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Subject: Natural Resources Canada's Submission for Technical Review of the Environmental Impact Statement for the Valentine Gold Project

On November 3rd, the Impact Assessment Agency of Canada (the Agency) requested that Natural Resources Canada (NRCan) conduct a technical review of Marathon Gold Corporation's (the Proponent) Environmental Impact Statement (EIS) for the proposed Valentine Gold Project (the Project) near Valentine Lake, Newfoundland and Labrador.

NRCan is participating in the environmental assessment process pursuant to Section 20 of the *Canadian Environmental Assessment Act, 2012* as a Department in possession of specialist or expert information or knowledge related to the Project. NRCan has conducted a technical review to assess the sufficiency and technical merit of the EIS and supporting documents (CIAR #17) based on the Department's expertise in hydrogeology, acid rock drainage and metal leaching, and in the context of the Department's regulatory role under the *Explosives Act*.

Details of NRCan's review can be found in the attached appendix below. If you have any questions, please contact me via e-mail at walker.smith@canada.ca or by phone at (613) 447-2892.

Thank you,

<original signed by>

Walker Smith
Environmental Assessment Officer
Office of the Chief Scientist

cc: John Clarke – Director, Environmental Assessment

Canada

Appendix 1: Natural Resources Canada’s Information Requirements Directed to the Proponent

ID	Link to CEAA 2012	Reference to EIS guidelines	Reference to EIS	Context and Rationale	Specific Question/ Request for Information
NRCan-01	5(1)(a)(i) Fish and Fish Habitat 5(1)(a)(ii) Aquatic Species	7.1.5 Project Setting and Baseline Conditions – Groundwater and Surface Water	Baseline Study Appendix 3, Attachment 3D, Hydrogeology Baseline Report, Section 4.4	Adequate temporal monitoring of groundwater elevation is required to understand groundwater flow rates, groundwater flow direction, and the seasonal timing of groundwater discharge to surface water. A complete seasonal cycle of groundwater elevation change was only monitored in open exploration holes, which may dampen temporal variability. Monitoring from October to March in hydrogeological monitoring wells resulted in 3m of seasonal variability in the absence of potential summer seasonal lows. Additionally, groundwater level information is spatially limited to the area within, and between the open pits. There is very limited information down gradient of the waste rock storage facilities and tailings management facility (TMF). Adequate groundwater level information, both in terms of spatial and temporal distribution, is required to understand groundwater flow quantity and timing in terms of seepage towards, or loss of flow from, surface water bodies. These changes are a component of the assessment of changes to fish and fish habitat and the aquatic species.	a. Provide groundwater elevation data from hydrogeological monitoring wells for a complete 12-month period. Incorporate this information into the conceptual model of groundwater flow, and the assessment of impacts from the project. b. Provide groundwater elevation information down gradient of waste rock storage facilities, and the TMF.
NRCan-02	5(1)(a)(i) Fish and Fish Habitat 5(1)(a)(ii) Aquatic Species	7.1.5 Project Setting and Baseline Conditions – Groundwater and Surface Water	Baseline Study Appendix 3, Attachment 3D, Hydrogeology Baseline Report, Sections 4.2, 4.3, 4.4, Appendix 2C Prefeasibility Geotechnical Report,	Faults may behave as hydraulic barriers or conduits, and can exert significant control on groundwater flow. It is noted that the Valentine Lake Thrust Fault, and other mapped faults, fracture and shear zones are not well characterized. However, complimentary data indicates the potential for the fault zone to be a zone of increased hydraulic conductivity (e.g., lower rock quality designation (Section 4.2)), or a structural control on groundwater flow direction (the presence of artesian conditions in bedrock (Section 4.4)). While only a single packer test was completed within the fault zone (Baseline Report Section 4.3), that test indicates that the fault zone has lower rock quality and a higher hydraulic conductivity (Appendix 2C, Prefeasibility Geotechnical Report, Section 5.6).	a. Discuss the results of the packer test completed within the fault and the relationship between rock quality and hydraulic conductivity within the context of the conceptual model of groundwater flow. b. Discuss the location and orientation of mapped fault, fracture and shear zones including the potential for these zones to hydraulically

			Sections 5.6, 7.2, and 7.4	Faulting can enhance hydraulic conductivity relative to surrounding bedrock. Faults of this type can act as a conduit between surface water features and the open pits. During pit dewatering, this may reduce water levels within connected waterbodies, impacting fish and fish habitat. Conversely, clay gouge along fault planes may lower hydraulic conductivity, and act as a barrier to groundwater flow. Faults of this type may direct drawdown related to open pit dewatering much further in one direction relative to another. Both fault types may influence the degree to which open pit dewatering influences groundwater – surface water interactions.	connect the open pits to surface water features. c. In the numerical assessment of the fault, provide maps indicating the drawdown and seepage flow paths under the various fault scenarios for both the water table and at depth within the bedrock.
NRCan-03	5(1)(a)(i) Fish and Fish Habitat 5(1)(a)(ii) Aquatic Species	7.1.5 Project Setting and Baseline Conditions – Groundwater and Surface Water	Baseline Study Appendix 3, Attachment 3D, Hydrogeology Baseline Report, Sections 2.3, Appendix 6A, Sections 2.2.1, 3.3, and 4.1 (Table 4-1).	In geological settings such as that of the Project, overburden can be the main unit through which seepage from mine facilities is transported, and is the unit through which groundwater is connected to surface water. The thickness and composition of the overburden is critical in understanding groundwater flow quantities, direction, and timing. No overburden has been logged (described) beyond 3m depth. If a higher hydraulic conductivity contact aquifer were present at the bedrock overburden interface this would not be apparent from logging. Additionally, it is stated that sands and gravels are present in the Victoria River Valley (Hydrogeology Baseline Report, Section 2.3). The presence of these materials would increase connectivity between the river and groundwater, and provide a more direct pathway for seepage from the TMF to the river. Within Appendix 6A, discussion of the maximum thickness of the overburden varies from 10m (Section 3.3) to over 17m (Section 2.2.1). It is not clear which statement was applied within the numerical model, nor is it clear which assumptions were made in modelling the overburden thickness throughout the site. Representation of the overburden thickness and composition affects the assessment of changes to groundwater quantity and groundwater – surface water interaction. These changes are integrated into the assessment of changes to surface water and fish habitat.	a. Provide a map of the simulated overburden thickness, including control points used. b. Discuss the simulated maximum and minimum overburden thickness, and any assumptions used in the generation of the overburden thickness map. c. Discuss the potential for increased hydraulic conductivity at the base of the till unit, and its impact on groundwater flow. d. Provide a map of the presumed extent of sand and gravel within the Victoria River valley. Discuss the impacts of this unit on groundwater – surface water interactions, and update the groundwater model to reflect the presence of this unit.

NRCan-04	5(1)(a)(i) Fish and Fish Habitat 5(1)(a)(ii) Aquatic Species	7.1.5 Project Setting and Baseline Conditions – Groundwater and Surface Water	Baseline Study Appendix 3, Attachment 3D, Hydrogeology Baseline Report, Sections 3.2, 4.3. Appendix 6A, Section 3.3, Appendix 2C Prefeasibility Geotechnical Report, Section 7.4	The relationship between geological units and hydraulic conductivity (the hydrostratigraphy) is key to understanding groundwater flow quantity and direction. Hydraulic conductivity in the overburden was assessed through single well response tests. The majority of these tests were completed in wells that were screened across the bedrock-overburden interface. A review of these tests indicate increased hydraulic conductivity with increased proportion of the screen within the bedrock (BSA, Section 4.3). These results, combined with the noted lower rock quality designation within the upper 5-10m of bedrock, appear to support a conceptualization of an upper, more permeable bedrock zone within the top 5-10m. Within the geological and groundwater models, the hydrostratigraphy of the bedrock has been classified into upper (0-20m), intermediate (20-120m), and deep (120-370m) bedrock units. These divisions do not appear to reflect the hydraulic conductivity data or the rock quality designation data, all of which point to higher hydraulic conductivity in the upper 5-10m. As shown on Figure 1, Section 7.4, Appendix 2C Prefeasibility Geotechnical Report, the packer testing data, while sparse, appears to show a with a lower uniform hydraulic conductivity for the remaining depth for the Marathon Pit and an increased hydraulic conductivity at depths greater than 350 m for the Leprechaun Pit. Single well response testing within the bedrock (MW5, MW6, and MW8) should not be relied upon to characterize bedrock hydraulic conductivity. In MW5, groundwater elevations were only displaced by 10cm, and only two observation points were used in the analysis. At MW6, and MW8, the rising head tests (completed second) yield hydraulic conductivity estimates that were at least an order of magnitude higher than the falling head tests (completed first). These results may indicate continued development of these wells through testing. Results at these three wells may underestimate shallow bedrock hydraulic conductivity. Hydrostratigraphy implemented within the groundwater flow model is the main factor that controls the assessment of groundwater flow quantity and direction. Hydrostratigraphy should represent field observations to the extent possible. Failure to represent a conductive upper bedrock unit may result in an incorrect assessment of changes to surface water quantity and	a. Update the geological and groundwater models to represent the observed hydrostratigraphy and measured hydraulic conductivity variations with depth. Implement variations in bedrock hydraulic conductivity with depth, only to the extent supported by hydraulic testing and rock quality designation. b. Single well response tests at MW5, MW6, and MW8 should be reassessed to ensure sufficient displacement, and to evaluate the potential for well development through testing.

				quality, which would be carried forward to the assessment of fish and fish habitat.	
NRCan-05	5(1)(a)(i) Fish and Fish Habitat 5(1)(a)(ii) Aquatic Species	7.2.2 Changes to Groundwater and Surface Water	Appendix 6A, Sections 4.3.3, 4.3.4, Tables 5-1, 5-2, and 5-3, and Figures 4.1, 5.2 and 5.4	Boundary conditions within the groundwater flow model are user specified, and control the degree to which groundwater may interact with surface water. As stated in Section 4.3.3, all lakes are assigned a general head boundary condition such that groundwater elevations in the vicinity of the lake and lake levels are assumed to remain constant. As discussed in Section 4.3.4, the Victoria River has also been assigned a general head boundary condition. While this condition is reasonable for lakes with large catchment areas (such as Valentine Lake and the Victoria Lake Reservoir), groundwater drawdown in the vicinity of smaller lakes (such as the Middle, East and West Ponds, and Frozen Ear Lake), or in the upper reaches of the Victoria River, may result in lowering of the surface water levels. As shown on both Figures 5.2 and 5.4, the assignment of these boundary conditions limits drawdown near these features during both operations and closure. Given the lowering of the water table associated with open pit dewatering, the potential for these waterbodies to sustain the simulated flux to groundwater should be evaluated. In Section 4.5.4 it is noted that 2nd order or greater streams have been assigned a river boundary condition. Unlike a general head boundary, groundwater drawdown may occur below these features. However, the assumption that there is sufficient surface water flow to sustain continued flux to the groundwater remains. This assumption should be validated using water balances for these streams. In both cases, it is critical that these boundary conditions be applied only in cases where sufficient surface water flow is available to counter the loss of surface water to groundwater. Dewatering of surface water features and loss of fish habitat is possible with pit dewatering, and should be properly represented within the groundwater model. Although distant from the mine infrastructure, the northwest (abutting the northern reaches of Long Lake) and northeast (abutting Red Cross Lake) model boundaries appear to be set as no flow boundaries. These	a. Update Figure 4.1 so that the type, elevation, and location of all boundary conditions (General Head, River, and Drain) are clearly visible, including those at the boundary of the model. In Tables 5-1 and 5-2, include the boundary condition type for each surface water feature listed. Include the Victoria River reach that is within the groundwater model. b. Complete a water balance for all surface water features for which a general head or river boundary has been applied. The water balances should be completed for baseline, operations and closure conditions. Simulated flux to groundwater should be compared to available water, and model boundaries should be updated accordingly.

				boundaries should be specified to reflect the lake elevation to ensure regional groundwater flow is represented.	
NRCan-06	5(1)(a)(i) Fish and Fish Habitat 5(1)(a)(ii) Aquatic Species	7.2.2 Changes to Groundwater and Surface Water	Appendix 6A, Section 4.4, Tables 4-2 and 4-3, and Figures 4-3 and 4-4	Groundwater model calibration is the measure of the ability of the groundwater model to replicate the interpreted conceptual model of groundwater flow. Without a reasonable calibration, any forecasted changes to groundwater quantity, or groundwater-surface interaction are not reliable. These results are then transferred to the assessment of surface water flow, and subsequently fish and fish habitat. An automated calibration process was employed in which model parameters were adjusted until the model matched observed groundwater elevations and baseflow. Baseflow is an important metric, as it provides a more regional scale measure of the shallow hydrostratigraphic units. Although it is stated that calibration to baseflow was conducted, no results have been provided. Simulated baseflow may be sensitive to parameters such as river conductance, recharge, and the hydraulic conductivity of the overburden. Given that the calibrated value of river conductance is a factor of 26 times greater than the host overburden (a much higher conductance factor than is typical), calibration to baseflow should be presented and justified. Calibration to water levels was conducted primarily using data from long open exploration holes (96% of data). An open hole can connect several hydrostratigraphic units (HSUs) such that groundwater elevations are representative of several units. As a result, differentiation of the water levels in the various HSUs is difficult. While several methods are available to integrate this type of data into a calibration process, the method chosen should be discussed, as should its implications on calibration. Calibration to water levels is evaluated by comparing simulated to observed groundwater elevation values at the various observation points (Shown on Figure 4-3 and summarized in Table 4-2). Results show that the modelled groundwater levels tend to be higher than observed at low elevations, and lower than observed at high elevations. These results indicate that the model may underrepresent the observed magnitude of hydraulic gradients. Magnitude of error should be discussed in both a	a. Discuss the calibration of the groundwater model to baseflow. Provide a rationale for the river conductance factor derived from the calibration. b. Describe the methodology for specifying the exploration holes as observation wells in the groundwater model. If each hole is assigned to a single HSU, include this unit in Table 4-2, and colour the data by HSU on Figure 4-3. Discuss the number of observation points in each HSU. c. Discuss calibration to water levels in terms of HSU and spatial location. Reevaluate the calibration to ensure hydraulic gradients are properly represented. d. Review the hydrostratigraphic conceptualization and its effect on calibrated hydraulic conductivity and anisotropy values.

				spatial and geological sense, and its implications on model performance should be discussed. Although automated calibration can efficiently generate parameter sets that minimize errors, the solution is non-unique, meaning that other possible parameter combinations may yield the same result. As such, it is important that results are evaluated to ensure that they align with observations and the conceptual model. In Section 4.4.3 it is stated that the calibrated hydraulic conductivity is generally less than that observed in the single well tests. This result does not seem to be consistent with the accepted observation that hydraulic conductivity increases with scale (e.g. Schulze-Makuch et al., 1999). Although it is noted that bedding in the bedrock units follows the near vertical dip of the units, the calibrated anisotropy value results in a higher hydraulic conductivity across the bedding planes. This result is inconsistent with typical conceptualization. As discussed in NRCan-04 these results may indicate that the modelled hydrostratigraphy is not aligned with observations. As shown on Figure 4-4, recharge is the most sensitive parameter in the calibration. The calibrated recharge value is validated against an assumed range for all of Newfoundland. However, sufficient water balance data is presented in Baseline Study Appendix 3C Section 4.1 that would allow calibrated recharge to be compared to a local annual water surplus. Given that hydraulic conductivity parameters are outside of the assumed range, calibrated recharge warrants this level of comparison. *Schulze-Makuch, D., Carlson, D. A., Cherkauer, D. S. & Malik, P. Scale Dependency of Hydraulic Conductivity in Heterogeneous Media. Groundwater* ***37****, 904–919 (1999).*	e. Provide details on the presentation of two overburden units on Figure 4-4, which are not included in Table 4-3. f. Discuss calibrated recharge relative to site water balance data.
NRCan-07	5(1)(a)(i) Fish and Fish Habitat 5(1)(a)(ii) Aquatic Species	7.2.2 Changes to Groundwater and Surface Water	Appendix 6A, Section 5.2.1.2	The effect of the Valentine Lake Thrust Fault on groundwater flow was assessed through a sensitivity analysis. The results of this analysis were evaluated in terms of groundwater inflow to the open pit under operational conditions. While this mode of analysis is required for water management purposes, it neglects to account for related changes in groundwater elevations. An increased hydraulic conductivity in the fault zone more than doubles the groundwater inflow to the open pits. The source of this additional groundwater needs to be understood to properly evaluate the effects on fish and fish habitat.	a. Provide groundwater elevation maps for baseline conditions for both fault scenarios. Discuss the effect of the fault scenarios on model calibration and groundwater flow in both overburden and bedrock under baseline conditions.

				As stated in Section 5.2.1.2, the simulated fault plane connects the pits to Victoria Lake. Given this connection, simulations which include the fault are likely to result in changes to groundwater-surface water flux rates for Victoria Lake and the small lakes proximal to the pits. Expanded evaluation of the fault scenarios is required.	b. Provide groundwater elevation and drawdown maps for both fault scenarios in both operations and closure. Groundwater drawdown should be provided for both the water table and within the bedrock at the depth of maximum drawdown. c. Provide tables summarizing the changes in baseflow to surface water bodies for both fault scenarios under both operations and closure. d. Complete particle tracking for both fault scenarios under both operations and closure.
NRCan-08	5(1)(a)(i) Fish and Fish Habitat 5(1)(a)(ii) Aquatic Species	7.2.2 Changes to Groundwater and Surface Water	Appendix 6A, Sections 5.2.2 and 5.3.2, Tables 5-3 and 5-6. And Figures 5-2 and 5-4	Baseflow, or groundwater discharge to surface water, can be the main sustaining flow for surface water bodies during periods of low precipitation. This flow can be critical to fish, fish habitat and other aquatic species. Changes to baseflow, or changes to the flux between groundwater and a surface water body is one of the key outputs from the groundwater model, and feeds the assessment of impacts to other valued components. To assess model results, groundwater drawdown can be compared to simulated changes in groundwater discharge to surface water. Maps on Figures 5-2 and 5-4 show simulated groundwater drawdown under operations and closure conditions. However, it does not appear that all of the waterbodies listed in Tables 5-3 and 5-6 are shown on the map (e.g., VR4). It is also apparent that not all of the water bodies in the model have been included in Tables 5-3 and 5-6. Specifically, the reach of the Victoria River that falls within the model domain is not reported. This information is required to fully evaluate changes in groundwater flow to surface water and subsequent changes in surface water affecting fish and fish habitat.	a. Provide maps in which all waterbodies listed in Table 5-3 and 5-6 are clearly labelled. b. Where the results shown in Table 5-3 and 5-6 appear to be inconsistent with the water table drawdown or expected results, ensure correct values are reported, and discuss any rationale for the discrepancy. c. Provide simulated changes to groundwater-surface water exchange rates for the reach of the Victoria River that is within the model domain under both operations and closure

				Results in Table 5-3 and 5-6 both indicate that waterbodies NT1 and NT2 receive more groundwater discharge in operations and closure relative to baseline conditions. This table appears to be inconsistent with the drawdown shown on Figures 5-2 and 5-4, as well as the discussion within the text. Additionally, waterbody ST3 appears to lose between 500 and 1000 m^3/day of groundwater discharge in operations and closure. This water body is outside of the zone of influence of the pits, and within an area of increased groundwater elevations due to the presence of the TMF. These results should be evaluated against expected outcomes.	conditions. Discuss these results in comparison to a water balance for this reach of the river, and ensure sufficient surface flow is available to maintain any flux to groundwater.
NRCan-09	5(1)(a)(i) Fish and Fish Habitat 5(1)(a)(ii) Aquatic Species	7.2.2 Changes to Groundwater and Surface Water	Appendix 6A, Sections 5.2.1.3 and 5.3.1.2, Tables 5-4, 5-6, and 5-7.	The quantity of groundwater seepage that originates from waste rock storage facilities and discharges to surface water bodies is used to assess water quality within these waterbodies. The quantity of this seepage affects the assessment of fish and fish habitat. Implementation of these facilities and their seepage collection infrastructure within the groundwater model has implications on these assessment results. As reported in Section 5.2.1.3, during operations, recharge was applied to the waste rock pile at a rate of 82% of precipitation (indicating that the remaining 18% does not infiltrate the pile and runs off). However, results in Table 5-4 are presented as percentage of total infiltration, and sum to 82%. These results appear to suggest that 18% of the applied recharge is not accounted for within the table. During closure, as reported in Section 5.3.1.2, recharge rates for the facilities were changed to a post-closure value, which is meant to reflect changes in grading and vegetation. This value is not provided. In review of the results in Table 5-7, again presented as a percentage of total infiltration, the total for the Leprechaun facility appears to be 50%, while the total for the Marathon facility appears to be 82%. These discrepancies should be clarified such that all applied recharge to the facilities is accounted for, and that the value of recharge applied is clear within the report. Results presented in Tables 5-4 and 5-7 indicated that the majority of the seepage from the waste rock facilities is captured by the ditch network and seepage collection ponds. These features limit the amount of seepage received by the natural environment. As stated in section 5.2.1.3 ditches were specified as 25m wide, aligned with the model grid size. Based on results shown in Table 5-6, these ditches appear to capture a large quantity	a. Provide the recharge value applied to the waste rock facilities in both operations and closure, and the method used to derive this value. Present the results in Tables 5-4 and 5-7, either as percent of recharge or flux value. Discuss any discrepancies between recharge applied and total seepage that was accounted for. b. Include the results for the closure scenario without ditches in the assessment of the seepage of the waste rock facility. c. Include an assessment of the travel time for seepage from the facilities to the discharge points. Include a discussion of the parameterization of this assessment.

				of groundwater. The setting of 25m wide ditches may over-represent the zone of influence of the seepage collection system, and model results may underestimate the quantity of groundwater seepage that bypasses these systems. The timing of the arrival of seepage at the various groundwater discharge points has implications for the ability to monitor and mitigate the effects of this seepage. Results from the model should include travel time from the facilities to the discharge points.	
NRCan-10	5(1)(a)(i) Fish and Fish Habitat 5(1)(a)(ii) Aquatic Species	7.2.2 Changes to Groundwater and Surface Water	Appendix 6A, Sections 5.2.1.4 and 5.3.1.2	Similar to seepage from waste rock facilities, the quantity of groundwater seepage that originates from the TMF and discharges to surface waterbodies is important to the assessment of water quality, as it affects the assessment of fish and fish habitat. As discussed in Appendix 6A, a contaminant transport approach using MT3D was implemented to generate an attenuation factor for seepage from the TMF prior to discharge to the Victoria River. To review the assessment of TMF seepage, the details of the parameterization of the MT3D model should be provided. Results of the model including the quantity of seepage, point of discharge (i.e. Victoria River or its tributaries) and travel time should be provided.	Provide details of the MT3D model set-up, including parameterization. Discuss the results of the MT3D model in terms of seepage quantity, seepage discharge points, and travel time.
NRCan-11	5(1)(a)(i) Fish and Fish Habitat 5(1)(a)(ii) Aquatic Species	7.2.2 Changes to Groundwater and Surface Water	EIS Chapter 2, Section 2.6.3.3, Appendix 6A, Figure 5-4	The EIS states that following the exhaustion of the Leprechaun Pit in year 9, tailings will be backfilled within the pit. These tailings represent a potential source of mining impacted groundwater seepage, which may affect fish and fish habitat should hydraulic containment within the open pit be lost upon pit flooding. While Figure 5-4 demonstrates that some degree of water table drawdown around the open pit is maintained during the post closure period, this shallow 2D assessment is not sufficient to assess hydraulic containment. As such, the potential effect of backfilled tailings within the open pit has not been evaluated.	Complete particle tracking for the backfilled tailings within the Leprechaun open pit, and report on any discharge points for seepage. Assess the sensitivity of the model results to the post-closure pit elevation and the presence of the fault.
NRCan-12		Section 2.2. Alternative means of carrying out the project	Chapter 2, 2.3.11.1 Waste Rock Management	The Proponent indicates that the economic impact of backfilling waste rock in open pits at closure places a significant financial burden. However, the prediction of several metals in surface water is high and predicted to be stable for many decades, which will lead to a build-up of metals in sediments. These predictions may be even higher if the comments on the waste rock characterization below (NRCan-13 to NRCan-20) are accounted for. The waste rock and open pits may be important contributors of metals to surface water during the post-closure period.	Using surface water and sediment quality predictions, provide an alternative means assessment for the management of waste rock piles (i.e., engineered cover with erosion rates over time vs. backfill into available pits). Apply the Government of

					Canada guidelines on the assessment of alternatives for mine waste disposal.
NRCan-13		Part 2, section 7.1.2 and 7.2.2	Baseline Study Appendix 5 Attachment 5-B Section 3.1.1, 4.1.1, and 4.3.1 and Appendix A	The EIS Guidelines require the proponent to complete a geochemical characterization of waste rock, ore, low grade ore, and overburden in order to predict metal leaching and acid rock drainage. Geochemical samples collected from ore, low grade ore, and waste rock were presented on two plan views (Appendix A Figures A.4 and A.7) and four cross sections (Appendix A Figures A.5, A.6, A.8, A.9). These figures do not meet the guidance provided in MEND (2009)[1], and do not adequately present the spatial distribution of all ore, low grade ore, and waste rock samples collected as part of this study. The mine rock sample interval length ranged from 1.0-1.5m, which is shorter than that recommended in the MEND (2009)[2] guidance document. Additionally, short sample intervals can be skewed by potential mineralogical heterogeneity across a geological unit and thus may not be representative of the overall composition of the geological unit. MEND (2009)[2] provides a recommended minimum sampling frequency per waste rock lithology, where the final sample number must be determined based on site-specific conditions, study objectives, and the overall tonnage of each lithology to be mined. Tonnage estimates by waste rock lithology were not provided in BSA-5 to demonstrate that the number of samples collected per lithology are sufficient for each of the main waste rock lithologies to be mined. The approximate proportions of some waste rock lithologies are stated in BSA-5; however this does not reflect the overall tonnage of material.	a. Provide cross sections or block model images that show the location of all ore, low grade ore, and waste rock samples from both Leprechaun and Marathon deposits. Also, provide maps of overburden sample locations from both deposits. b. Provide a review of sample heterogeneity with respect to mineralogy and sample observations in the field to justify the short sample interval utilized in this study. If possible, include an evaluation of exploration assay data to support this discussion. c. Provide tonnage estimates for each waste rock, low grade ore, and ore lithology from both the Leprechaun and Marathon deposits, and quantitative justification for the number of samples collected to date. Include a plan to address data gaps.

[1] MEND, 2009. Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials. MEND Report 1.20.1. Mining Environment Neutral Drainage Program, Natural Resources Canada. December 2009.

[2] MEND, 2009. Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials. MEND Report 1.20.1. Mining Environment Neutral Drainage Program, Natural Resources Canada. December 2009.

NRCan-14		Part 2, section 7.1.2 and 7.2.2	Baseline Study Appendix 5 Attachment 5-A and 5-B	The EIS Guidelines require the proponent to complete a geochemical characterization of potential construction material in order to predict metal leaching and acid rock drainage. A geochemical characterization study must be completed for all construction materials to evaluate their suitability related to acid rock drainage and metal leaching (ARD/ML). The potential use of waste rock, overburden, and/or quarry material was not discussed in BSA-5, nor was the suitability of waste rock and overburden materials for construction use.	Provide an evaluation of the ARD/ML potential of all materials planned to be used for construction purposes, including quarries, if applicable.
NRCan-15		Part 2, section 7.1.2 and 7.2.2	Baseline Study Appendix 5 Attachment 5-B Appendix B and C	The EIS Guidelines require the proponent to complete a geochemical characterization of the expected mine materials in order to predict metal leaching and acid rock drainage, including the longer term rates of acid generation (if any) and metal leaching, and the quality of leachate from samples of tailings, waste rock, and ore. The MEND (2009)[3] guidance document recommends presenting geochemical test results in tabulates with descriptive statistics, as well as in scatter plots and time series graphs. A complete set of tabulated static test results grouped by lithology and including sample descriptions was not provided for all samples tested. Further, statistics provided in Appendix B Tables present results that do not follow basic principles. For example, average concentrations that are outside of the minimum and maximum range. Without a complete set of tabulated data, it is not possible to complete the ARD/ML review in terms of evaluating the variability in sample chemistry across each lithology, nor to confirm the validity of the statistical distribution of results. Additionally, a complete set of tabulated kinetic test results for each humidity cell, "subaqueous column, and ageing test was not provided in Appendix B, and time series graphs were only provided for select parameters in Appendix C. As such, the long-term evolution and change in leachate quality can not be evaluated for all parameters.	a. Present updated versions of Appendix Table B-5 and B-17 with the correct statistical calculations. b. Provide a complete set of tables for each static test completed for waste rock, low grade ore, and ore by rock type. c. Provide updated Appendix Tables B-6, B-7, B-18 and B-19. d. Provide tables and time series graphs for each humidity cell, subaqueous column, and ageing tests for all tested parameters.

[3] MEND, 2009. Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials. MEND Report 1.20.1. Mining Environment Neutral Drainage Program, Natural Resources Canada. December 2009.

NRCan-16		Part 2, section 7.2.2	Baseline Study Appendix 5 Attachment 5-B Section 3.1.2, 3.2.2, 3.2.3, 4.0, 5.0 and Chapter 7 Appendix 7A and 7B	The EIS Guidelines require the proponent to evaluate the longer term rates of acid generation and metal leaching, estimates of the potential time to onset of acid rock drainage or metal leaching, and the quantity and quality of leachate from samples of tailings, waste rock, and ore. These leachate compositions are then used in the water quality model to evaluate the quality of effluent to be released from the site into receiving waters. The samples selected for kinetic testing must be conservatively representative of the lithology they represent, taking into consideration mineralogy, ARD potential, metal/metalloid content, and leaching potential, and documented in the MEND (2009)[4] guidance document. Composite samples were developed to represent low-grade ore, waste rock, and tailings, and were subjected to laboratory static tests, mineralogy, and humidity cell tests to evaluate long-term ARD/ML potential and timing to onset of ARD. A detailed quantitative rationale was not provided to demonstrate that the composite samples are conservatively representative of the overall chemical composition of their respective waste rock lithologies for ARD/ML parameters of concern. Therefore, it is not possible to determine whether the humidity cell test results are a conservative representation of weathering rates for the tested material, and thus appropriately conservative for use as source terms for the water quality models to evaluate the potential future effluent quality related to ARD /ML and neutral mine drainage (NMD). This information is paramount for decision making regarding management of waste rock, low grade ore, and exposed pit walls, as well as water management and treatment. All composite samples are non-acid generating based on neutralization potential ratio (NPR) values less than 2 (Table 5-2 and Appendix Table B-8), despite approximately 14% of waste rock at Marathon having been classified as potentially acid generating (PAG) based on samples tested and reported to date. This does not meet the MEND (2009) guidance to design a kinetic test program that incudes material that will produce problematic	a. Provide a quantitative rationale for the targeted chemistry of each composite sample used for kinetic testing with respect to the lithology that they represent and percentile rankings for all parameters of interest with respect to ARD-NMD/ML. b. Provide a detailed plan to test potentially acid generating samples from those lithologies identified as containing potentially acid generating material, including static, mineralogy, and kinetic tests. c. Provide rationale for the methods used to determine the lag time to acidic conditions, and a discussion around the sensitivity of the water quality model to the assumptions related to this assumed lag time. d. Provide rationale for assumptions in the water quality model related to the metal load associated with acidic drainage. Complete a

[4] MEND, 2009. Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials. MEND Report 1.20.1. Mining Environment Neutral Drainage Program, Natural Resources Canada. December 2009.

				drainage chemistry in terms of ARD/ML, even if this material is a lower anticipated waste volume than other units. Further, the timing to onset of acidic conditions was estimated based on mineral depletion calculations using sulphate and alkalinity production rates associated with the dissolution of soluble secondary salts rather than sulphate production from sulphide mineral oxidation. Due to the absence of any evidence of active sulphide mineral oxidation in the tests completed to date, these time estimates are not considered reasonable to support assumptions in the water quality model related to the timing of ARD for low grade ore and waste rock, nor decisions related to waste rock management. Lastly, the metal leaching potential under acidic conditions has not been captured in the humidity cell tests completed on non-acid generating samples to date, which has implications for the source terms and assumptions that were made in the water quality models (Chapter 7 Appendix 7A and 7B) to represent acidic drainage quality from the pit walls and waste rock piles. Therefore, it is not possible to confirm that humidity cell test leachate on potentially acid generating samples would maintain leachate concentrations below MDMER limits. A complete understanding of the risk and extent of ARD and metal loading is required to appropriately manage PAG waste and exposed PAG rock in the pit walls, as well as water management and treatment planning. Therefore, the potential development of ARD in pockets of the waste rock pile or the pit walls has not been sufficiently evaluated to support the assumptions made in the water quality model related to the maintenance of neutral contact water in the ponds below the waste rock and low grade ore stockpiles and captured pit wall runoff.	sensitivity analysis related to the assumed metal load for potentially acid generating material, including but not limited to the ore, low grade ore, and waste rock piles, and the pit walls. e. Discuss the sensitivity of water quality model predictions in relation to the conservatism of the source terms.
NRCan-17		Part 2, section 7.1.2 and 7.2.2	Baseline Study Appendix 5 Attachment 5-A and 5-B	The EIS Guidelines require the proponent to evaluate the effects of imperfect segregation of waste rock. The proponent proposes the development of an ARD block model to identify the location of discrete acid generating pockets of waste rock material and the sequence in which it will be mined. The objective of this is to support the management of potentially acid generating waste rock through blending or encapsulation.	a. Provide a detailed approach to locate and segregate waste rock for the management of acid generating rock, as well as identifying waste rock suitable for construction use. This can be in the form of an ARD/ML Management Plan.

				The success of this approach is dependent in part on the effectiveness of locating and segregating this material. An approach to PAG rock segregation was not provided.	b. Provide a detailed summary of the ARD block model evaluation and images presenting the distribution of acid generating waste rock.
NRCan-18		Part 2, section 7.1.2 and 7.2.2	Baseline Study Appendix 5 Attachment 5-A and 5-B and EIS Section 2.0 and Project Description and Chapter 7 Appendix 7A and 7B	The EIS Guidelines require the proponent to evaluate the pit water chemistry during operation and post-closure, and pit closure management measures (e.g. flooding). This will include geochemical modelling of pit water quality in the post-closure period. In the geochemical baseline study, four samples were collected and tested from the gabbro unit at the Marathon Pit, suggesting it is a nominal unit in terms of overall tonnage. However, it appears to constitute a portion of the exposed pit wall based on cross-sections provided in Appendix A, and Figure 2.7-a of the Project Description, and is considered to represent 12% of the pit rubble and walls in the water quality model. This sample count is not considered sufficient to capture the potential variability of this unit with respect to ARD/ML, particularly considering that one of the four samples was classified as potentially acid generating. Additionally, a composite sample was not generated and tested for this unit, so the long-term ARD/ML potential is not known. This is considered to be a significant data gap with respect to evaluating the quality of pit water discharge during operations and long-term pit lake water quality. Further, the low grade ore and ore at the Marathon Pit are assigned 5% of the area of the pit rubble and walls in the water quality model. Based on the same cross sections, this value appears to underrepresent the likely exposed surface area of these units. In total, 50% and 67% of samples of low grade ore and ore, respectively, have been classified as PAG. Potentially acid generating samples of low grade ore and ore were not subjected to kinetic testing, and as such the long-term ARD/ML potential of these units is not known, nor their potential impacts to pit water quality during operations and long-term closure.	a. Provide a detailed plan to conservatively evaluate the ARD/ML potential of the gabbro waste rock unit, low grade ore, and ore, including additional sample collection, static and kinetic tests. b. Using the block model, provide proportions of exposed gabbro, low grade ore, and ore for each year of operation, and the final pit shell. c. Complete an evaluation of the pit water chemistry during operations, pit filling, and post-closure, and the potential for the development of acidic drainage. This should consider timing to onset of ARD and acidic loading rates from new humidity cell tests on PAG material from the gabbro, low grade ore, and ore as well as the exposed pit shell proportions during the life of the mine.

				The potential for Marathon Pit water to be acidic with an elevated metal load has not been sufficiently evaluated for operations, closure, and post-closure phases of the Project.	
NRCan-19		Part 2, section 7.1.2 and 7.2.2	Baseline Study Appendix 5 Attachment 5-A and 5-B and Project Description and Chapter 7 Appendix 7A and 7B	The EIS Guidelines require the proponent to complete a geochemical characterization of tailings in order to predict metal leaching and acid rock drainage. Of the low grade ore, approximately 10% from the Leprechaun Pit and 50% from the Marathon Pit have been classified as potentially acid generating. Per NRCan-16, all tested composite samples, including low grade ore, are non-potentially acid generating. As such, the long-term ARD potential of problematic low grade ore and ore cannot be evaluated, nor the associated metal load. Low grade ore will be stockpiled adjacent to both pits for blending with higher grade ore or processing towards the end of mine life. At the Marathon Pit, the lag time to generation of ARD is considered to be within the expected residency time of material in the low grade ore stockpile. The timing to onset of acidic conditions was determined based on non-acid generating kinetic tests per NRCan-16 and is not considered a reasonably conservative estimate of timing to ARD/ML production in the low grade ore stockpile. Further, the reactivity of the material in the stockpile depends in part on the sequence in which material is mined. Further, per section 2.3.2.3 of the Project Description, low grade ore stockpiles might not be processed until the end of mine life and thus the material is exposed at surface for the duration of mine life.	a. Provide an evaluation of the sequencing of low grade ore from the Marathon Pit and the ARD/ML potential of material during the life of the mine. b. Evaluate the sensitivity of the water quality model predictions to the sequencing of low grade ore in the stockpile at the Marathon Pit during the life of the mine. c. Provide mitigation options for the management and treatment of ARD/ML generated from the low grade ore stockpiles.
NRCan-20		Part 2, section 7.1.2 and 7.2.2	Baseline Study Appendix 5 Attachment 5-A and 5-B and	The EIS Guidelines require the proponent to complete a geochemical characterization of tailings in order to predict metal leaching and acid rock drainage. Insufficient information was provided on the origin of the tailings samples analyzed to understand whether they are representative of the anticipated thickened tailings composition to be managed on the property. Previous testing of tailings demonstrate that it could be potentially acid generating. Any deviation from the head ore composition or methods used to generate	a. Provide additional information on the source of the contaminated neutral drainage tailings samples, including the head ore composition used to generate these samples relative to the anticipated average ore feed to the plant, and the metallurgical

			Chapter 7 Appendix 7A and 7B	these samples could result in a different ARD potential and concentrations of cyanide species and associated nitrogen by-products from cyanide degradation, which has implications for tailings runoff, seepage quality and water treatment design.	process and cyanide destruction method used to generate these samples relative to the anticipated process to be used during mine operations. b. Complete an analysis of the sensitivity of the water quality model to the generation of ARD/ML from the low grade ore stockpiles.
NRCan-21		Section 7.1.5 Groundwater and surface water	Chapter 7 and Baseline hydrology and surface water quality monitoring program (Appendix D Local water quality tables)	Baseline water quality has been monitored at the site since 2011. Upon review of table 7.24 of Chapter 7, the baseline concentrations for a number of elements (including chromium) are high compared to the regional water quality monitoring stations. Currently, the proponent derived local baseline concentrations by pooling all water quality monitoring stations together and calculated a 75th percentile value as baseline water quality. Upon review of Appendix D of the baseline document, high chromium levels appear to have occurred predominantly in 2011 and have often been below the detection limit of 1ppb ever since. The variability in metal concentration depends on many factors and it is likely not appropriate to use baseline metal data in streams to derive a baseline for Valentine and Victoria Lakes.	a. Set baseline metal concentrations for Valentine Lake, Victoria Lake and Victoria River based only on measurements in the given water bodies that will receive effluent discharge. Discuss the baseline water quality for chromium in comparison to the Canadian Water Quality guideline for the protection of aquatic life of 1pbb for hexavalent chromium and 8ppb for trivalent chromium. b. Assess the need to include chromium as a contaminant of potential concern in the EIS given its toxicity to fish and fish habitat as well as carcinogenicity.

NRCan-22		Section 7.1.5 Groundwater and surface water	Chapter 4 assessment of effects to surface water Appendix 7c assimilative capacity assessment	There is no indication of spatial extent of contamination of the receiving surface water, nor is there an assessment of sediment quality in the effects assessment or the assimilative capacity assessment. Considering that exposure to metals will peak during operations (See time plot series in Appendix 7) and will remain high during post-closure for several decades, and considering the uncertainty in the conservatives of the source terms discussed in NRCan 13 to 20, it is important to predict concentrations of metals in sediments where benthic invertebrates live. These invertebrates are part of fish habitat that needs to be protected, and which require ministerial permits to release deleterious substances in surface water inhabited by fish (i.e., in this case Atlantic Salmon, Brook Trout and stickleback).	a. Provide time series plots (construction, operations, closure and post-closure) of Al, As, Ag, Cd, Cr, Cu, Fe, Mn, Hg, Se, U, Zn, NO_2, Cyanide, Un-NH_3, SO_4, F in sediments of Victoria Lake Reservoir, Valentine Lake and Victoria River. b. Determine the spatial extent of contamination within the receiving water bodies for surface water and sediment.