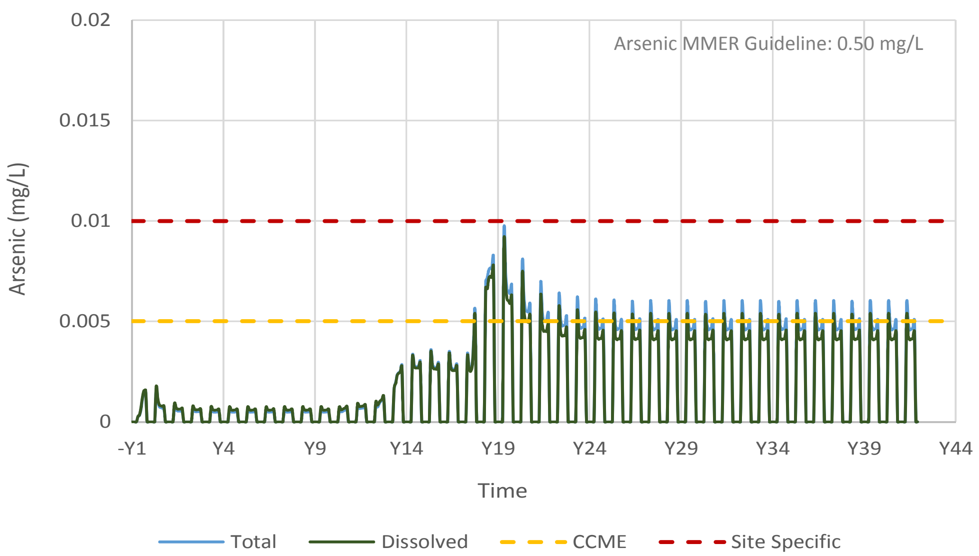


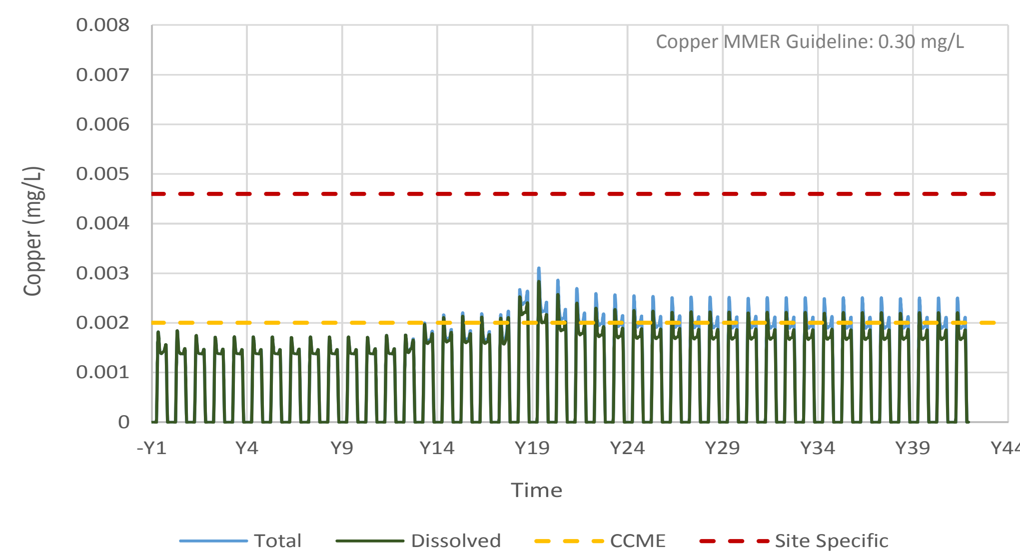
Figure 2

PN03 Water Quality Prediction Results

Prepared SD
Design TL
Reviewed TL
Approved SK

GOLDER





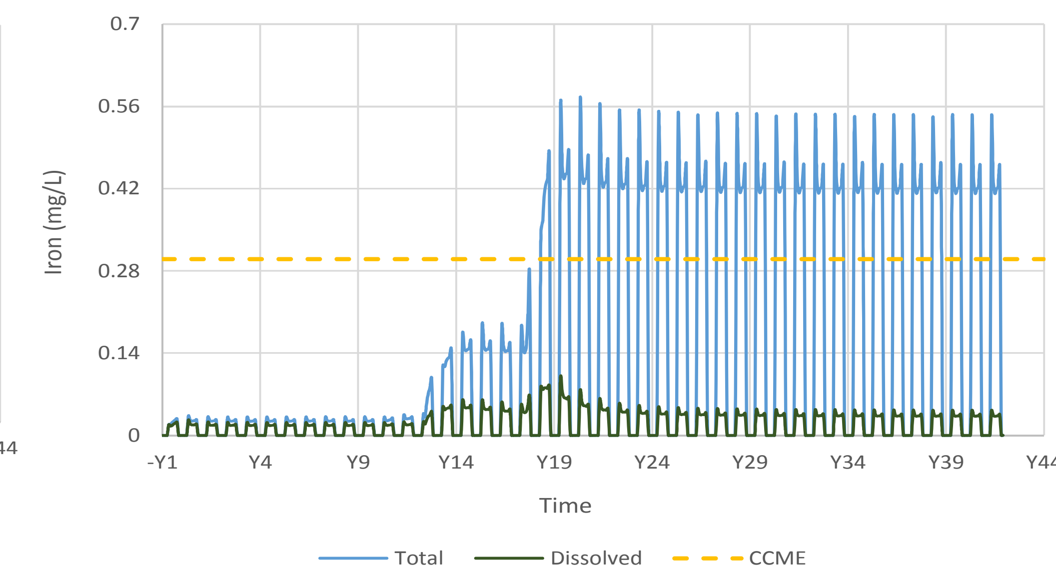
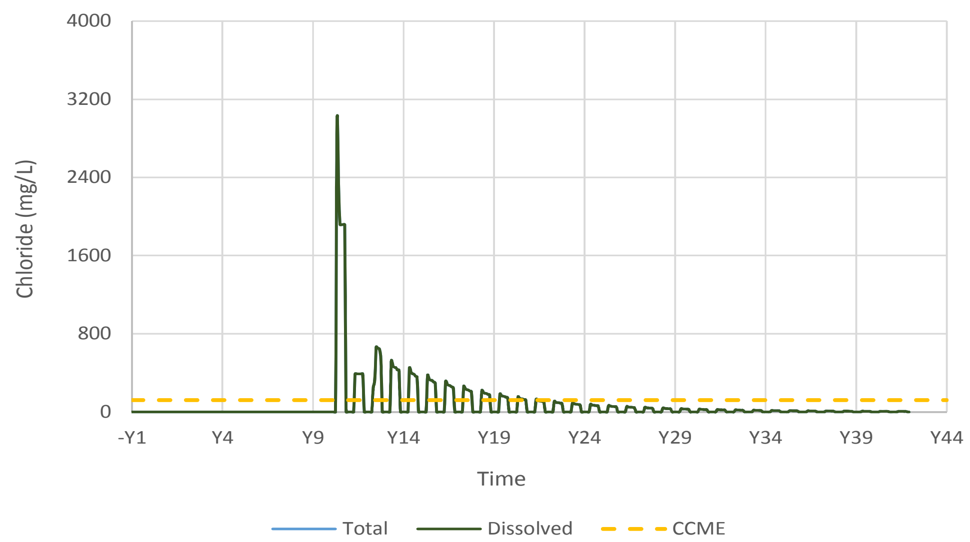


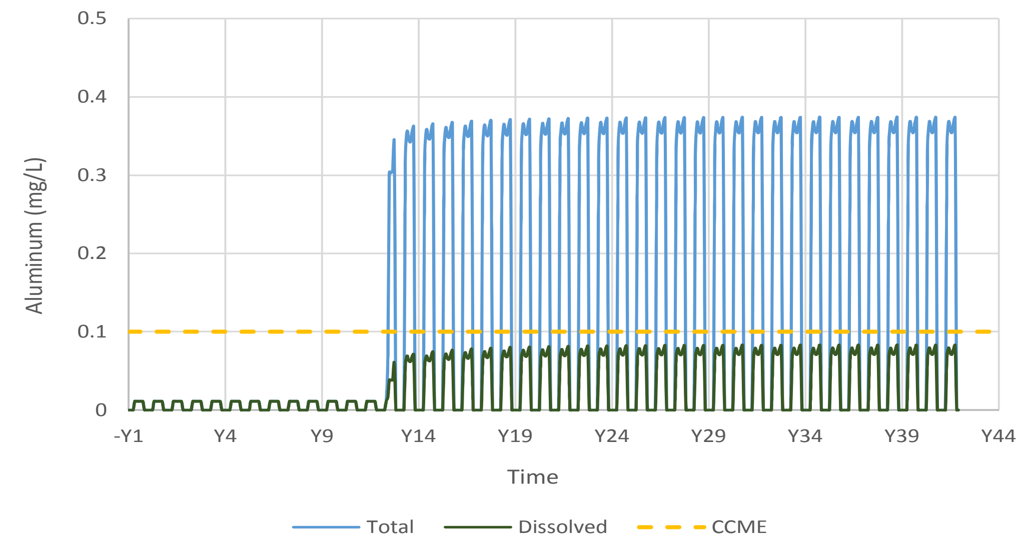
Figure 3

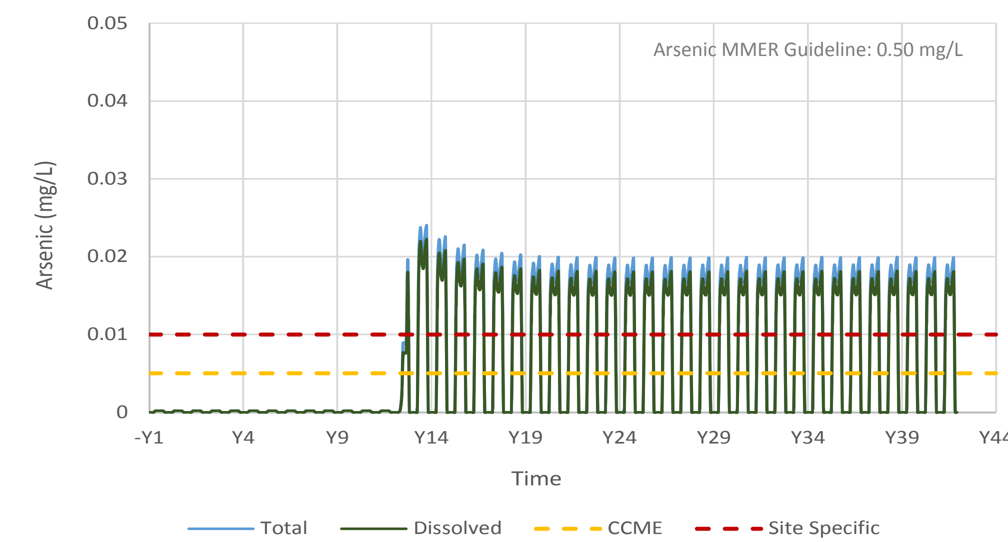
PN02 Water Quality Prediction Results

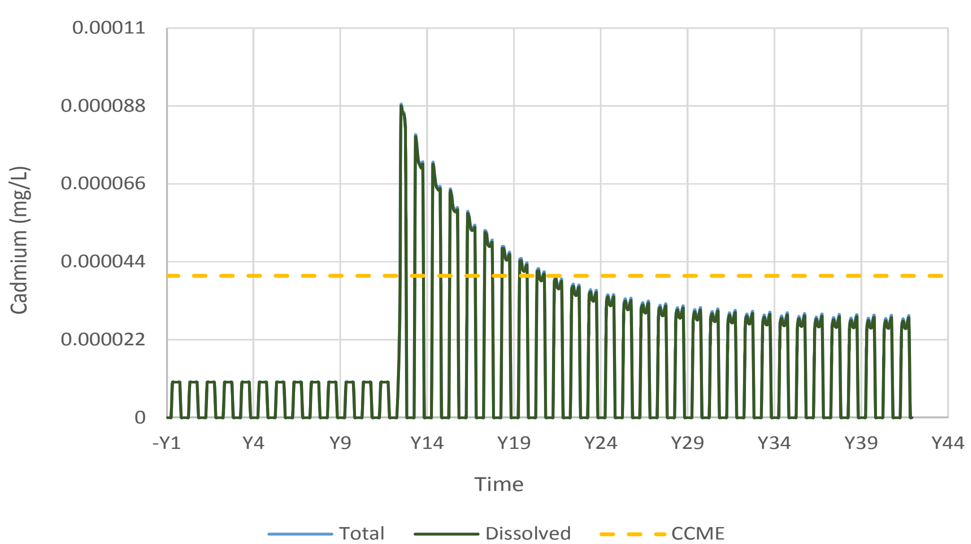
Prepared SD
Design TL
Reviewed TL
Approved SK

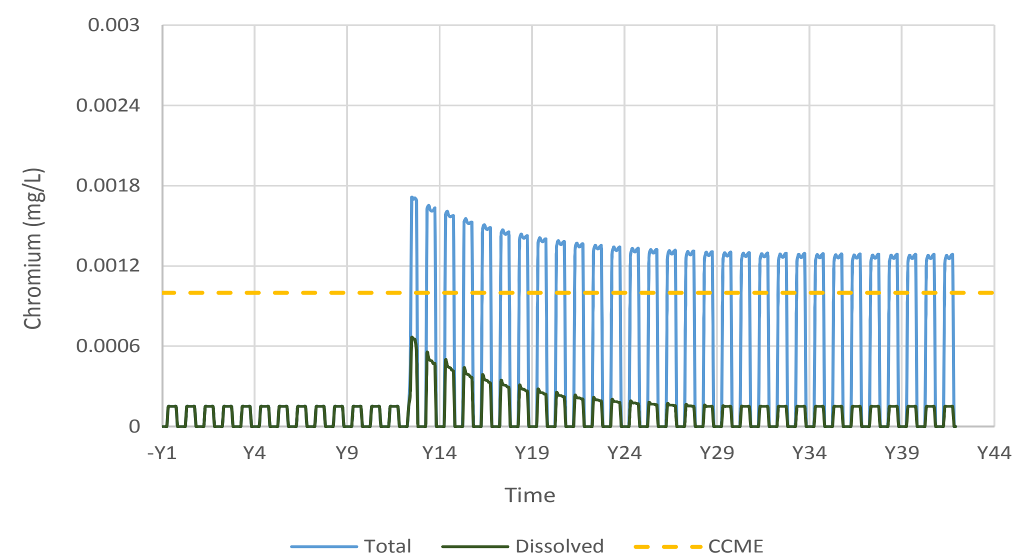
GOLDER

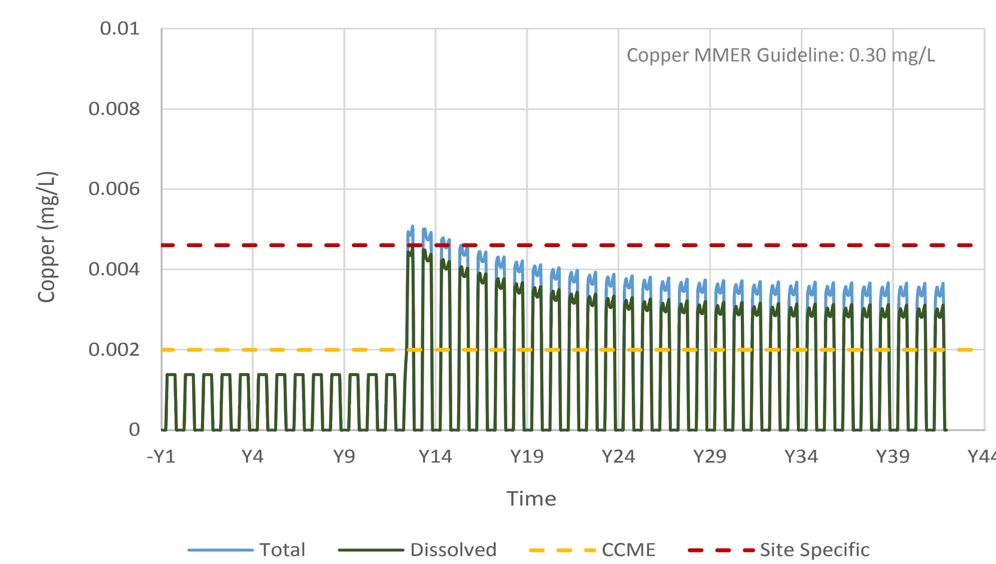


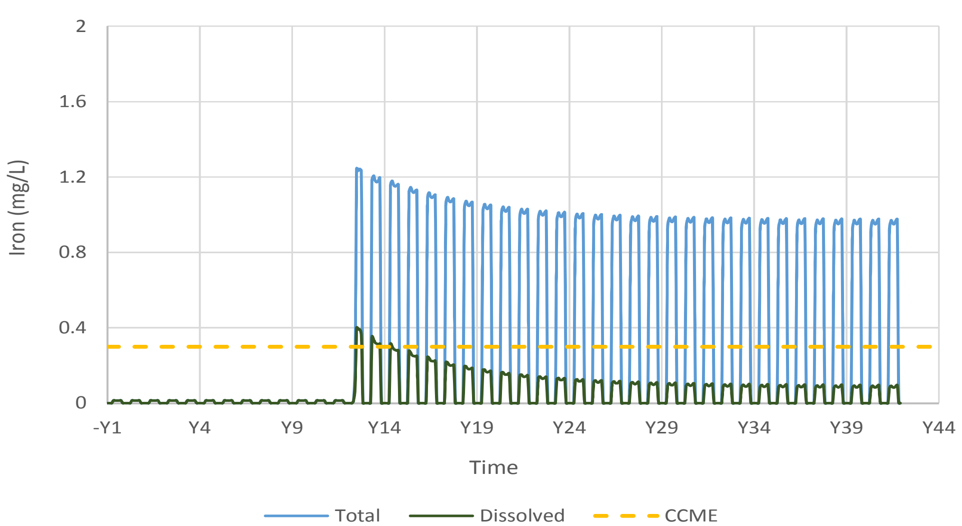












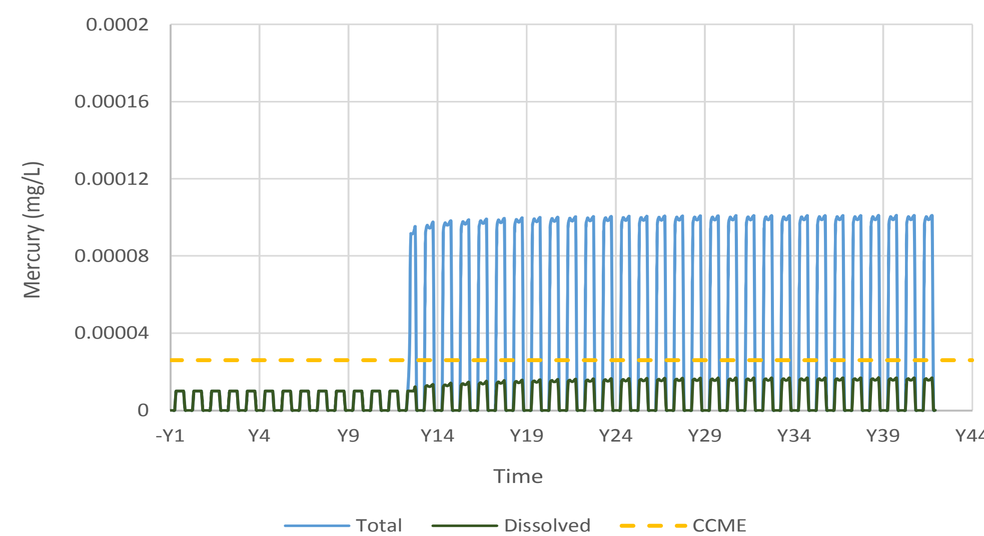
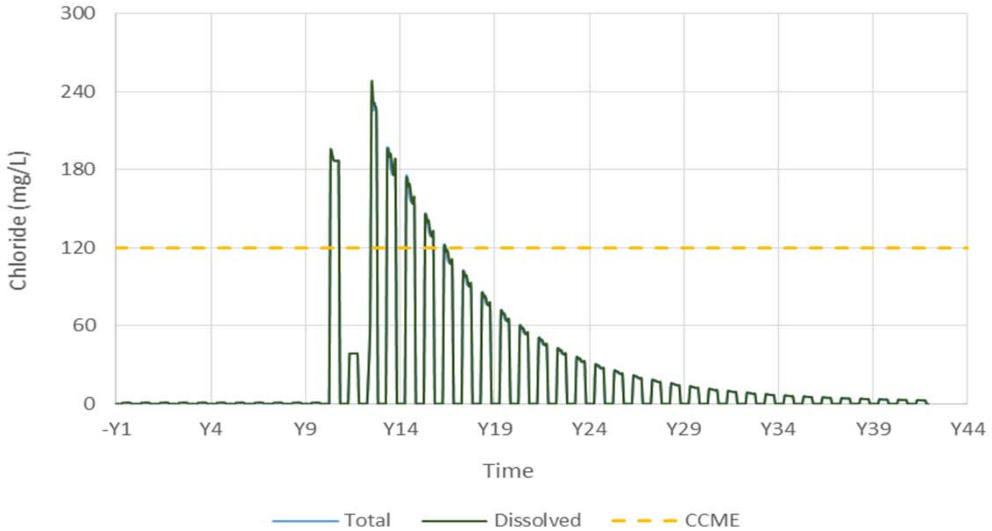


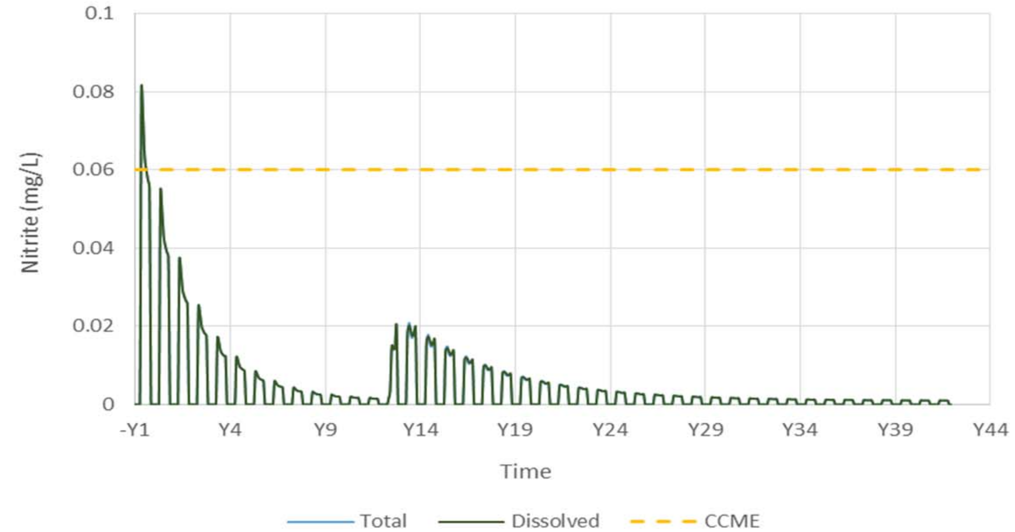
Figure 4

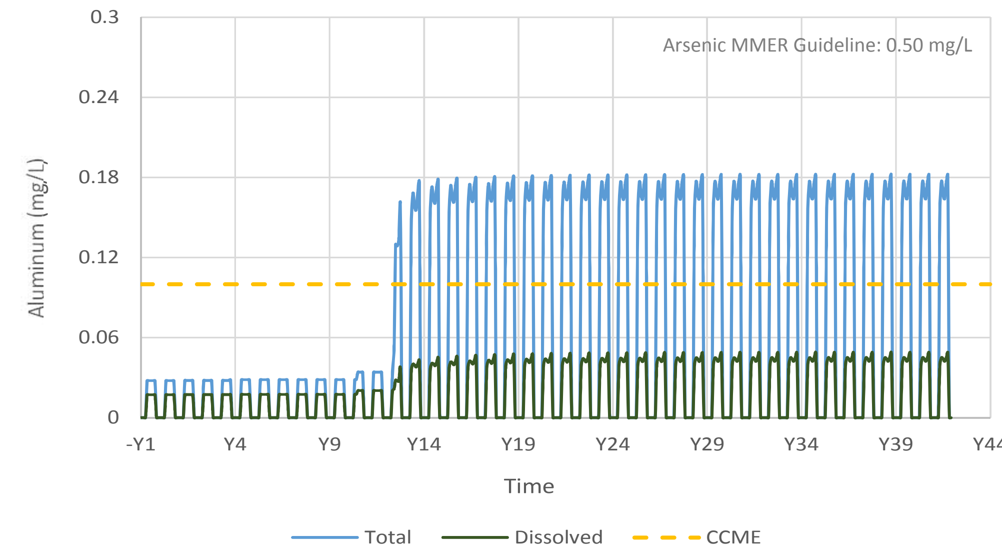
PN10 Water Quality Prediction Results

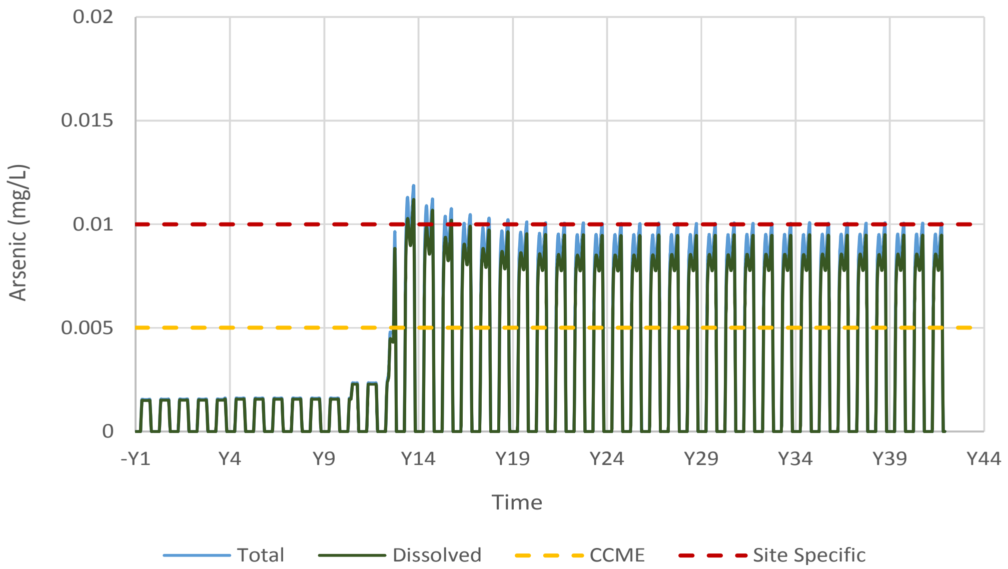
Prepared SD
Design TL
Reviewed TL
Approved SK

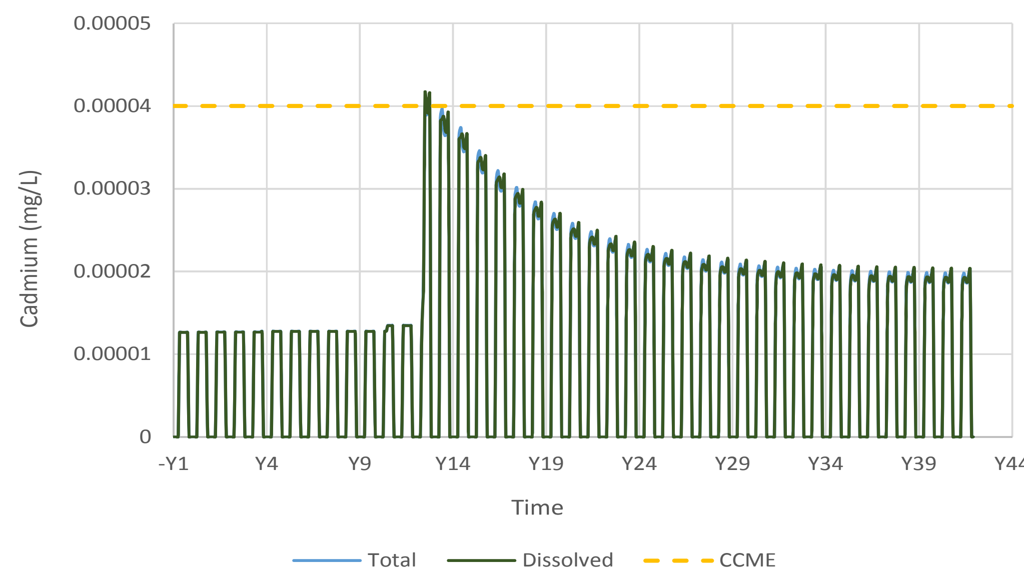
Attachment 2
Select Load Balance Model Results

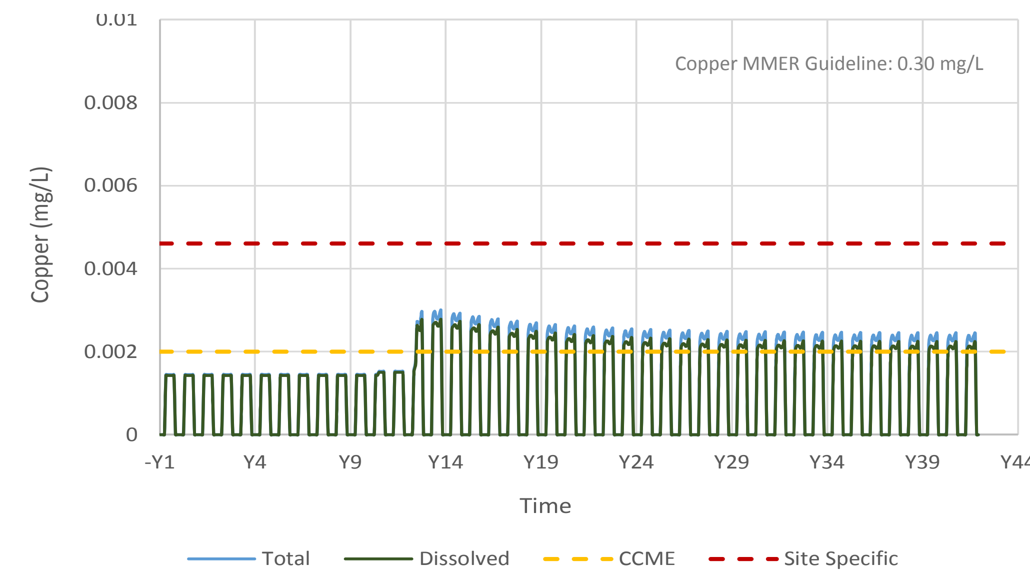


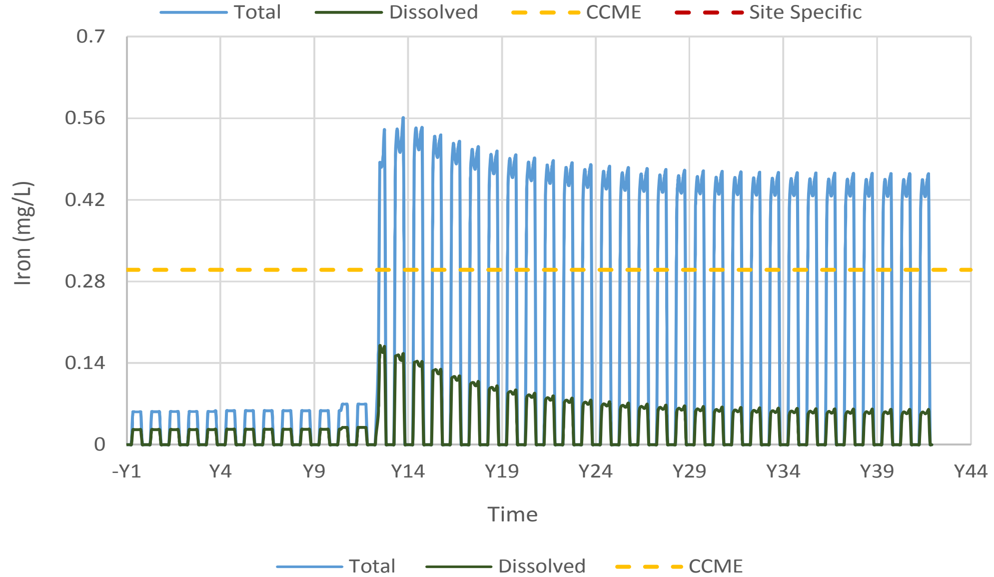












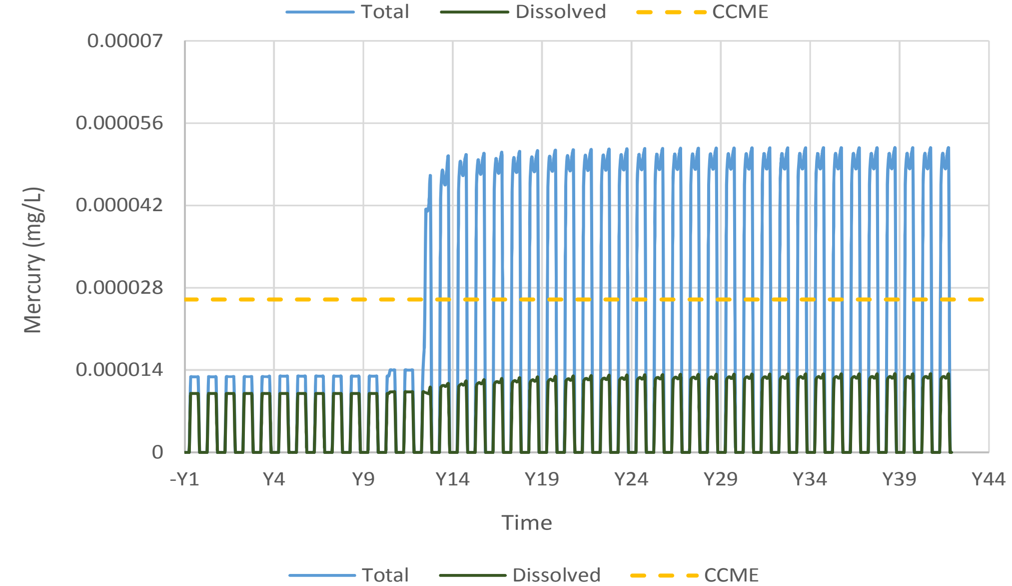
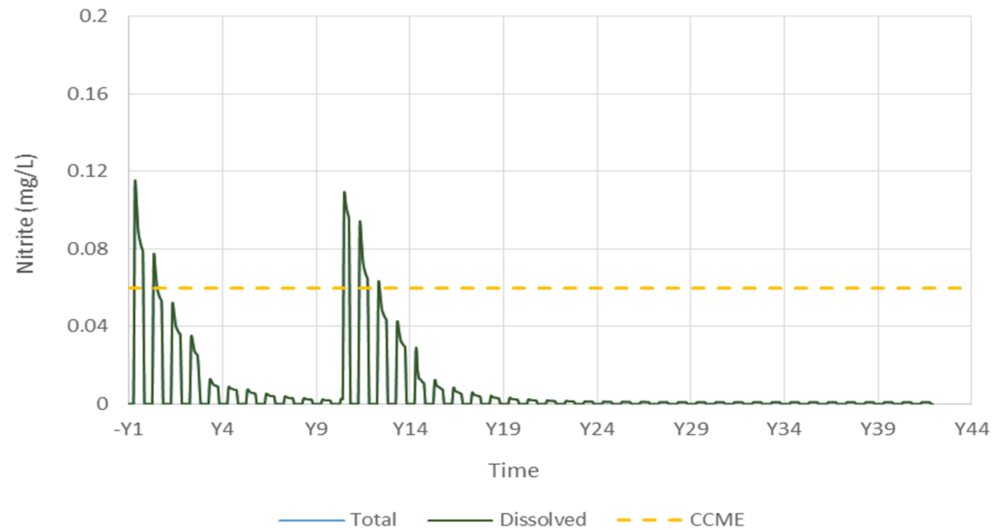


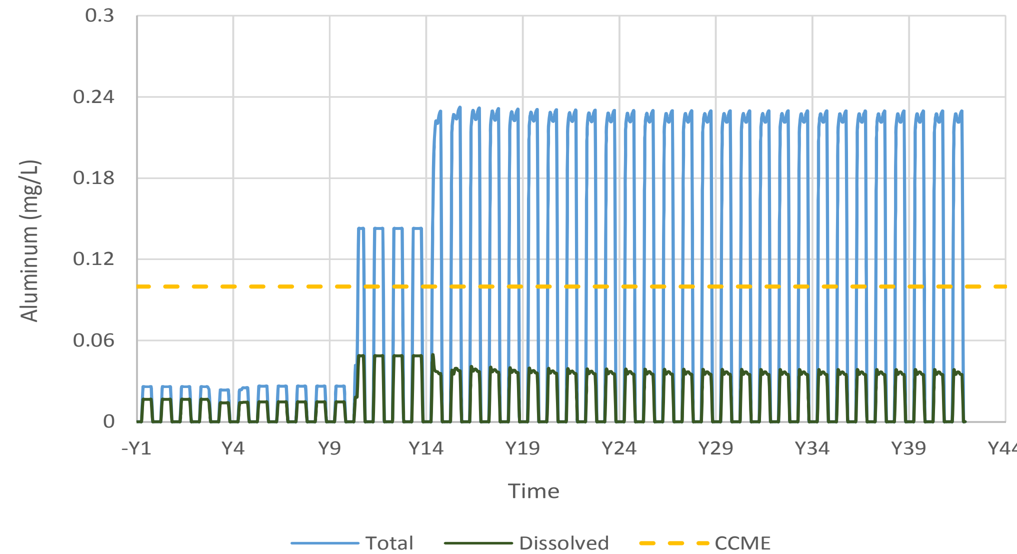
Figure 5

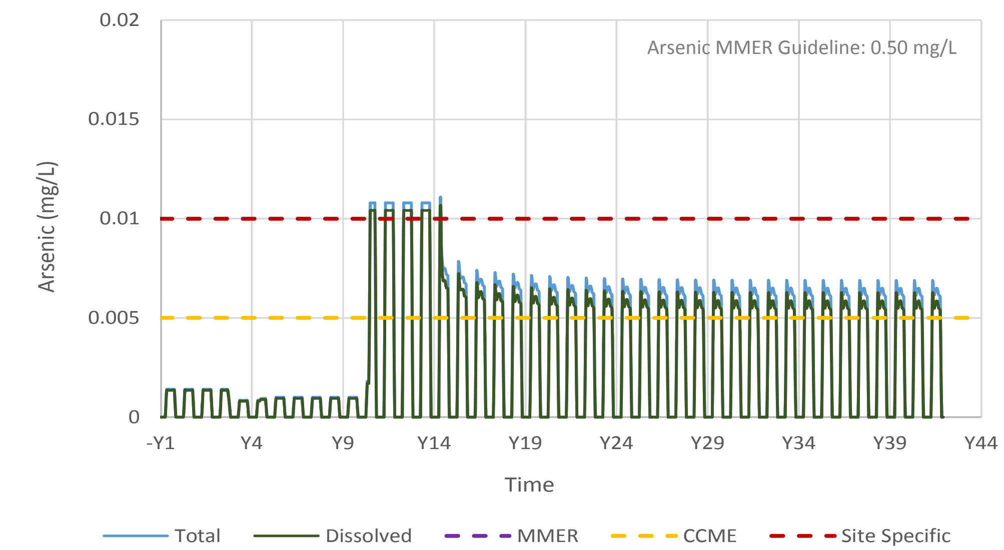
PN04 Water Quality Prediction Results

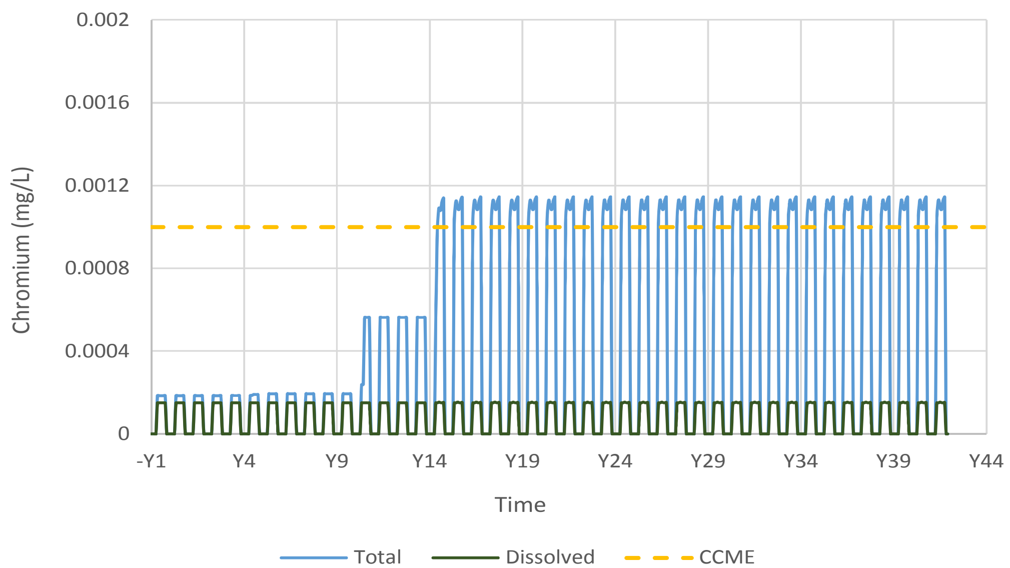
Prepared SD
Design TL
Reviewed TL
Approved SK

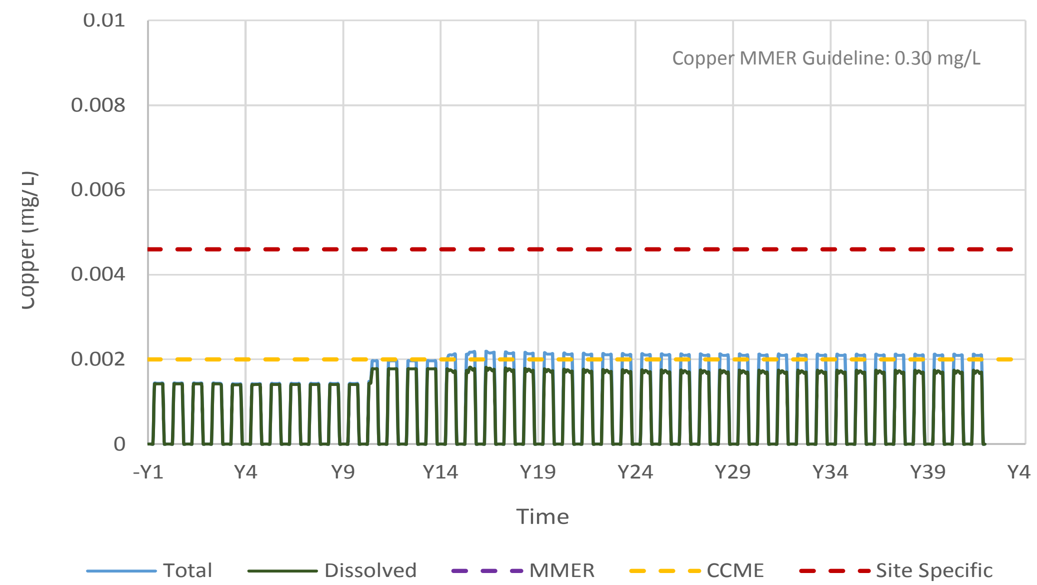
GOLDER

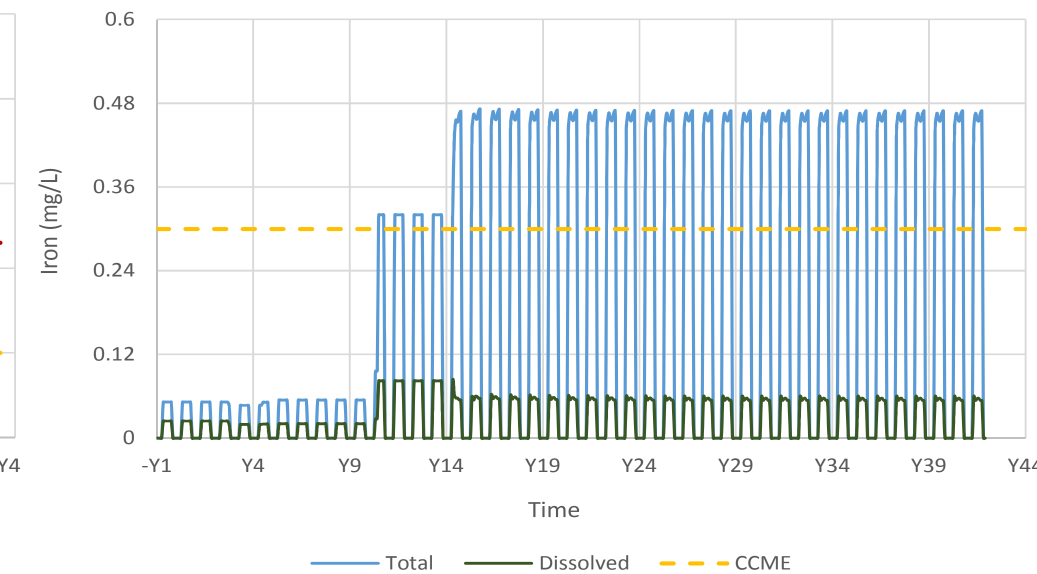












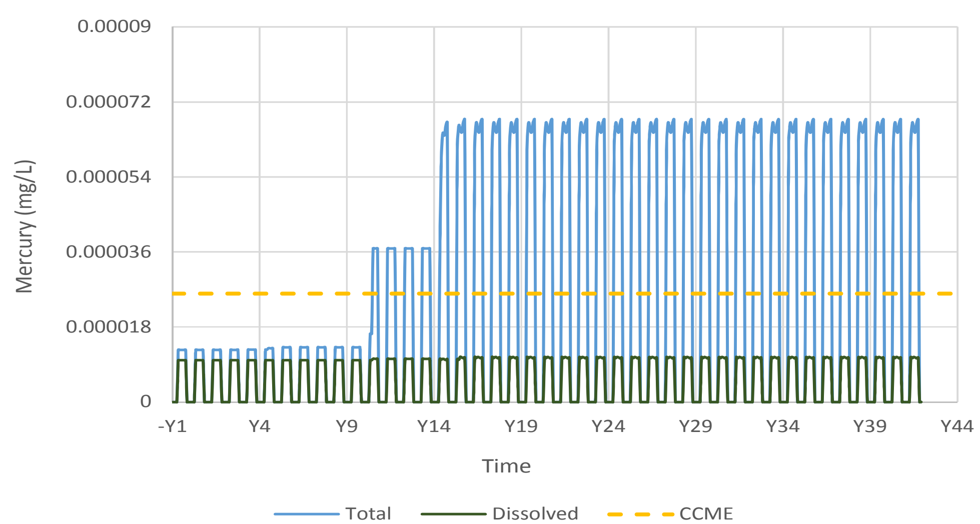
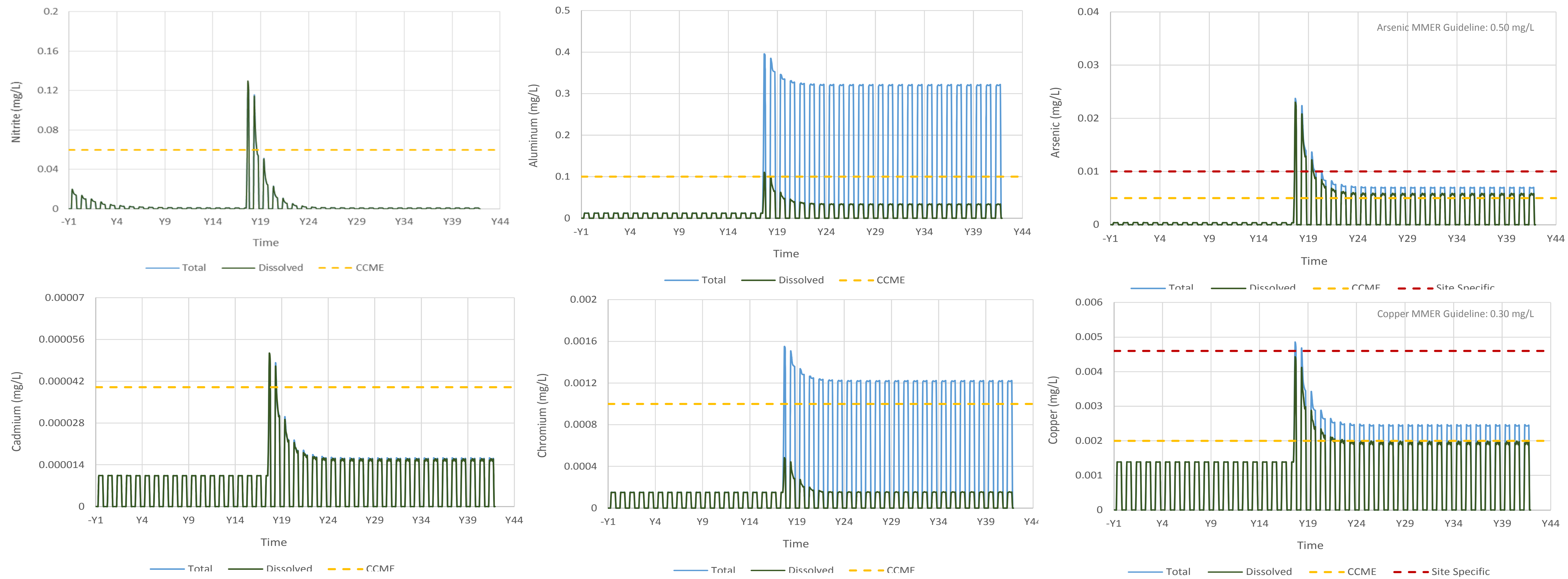


Figure 6

PN09 Water Quality Prediction Results

Prepared SD
Design TL
Reviewed TL
Approved SK

GOLDER



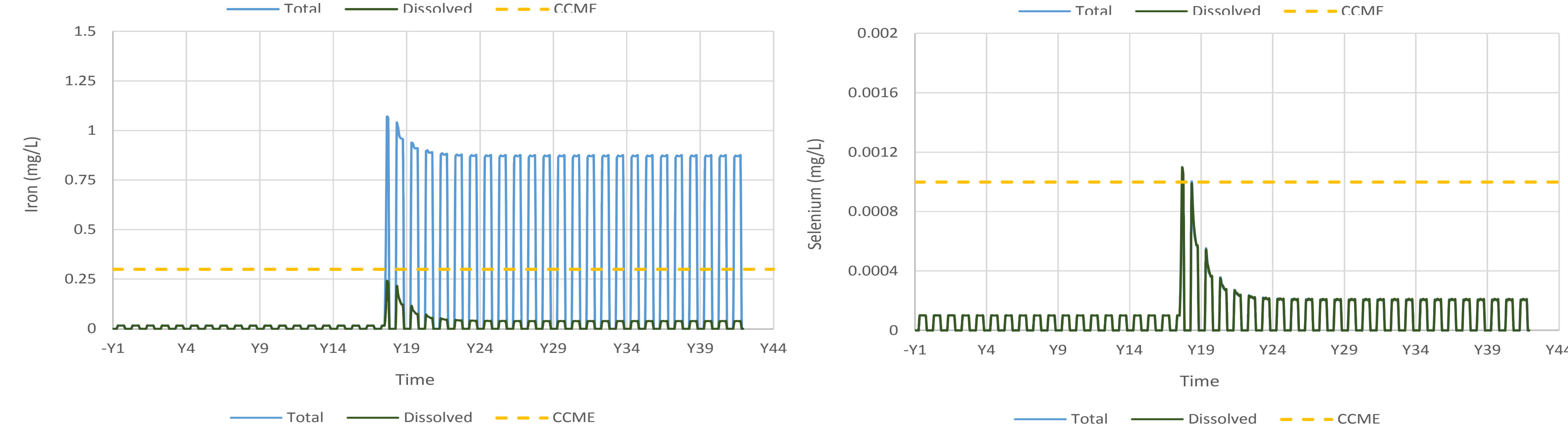


Figure 7-A

PN06 Water Quality Prediction Results

Prepared SD
Design TL
Reviewed TL
Approved SK

GOLDER

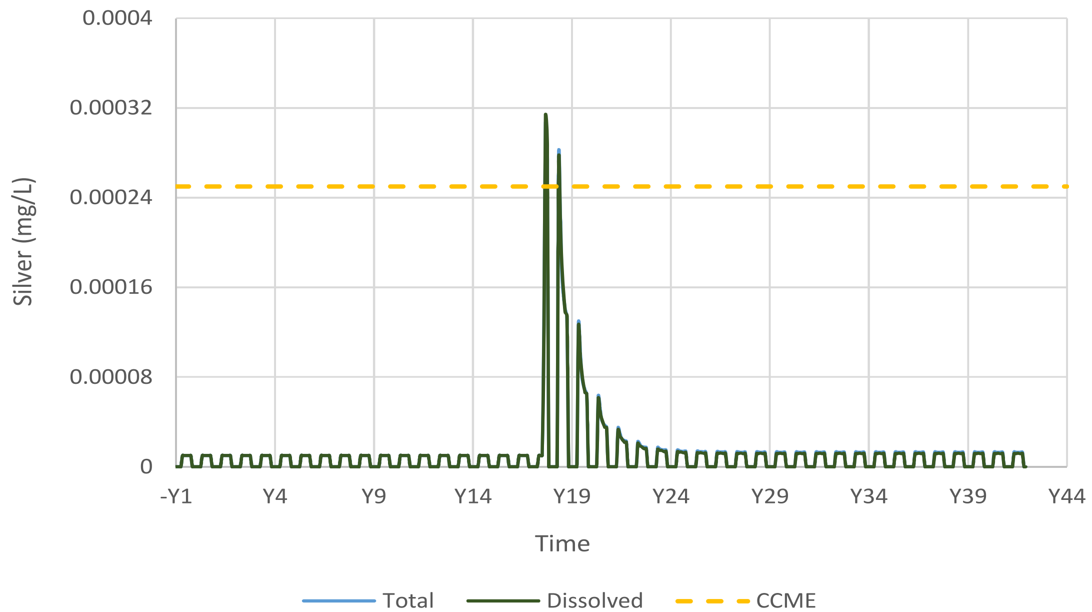


Figure 7-B

PN06 Water Quality Prediction Results (cont.)

Prepared SD
Design TL
Reviewed TL
Approved SK

GOLDER

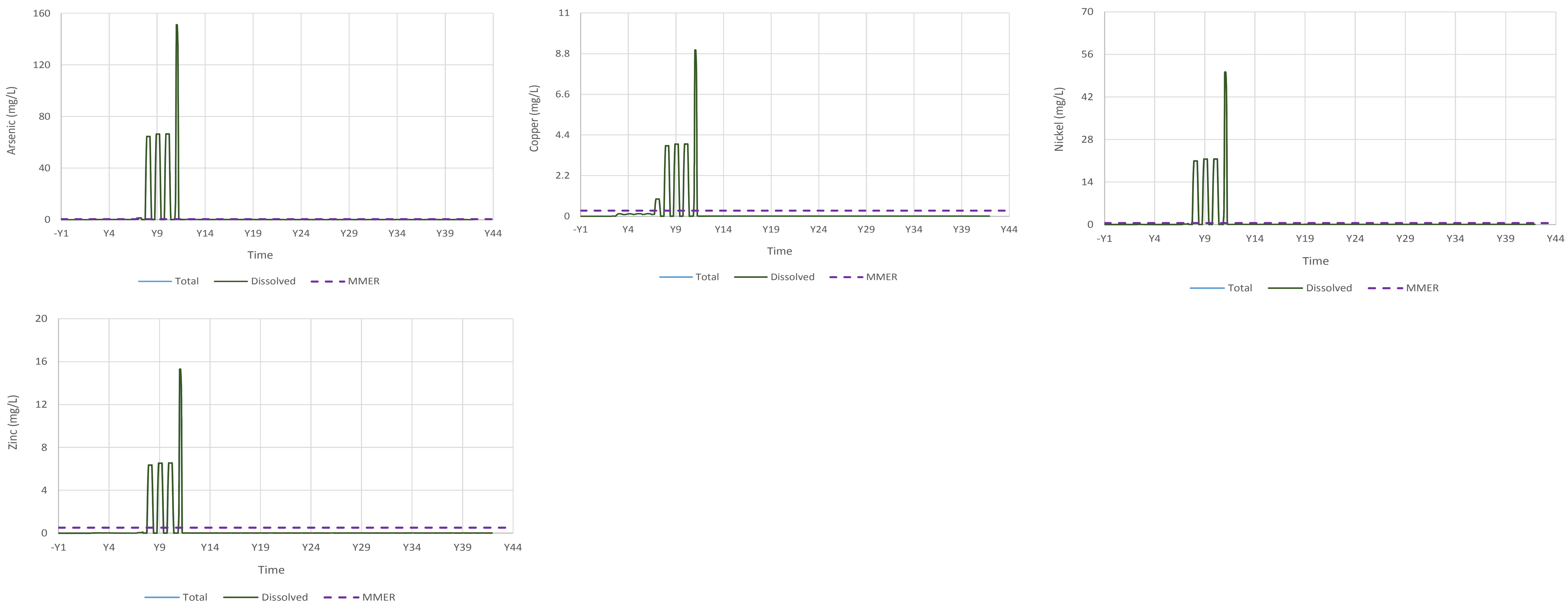


Figure 8

Umwelt Tailings Facility Water Quality Prediction Results

Prepared SD
Design TL
Reviewed TL
Approved SK

GOLDER

Attachment 2
Select Load Balance Model Results

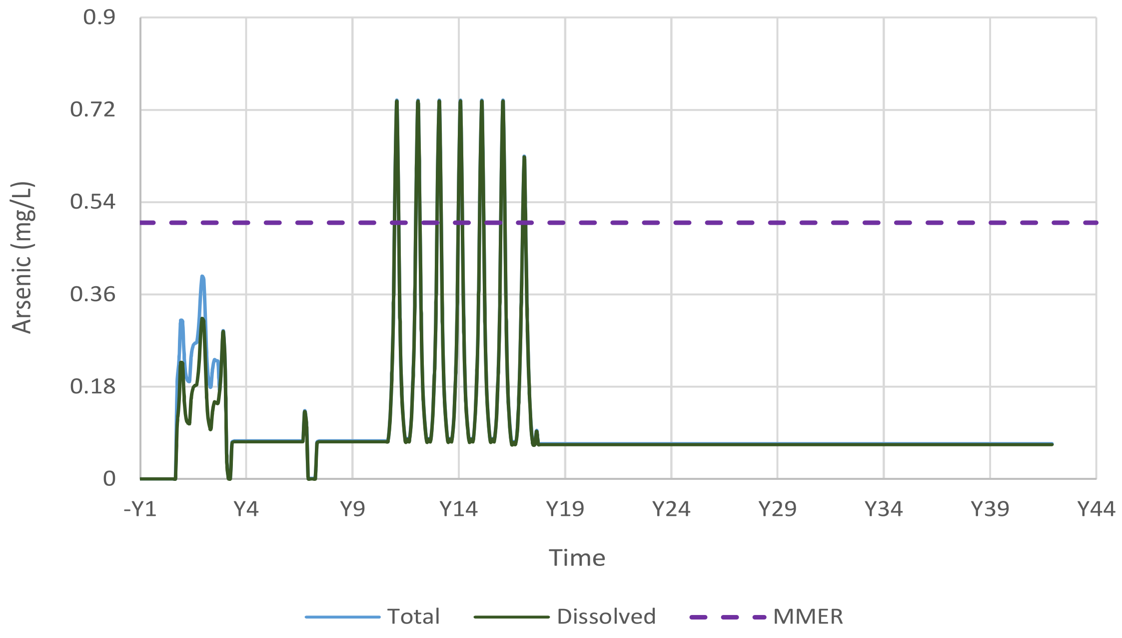


Figure 9

Main Tailings Facility Water Quality Prediction Results

Prepared SD
Design TL
Reviewed TL
Approved SK

GOLDER