13 March 2020

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RE: Response to Intervenor Comments, Phase 1 Waste Rock Management Plan Revision 2 Mary River Project, Type 'A' Water Licence - 2AM-MRY1325 - Amend. No. 1

Baffinland Iron Mines Corporation (Baffinland) provides the attached responses to comments and requests for clarification received from the Nunavut Water Board (NWB)[1], Qikiqtani Inuit Association (QIA)[2], Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC)[3] and Environment and Climate Change Canada (ECCC)[4] regarding the Phase 1 Waste Rock Management Plan, Revision 2, submitted to the Nunavut Water Board on December 31st, 2019. Note that these responses include additional comments received by Baffinland through the review process associated with the Phase 2 Proposal currently under consideration by the Nunavut Impact Review Board (NIRB), specifically comments received from CIRNAC[5]. Baffinland maintains that the approval of the Phase 1 Waste Rock Management Plan is required under the current Type 'A' Water Licence 2AM-MRY1325, Amendment No. 1 in respect of the current operations, and will be required irrespective of the approval process for the Phase 2 Proposal.

We trust that the attached responses provide additional clarification on the Waste Rock Management Plan. Please do not hesitate to contact the undersigned should you have any remaining questions or comments.

Regards,

Christopher Murray
Environmental & Regulatory Compliance Manager

Attachments:
Attachment 1: Baffinland Response to Comments

Cc: Karén Kharatyan (NWB)
Chris Spencer, Jared Ottenhof (QIA)
Bridget Campbell, Godwin Okonkwo, Felexce Ngwa, Alexandre Chaikine (CIRNAC)
Anne Wilson, Reg Ejeckam, Gabriel Bernard-Lacaille (ECCC)
Megan Lord-Hoyle, Lou Kamermans, Tim Sewell, Shawn Stevens, Connor Devereaux, Simon Fleury, Daniel Janusauskas (Baffinland)

[1] NWB (2020) Re: Licence No. 2AM-MRY1325 Type "A"; Mary River Project, Baffinland Iron Mines Corporation; Phase 1 Waste Rock Management Plan – NWB Review. Letter dated February 11, 2020

[2] QIA (2020) Re: NWB Request for Comment on Baffinland's Phase 1 Waste Rock Management Plan (Rev. 2). Letter dated February 5, 2020.

[3] CIRNAC (2020) Re: Crown-Indigenous Relations and Northern Affairs Canada Technical Review Comments on Baffinland Iron Mines Corporations Phase 1 Waste Rock Management Plan (Revision 2) as part the Phase 2 Amendment Application for the Mary River Project, Water Licence 2AM-MRY1325 - Amendment No. 1. Letter dated February 5, 2020.

[4] ECCC (2020) Re: 2AM-MRY1325 – Baffinland Iron Mines Corporation – Mary River Project – Water Licence Amendment Application – Phase 1 Waste Rock Management Plan. Letter dated February 11, 2020.

[5] CIRNAC (2020) Technical Comments, Baffinland Iron Mines Corporation Mary River Project Phase 2 Proposal. February 6, 2020

Attachment 1

Baffinland Response to Comments

Comment ID : NWB-1	
Recommendation/ Request	Under the point titled "Lift thickness", Baffinland commits to "regularly inspect the waste rock lift advancement for signs of material segregation". The NWB requests that the frequency of such inspections as well as responsible persons be outlined in the document.
Baffinland Response	Responsibilities and frequencies for survey and inspection of the Waste Rock Facility (WRF) are outlined in the Waste Rock Facility QA/QC Monitoring Plan, provided as Appendix C of the Waste Rock Management Plan (WRMP).

Comment ID : NWB-2	
Recommendation/ Request	The last paragraph of the section states, "…in the near-term until the WRF footprint can be sufficiently expanded, waste rock deposition following the above guidelines may not always be possible." The NWB requests further clarification on the deviations from the deposition strategy outlined in the Plan and any risk mitigation measures that Baffinland intends to take in the case of such deviations.
Baffinland Response	In the event that Baffinland is required to deviate from the placement strategy outlined in the WRMP, Baffinland will document and keep records of any deviations. This is required to maintain a level of operational flexibility in the development of the WRF, while recognizing the ultimate objectives for the management of the facility. Deviations may include placement of thicker lifts or material segregation. Specific mitigation measures will be dependent on the nature of the deviation, however mitigation measures that could be employed include but are not limited to; • Monitoring for freeze back of thicker lifts prior to successive placement of material; • Increased buffer zones of NAG material surrounding PAG material placement; and • Adjusting thickness of lift placement to reduce segregation of materials.

Comment ID : NWB-3	
Recommendation/ Request	The reference source is missing on p. 18. The NWB requests updating the reference.
Baffinland Response	Noted, Baffinland will provide an updated version of the WRMP Revision 2 with the reference. The missing reference is for Figure 1 WRF Design Footprint.

Comment ID : NWB-4	
Recommendation/ Request	The NWB requests that the monitoring schedule and parameters be included in this section. It is the Board's opinion that the Plan ought to inform Baffinland's responsible personnel on the proper operation of the waste rock storage facilities. Thus, outlining monitoring requirements or, at a minimum, how to locate them is essential for inclusion in the Plan.
Baffinland Response	Baffinland will update this section of the WRMP to include the monitoring frequencies. The frequency of monitoring for water quality parameters at a minimum follows the schedule outlined in Table 14 of the Type 'A' Water Licence 2AM-MRY1325. However, Baffinland is committing to monitoring water quality in the water management structures on a weekly basis during periods of flow.

Comment ID : NWB-5	
Recommendation/ Request	In this section, Golder Associates Ltd. recommends, "(d)elaying winter deposition or reducing the thickness of summer deposition would decrease freezing times and reduce the extent of thawed portions within the WRF." The NWB requests that Baffinland confirm if it intends to follow the recommendation.
Baffinland Response	Baffinland has addressed this recommendation in Section 8.2 of the WRMP. Specifically, "Winter waste rock placement shall defer covering over summer placed material to the extent possible. When required and to the extent practical, waste rock placed during winter shall cover over the earliest placed waste rock from the preceding summer."

Comment ID : NWB-6	
Recommendation/ Request	The NWB requests that Baffinland confirm if it intends to take measures to collect accurate water balance data. If so, please outline the measures and the corresponding timeline.
Baffinland Response	Improvements to the measurement of the WRF Pond inflow and outflows are required to calibrate the water balance, in addition to the continued monitoring of site meteorological conditions. The following improvements are planned for 2020: • Installation of a pressure transducer at the WRF Pond to provide continuous water level readings. • Continuous tracking of outflow from the WRF Pond to the Water Treatment Plant (WTP) and potential recirculation from the WTP back to the WRF Pond. • Continuous tracking of inflows to the WRF catchment or treatment plant from other locations (e.g. mining operations). • Installation of a totalizer on the Deposit 1 discharge to the WRF Pond.

Comment ID : NWB-7	
Recommendation/ Request	Considering the statement in Issue No. 2 of this Table, the NWB requests that Baffinland clarify if the provided water quality model takes into account possible deviations from the deposition strategy.
Baffinland Response	From the Water Quality Model memorandum provided in Appendix A4 of the WRMP, Section 3.2, the inputs to the model consider the runoff from exposed PAG and Non-AG waste rock. The assumptions outlined in Section 3.3.1 further clarify that the model only considers flow as runoff or interflow within the active layer. It also conservatively assumes that no seepage the infiltrates vertically with the WRF will become frozen due to permafrost aggradation. The model considers relative contributions from PAG runoff and Non-AG runoff as outlined in Table 3 (Flow inputs to the WRF Pond), but is not specific to deposition strategies and lift thicknesses. The model did however consider the effect of reduced PAG exposure in the sensitivity analysis found in Section 4.2. The model demonstrated that with increasing PAG coverage with Non-AG material prior to freshet each year, this generally resulted in an increase in pH. As a result, Baffinland has included in it's deposition strategy that to the extent practicable, PAG waste rock placed in winter months will be covered with Non-AG material prior to summer. As recommended by Golder, Baffinland will continue to utilize the WRF water treatment plant to maintain compliance with all applicable discharge criteria in the Type 'A' Water Licence and MDMER.

Comment ID : NWB-8	
Recommendation/ Request	The last paragraph of this section repeats the statement quoted in Issue No. 2 of this Table. The NWB requests that Baffinland clarify in the Plan the deviations from the suggested deposition strategy, especially given the fact that the Plan includes a separate Waste Rock Management Plan for 2020 through 2021 (dated December 31, 2019).
Baffinland Response	Refer to the response provided in NWB-2. The Golder Waste Rock Management Plan document considers the inputs from the various modelling exercises and monitoring completed in 2019, and is the basis for revisions to the Baffinland Phase 1 Waste Rock Management Plan, therefore this discussion on deviation is noted in both documents.

Comment ID : NWB-9	
Recommendation/ Request	Baffinland should provide a clarification on how it integrates the effects of climate change into the Plan.
Baffinland Response	Baffinland has considered climate change in the selection of the closure strategy for the WRF, as discussed in Section 11.1, and considered in the approved Life-of-Mine Waste Rock Management Plan (BAF-PH1-830-P16-0031). It is noted that this Phase 1 Waste Rock Management Plan only applies for years 2020 and 2021, and the effects of climate change are not anticipated to be measurable during this limited timeframe. Never-the-less, Baffinland's commitment to continue to monitor the thermal condition of the pile over the life of the WRF will evaluate the ability of permafrost to form in the pile and be maintained into closure.

Comment ID : QIA-WRMP-1	
Summary/Issue	BIMC has developed a water balance for the WRF that includes significant uncertainty and has not been calibrated to on site conditions. Specific concerns are highlighted with inputs used for precipitation, seasonality, snowpack and, in the longer term, deep interflow in potentially unfrozen portions of the WRF. These concerns introduce significant uncertainty in all modelling, mitigations and management approaches that have used the Water Balance as an input. Specifically, the resulting water quality model used to predict concentrations of key contaminants in WRF contact water may under or over predict impacts to the aquatic environment, and water storage and conveyance infrastructure may be under or oversized. The Water Balance has significant uncertainty as a result of an incomplete set of inputs and the unavailability of accurate onsite measurements that can be used to calibrate model outputs. This results in significant uncertainty in all modelling, mitigations and management approaches that have used the Water Balance as an input. Specifically, the resulting water quality model used to predict concentrations of key contaminants in WRF contact water may under or over predict impacts to the aquatic environment, and water storage and conveyance infrastructure may be under or oversized.
Detailed Review Comment	BIMC has developed a water balance for the WRF that includes significant uncertainty. It is therefore unclear: 1) whether the water management infrastructure is sufficiently sized to handle the range of weather scenarios that may be reasonably encountered on site, and; 2) if the water quality model, which uses the water balance is a key input, can accurately predict potential impacts to the aquatic environment. We highlight the following inputs as key sources of uncertainty in the water balance model: a) Precipitation: *"The historic climate data available from the on-site climate station was insufficient to carry out a frequency analysis and assess various climatic return periods. A long-term data record was constructed for the period of 1923 – 2019 using the nearby regional climate stations at Pond Inlet."* While valuable, the data between 1923 and 2000 represent a period prior to the more recent influences of a climate change which have resulted in more frequent and more intense storm events. Sizing infrastructure based on a storm event that is estimated primarily relying on data from the 20th century may result in an underprediction of current and future storm events. b) Snowpack: "*No local snowfall or snowpack information was available and therefore the precipitation analysis was focused on the summer period only."* Snowpack represents a significant input to water balances in Nunavut given the generally arid conditions and the presence of significant snow drifts in elevated locations such as the growing WRF. Failure to include snowpack in water balance modelling may significantly underpredict the volume of both contact and noncontact water requiring management. It may further result in an underprediction of loadings to the WRF Pond should the snowpack mobilize metals or other contaminants during freshet. c) Deep interflow: The model currently assumes that Lower Storage "*infiltration is defined as deep percolation and is considered as a loss in the runoff model.*" We agree with BIMC that the majority of WRF toe seepage during the 2020-2021 period will be associated with the shallow interflow, and that deeper interflow will likely be sequestered in the interim. However, as noted with our concerns for the waste rock deposition strategy outlined in QIA-WRMP-#3, BIMC's deposition approach may introduce the potential for unfrozen waste rock within the WRF which may result in seepage draining to the water management infrastructure from sections of the WRF below what would be considered the shallow interflow (below the first 3-7 m). As noted, this uncertainty has direct implications with respect to the sizing of the WRF Pond, the associated conveyance structures, the loadings used as input to the water quality model and the associated potential for short- and long-term impacts to the aquatic environment. The uncertainty has already manifested in an inability to calibrate the model to the site. BIMC summarizes a series of reasons why this was the case: 1) "The measured WRF Pond water levels were occasionally below the WRF Pond surveyed floor 2) Differences between the predicted and observed water levels cannot be reconciled because the inflow from the Deposit 1 sump, which ultimately reports to the WRF Pond, is not measured with sufficient accuracy. 3) The flow measurements from the west and east ditches did not align with the WTP discharge totalizer. From June 1, 2019 to September 12, 2019 the WTP discharge

Comment ID : QIA-WRMP-1	
	totalizer recorded approximately 90,000 m3 more flow than that calculated from the WRF east and west ditch flow measurements 4) It is acknowledged that the WRF east and west ditch flow measurements would not provide a reliable method for estimating the total inflow to the WRF Pond unless frequent measurements were taken or continuous devices were installed to capture precipitation events" Insufficient consideration of key inputs and an inability to calibrate the Water Balance model to the site raises significant uncertainty as to the accuracy of the model outputs in modeling current conditions and predicting future conditions.
Recommendation/ Request	The Water Balance at present appears unable to accurately predict both current and future conditions associated with the WRF and raises significant uncertainty as to the accuracy of all models, mitigations and management actions in which it is used as an input. We recommend BIMC refine the water balance model to include snowpack as an input. While we commend BIMC's commitment to install a pressure transducer to get an accurate record of water level in the WRF Pond, the water balance model must still be calibrated to site observations to provide confidence in its accuracy. We recommend BIMC improve hydrological monitoring in both the winter months to assess snowpack accumulation, and summer months to characterize flow within the WRF footprint and associated watersheds. The refined water balance should be informed by on site measurements of wind direction to determine where the snowpack can be expected to accumulate in future years. At this time, we recommend BIMC provide a discussion of the uncertainty surrounding the water balance outputs, and how this uncertainty impacts both the water quality model and the current sizing of water management infrastructure. This discussion should address both short- and long-term impacts to the environment and outline a defined adaptive management response for measured water volumes on site. Responses should be tied to measured water levels within the WRF Pond as well as to measurable volumes of toe seepage.
Baffinland Response	***Water Management Sizing*** Baffinland previously submitted a modification request and received subsequent approval for the expansion of the WRF pond in 2018 (Motion No. 2018-A1-015). At that time, intervenors including the QIA reviewed the validity of the climate and hydrology considerations accounted for in the design. The hydrological frequency analysis used to size the WRF Pond was based off the measured stream flows at a local station that was considered most representative of the site conditions. The water balance was not used for sizing of the WRF Pond and WRF ditch systems, and therefore, the current limitations in the calibration of the water balance does not impact the design of the WRF water management system. ***Water Balance Calibration*** For clarity, the water balance model does consider snow pack as an input, at an assumed conservative depth of 0.5 m of snowpack over the WRF. This is based on the fact that as part of Baffinland's freshet preparedness plan, Baffinland clears snow over the WRF during winter to reduce the volume of water reporting to the WRF Pond at spring freshet. A 0.5 m deep snow pack is assumed as only non-contact snow is removed from the facility. Baffinland will review and evaluate if the addition of a snowpack survey would assist with calibration of the WRF Pond, given the variation in the annual snowpack and in particular the influence of Baffinland's freshet preparedness practices to clear snow from the WRF. While this data would be relatively straightforward to collect, the usefulness of this data is likely to be limited based on the snow clearing practices at the WRF. Improvements to the measurement of the WRF Pond inflow and outflows are required to calibrate the water balance, in addition to the continued monitoring of site meteorological conditions. The following improvements are planned for 2020: • Installation of a pressure transducer at the WRF Pond to provide continuous water level readings. • Continuous tracking of outflow from the WRF Pond to the Water Treatment Plant (WTP) and potential recirculation from the WTP back to the WRF Pond.

Comment ID : QIA-WRMP-1	
	• Continuous tracking of inflows to the WRF catchment or treatment plant from other locations (e.g. mining operations). • Installation of a totalizer on the Deposit 1 discharge to the WRF Pond. ***Water Balance Uncertainty*** Due to the relatively short duration of time that the Mary River Mine has been operational, an insufficient duration of site measured climatic conditions exists to support a long-term precipitation frequency analysis. Therefore, a frequency analysis was carried out on the long-term precipitation records obtained from the regional meteorological stations operated by Environment Canada Climate Change (ECCC). The results of the frequency analysis were scaled up by 30% to account for variation between the precipitation measured at site and the ECCC stations. Ongoing comparison of the ECCC station precipitation to that measured at site will allow for the refinement of this 30% factor with time. Improved measurement of the WRF Pond inflows and outflows will support back calculation of the WRF runoff coefficient. The amount of runoff from, and seepage into, the WRF is currently based off limited available information, and climatic data, and professional judgement. As the Site data used to calibrate the water balance was influenced significantly by inputs from Deposit 1 discharge, it is not possible to provide a numerical value of the water balance accuracy. The water balance inputs have been assessed based on professional judgement and experience with similar projects. While there remains some uncertainty with respect to the accuracy of the water balance and water quality model, the results of the modelling carried out to date supports that continued treatment of the WRF Pond discharge will be required over the modelled period. The existing WTP has been proven to discharge effluent compliant with the requirements of the Type A water licence and MDMER criteria. For these reasons the results of the water balance and water quality model are considered appropriate for the current level of study.

Comment ID : QIA-WRMP-2	
Summary/Issue	The Water Balance has significant uncertainty as a result of an incomplete set of inputs and the unavailability of accurate onsite measurements that can be used to calibrate model outputs. This results in significant uncertainty in all modelling, mitigations and management approaches that have used the Water Balance as an input. Specifically, the resulting water quality model used to predict concentrations of key contaminants in WRF contact water may under or over predict impacts to the aquatic environment, and water storage and conveyance infrastructure may be under or oversized. Failure for the WRF to ensure the core remains frozen and that PAG waste rock is isolated from water and oxygen may result in long term risks both structurally and to the environment.
Detailed Review Comment	We are concerned that the waste rock deposition strategy outlined in the WRMP is insufficient to ensure a solid frozen core throughout the WRF and prevent potentially acid rich surface and subsurface seepage stemming from interflow below the active layer. BIMC states that *"Results from thermal models suggest that between 5 m and 7 m of waste rock could be placed in summer and the entire thickness of material would freeze during the following winter, assuming the summer placed material was not covered over during the winter. However, depending on the existence of heat sources within the WRF, a 7 m thick waste rock summer deposition could cause the development of a thawed zone in portions of waste rock previously deposited.* *Limiting the thickness of summer placed waste rock to 5 m would reduce the risk of creating a thawed zone at depth within the WRF."* We note that BIMC states there may be stored acidity with exothermic potential given there is currently "*low sulphur waste rock with stored acidity classified as Non-AG under the current criterion"* that was placed when the previous iteration of the WRMP was in place that has *"some potential to release acidity".* BIMC further indicates that lifts in the WRF would *"target a maximum thickness of 5.0 m. This lift thickness has been established to reduce potential for waste rock segregation during placement while remaining operationally feasible with the available equipment…..The maximum recommended lift thickness has been increased from 3.0 m to 5.0 m, provided the material does not segregate."* We note that even the 5 m lift thickness is contingent on the absence of an internal heat source. Given the presence of acidic runoff from the waste rock pile and within the West Drainage Ditch, it appears that both water and air have reached acid generating waste rock within the existing WRF. BIMC attempts to minimize the potential for a thawed zone within the WRF by outlining a detailed deposition strategy in section 8.2 of the WRMP. However, BIMC concludes that *"in the near-term until the WRF footprint can be sufficiently expanded, waste rock deposition following the [deposition strategy] may not always be possible. Baffinland will document and keep record of deviations from the above waste rock deposition strategies, understanding that deviation from the above guidelines may temporarily or permanently influence the chemical stability of the WRF, and will need to be evaluated and possibly mitigated prior to, or as part of the ultimate WRF closure."* This approach provides BIMC significant operational flexibility, but also creates significant uncertainty as to how the WRF will perform. Failure to ensure a frozen core as the WRF grows both vertically and horizontally, and sufficient isolation of PAG creates significant uncertainty as to whether the proposed WRMP will be sufficient to mitigate potential environmental impacts associated with ARD during operation and into closure. Greater clarity with respect to how the deposition strategy will be implemented is required to provide assurance that treatment in perpetuity of acidic WRF seepage will not be necessary. We also note that it is unclear whether the current WRF has been constructed on a liner. It is clear however, that that BIMC intends to place waste rock on unlined native ground based on the following text*: "The first lift of the WRF on native ground shall be Non-AG waste rock. Waste rock placement over native ground shall be carried out in the winter to the extent practicable. As a minimum, the lift should be allowed to freeze prior to layering activities. Maintaining a frozen base and perimeter is expected to reduce potential for seepage."* While a frozen WRF base will mitigate interactions between deeper interflow within the WRF and the surficial groundwater regime, we are still concerned based on observed seepage in 2019 within the existing WRF that the strategies employed to date have not adequately mitigated this potential.
Recommendation/ Request	Please clarify the deposition strategy BIMC will use at the WRF and clearly define the approach that will be followed should it not be possible to employ the strategy outlined within the WRMP. These alternate approaches should be accompanied with a discussion of potential impacts to the

Comment ID : QIA-WRMP-2	
	WRF closure objectives and an associated security estimate. Please also ensure that any expansions to the WRF are constructed on lined tundra (native ground) to mitigate potential interactions with the surficial groundwater regime or provide a discussion as to why this is not required. Please ensure water quality and water quantity monitoring are scheduled to occur during freshet as well as in late summer. Sampling in these critical periods are intended to determine the volume and composition of a) contaminants mobilized during spring freshet, and b) basal seepage from the WRF during the driest part of the year.
Baffinland Response	Baffinland intends to follow the thin lift placement strategy outlined in the WRMP with close monitoring of the placement of the different material types within the WRF, as outlined in the Waste Rock Facility QAQC Plan (Appendix C of the Phase 1 Waste Rock Management Plan, Revision 2). Monitoring and supervision will ensure that materials is placed in lifts, such as to limit particle size segregation and that guidelines for minimum thickness of non-AG waste rock placement on the outside edges of the dump are followed. Following the recommendations of Golder, Baffinland will, to the extent practical, cover PAG lift areas with non-AG rock prior to the summer season and allow PAG lifts to remain uncovered for as long as possible during the winter month. Expansion of the WRF to the final design footprint associated with the current approved WRF pond will be carried out to enable Baffinland, to the maximum extent possible, to limit placement during the summer season to a single 5 m lift. Expansions to the current ditches and planning for future expansions of the WRF past 2021 for future development is expected to begin this year. The WRMP specifies for expansion of the WRF to be carried out during winter when the native ground is frozen, to the extent practical. Baffinland intends on complying with this requirement and developing the WRF in a manner conducive to permafrost aggradation. To date, all thermistors drilled through the WRF indicate that the entire column of waste rock and underlying native soil are frozen. No site measured data supports that thawing of the permafrost below the WRF has occurred. Construction of a lined base is not considered practical or warranted over the WRF footprint. If thawing of the permafrost under the WRF were to occur, large settlements would be expected that would likely exceed the geosynthetic liner strain capacity (i.e. the liner would be likely to fail and become ineffective). Material placement and operation of heavy machinery on top of a geosynthetic liner would likely result in failure of the liner and render it ineffective. In addition, significant earthworks and disruption to the existing permafrost would be required to provide positive drainage of the liner surface. For these reasons Baffinland intends to construct the WRF in a manner conducive to permafrost aggradation and maintain the existing permafrost at the WRF base. Preserving the existing permafrost will provide a more reliable barrier to mitigating groundwater impacts compared to a geosynthetic liner. Thermistors installed within the WRF future expansion will verify that the permafrost underlying the WRF expansion has been maintained. If thermistors indicate that thawing of the native permafrost is occurring, then adjustments to the waste rock deposition guidelines will be made to mitigate this occurrence. Baffinland has implemented a sample program within and outside the WRF area from the start of Freshet until freeze-up. Sampling of pond, water management structures and water treatment plant intake and discharge water is completed for the purposes of WRF optimization, monitoring and regulatory reporting purposes, on a weekly basis during periods of flow.

Comment ID : QIA-WRMP-3	
Summary/Issue	Water quality predictions were only generated for WRF pile runoff and the East and West drainage ditches for the 2020-2021 period. No predictions were provided for the WRF Pond where water will be stored prior to discharge nor were they provided for closure. Model outputs that were provided were relatively accurate in predicting nickel concentrations when calibrated to 2019 data, but were inaccurate for most other parameters. Poor performance of the water quality model and failure to provide predictions both within the WRF Pond and at closure creates uncertainty as to short- and long- term impacts contact water associated with the WRF will have on the aquatic environment. Poor performance of the water quality model and failure to provide predictions both within the WRF Pond and at closure creates uncertainty as to short and long term impacts contact water associated with the WRF will have on the aquatic environment.
Detailed Review Comment	BMIC states that *"The purpose of the* [water quality] *model was to assess the potential impact of the waste rock pile design on runoff water quality. The WRF Pond water quality was not predicted as part of the current model due to the lack of available data for other water inputs to the pond. Closure conditions were also not evaluated as part of the current model. Water quantity inputs were assigned for defined catchment areas, based on the water balance model. Water quality inputs to the model were based on observed site water quality from WRF runoff in 2019 to represent water interaction with PAG and Non-AG waste rock within the active layer."* We first highlight our overall concern that BIMC has not attempted to predict water quality within the WRF Pond, the location whose contained water will be subject to treatment prior to discharge to the environment. BIMC notes that *"The WRF Pond is not included as part of this model to due to other inputs to the pond that are currently not well defined"*. This approach is not accepted as it raises significant uncertainty as to whether the proposed treatment approach will be sufficient to ensure discharges to the aquatic environment will be consistently compliant with MDMER and water licence criteria under a range of operating conditions. Inputs associated with the water balance model used as a key input into the water quality model are outlined in QIA-WRMP-2 "Water balance uncertainty". An inaccurate water balance used as input to the water quality model raises significant uncertainty as to the relative contribution of each input as well as the overall loading to the drainage ditches and the WRF Pond. The water quality model was calibrated to measurements collected from the site. "Nickel was chosen as the primary comparison parameter due to known elevated levels above MDMER criteria in the WRF runoff data" The model calibrated with this key parameter resulted in relatively good agreement with measured nickel concentrations in the WRF runoff and in the drainage ditches. Water quality model outputs however appear inaccurate for most other parameters. BIMC notes however that "The model calibration underpredicts the WRF runoff concentrations for aluminum, arsenic, copper, iron and lead and has good agreement with the observed average range of concentrations for cadmium and zinc. All these parameters are at least an order of magnitude below their respective MDMER criteria (where applicable) in the WRF runoff water quality and are therefore, not considered as parameters of concern." We note BIMC's assertion that these parameters are at least an order of magnitude below their respective MDMER criteria is based on average water quality measured in WRF runoff and in the East Drainage Ditch. A more conservative comparison to MDMER criteria would be the 75th percentile of measured values. We further note that BIMC has asserted that these parameters are not considered parameters of concern in the 2019 samples, but a prolonged period of record has not been established as of yet to determine whether regulated parameters may become of concern in the future. The model predicts that water quality in the waste rock pile runoff will have pH below the MDMER criterion in all climate scenarios, and nickel is above the MDMER criterion in most climate scenarios. Other parameters are generally much lower than MDMER by an order of magnitude or more. However, given the uncertainties in the model, it is unclear if these model outputs are representative as even well calibrated models are still only assumed to be accurate within an approximate order of magnitude (Golder Associates Ltd. 2019). Water quality measurements collected from the waste rock pile and in the west drainage ditch in 2019 had relatively acidic water quality (minimum pH of 4.1), and concentrations of nickel and TSS were consistently in excess of MDMER discharge criteria.

Comment ID : QIA-WRMP-3	
	Exceedances of MDMER discharge criteria for copper and zinc were also occasionally measured in the pile runoff. Water quality measured in the west ditch was generally compliant with MDMER. Measurements of WRF Pond water quality had measured concentrations in excess of CCME water quality criteria for multiple parameters. The information provided within the WRMP does not provide sufficient information to evaluate the impacts of these exceedances on the receiving environment. Reference: Golder Associates Ltd. 2019. Mine Site and Downstream Receiving Water Quality Predictions. Whale Tail Pit – Expansion Project. Prepared for Agnico Eagle Mines Ltd.
Recommendation/ Request	We recommend that BIMC refine the water quality model and provide calibrated predictions for the WRF Pond. WRF Pond predictions are essential to ensure adequate treatment is available for the WRF Pond (e.g. sufficient reagents) to ensure discharges to the aquatic environment are compliant with both MDMER and water licence effluent quality criteria. These predictions will also facilitate the development of accurate estimates of the quantity of sludge (treatment by- products) that will be generated through the treatment process. These predictions should be informed by a detailed site water quality monitoring program where water quality samples are collected at least three times throughout the year (freshet, midsummer, late summer prior to freeze up) from the WRF, within the water conveyance structures, in the WFT Pond and at the outfall into the receiving environment. Until such time as this refined model can be updated, we recommend BIMC maintain a supply of reagents that can ensure compliant discharges of WRF Pond water quality containing concentrations of regulated parameters at least 50% greater than the 75% percentile measured in the 2019 dataset. We further recommend that BIMC develop preliminary WRF water quality predictions for closure that can be used to ensure sufficient security is held by both the QIA and Crown Indigenous Relations and Norther Affairs Canada (CIRNAC).
Baffinland Response	Predictions of the WRF runoff contained with the Water Quality Model are considered to be a conservative estimate of concentrations of parameters of potential concern that will ultimately report to the WRF pond. These are considered to be a conservative estimate as concentrations within the ditches are expected to be elevated compared to those at the WRF Pond, due to the reduced dilution from direct precipitation and natural ground runoff (i.e. clean water sources). Baffinland acknowledges that accurate predictions of the WRF Pond water quality is required. It is Baffinland's intent to improve measurement of the WRF Pond inflow/outflow (flow and water quality) in order to facilitate calibration of the model of the WRF Pond water quality. The WRF Pond water quality model will be developed following implementation of the water balance calibration recommendations under QIA-WRMP-1 above. In the interim, Baffinland has gained significant experience in the operation of the WRF treatment plant, and has mobilized a sufficient quality of reagents based on the utilization in 2018 and 2019, and there have been no pH or metals related non-compliant discharges from the facility during the time. Baffinland's predictions of water quality in closure from the FEIS remain valid, as the closure strategy of encapsulation with 50 m of non-AG material, combined with the current waste rock management practices of thin lift deposition, will promote the aggradation of permafrost into the WRF and eliminate the potential for formation of low pH runoff. Regardless, the current Interim Closure and Reclamation Plan and associated reclamation security estimate allocates sufficient security for the operation of the WRF treatment plan into closure.

Comment ID : QIA-WRMP-4	
Summary/Issue	The volume and composition of sludge resulting from treating water within the WRF Pond is unclear. This may have direct implications on BIMC's capability to ensure effluent is compliant with discharge criteria, and creates uncertainty as to the potential environmental risks associated with disposal of treatment sludge. The volume and quality of treated sludge that will be generated in order to ensure WRF Pond discharges are compliant with MDMER and Water Licence discharge criteria is currently unclear. Sludge composition may be consistent with hazardous waste and must be disposed of appropriately to mitigate potential adverse environmental impacts.
Detailed Review Comment	BIMC notes that *"Monitoring of the Waste Rock Pond and inflow into the pond have shown elevated levels of Nickel. If, during discharge, the water impounded in the Waste Rock Pond is found to have metals concentrations over the limits, further treatment will be required."* While water quality within the WRF Pond has been measured in 2019 and reported in the WRMP, the quantity and quality of sludge resulting from the proposed treatment approach is not clearly defined. There is significant uncertainty associated with the water quality that will be found in the WRF Pond in 2020; BIMC has not provided any water quality predictions for that location. Water quality in the runoff and in the drainage ditches that was measured in 2019 and modeled for 2020 is not consistently compliant with MDMER and Water Licence discharge criteria. We also note that water quality measured in the WRF Pond contained occasionally acidic water (lower than the MDMER discharge criterion) with elevated total suspended and dissolved solids that may require some degree of treatment. BIMC has not clearly defined how treatment of noncompliant water will occur. While an overall treatment system is proposed within the WRMP, BIMC lists a series of coagulants that may be used in Section 9.2.4 Solids Removal, and chemicals that may be used to either raise or lower the pH of discharges are outlined in Section 9.2.2 pH Adjustment Alternatives and Section 9.2.3 Metals Precipitation respectively. It is not clear what treatments will be applied to achieve compliant water quality. The actual dosing is not defined, with BIMC noting that *"A theoretical dose should be established through bench scale testing first for target dosing. An effective dose of coagulant will yield a clear supernatant and form a layer of thick solids, which is not easily disturbed. The lighter the solids layer, the more affected by wind it will be, and the greater the possibility the solids will go back into suspension".* BIMC also notes that *"When sludge needs to be removed*" which will occasionally be required when treating water, *"care should be taken to ensure it can be removed and stored without damaging the pond or the causing harm to the environment. Sludge is typically removed by first draining the pond, and a pump dredge system or other method removes the solids. A dewatering process may then be employed to reduce sludge volume and make storage and disposal easier. This can be passive, using a gravity drain system, or active, using a centrifuge or other similar piece of technology. Dewatered sludge could be stored in a landfill, encapsulated in the Waste Rock Stockpile or backhauled, depending on its composition."* It is unclear what criteria will be used to determine the fate of the sludge within the WRF Pond. This is particularly important as water quality within the WRF Pond has not been predicted, the accuracy of WRF runoff water quality predictions are questionable, and BIMC does not appear to have finalized the treatment reagents that will be applied to noncompliant water. The quantity and quality of the sludge is therefore unknown.
Recommendation/ Request	Please provide a prediction of the quantity and composition of sludge that will result from treating noncompliant water within the WRF prior to discharge. Please outline the criteria that will be used to determine a) when dewatering and sludge removal must occur to ensure the WRF continues to function as designed and effluent is compliant with relevant discharge criteria, and b) where the sludge will be disposed of. We further request BIMC provide an estimate of the volume of sludge that will be generated in the 2020-2021 period, and over the course of mine life.

Comment ID : QIA-WRMP-4	
Baffinland Response	Baffinland currently manages the sediment from the WRF through the geotube filter bags employed at the water treatment plant. Any excessive sludge or sediment buildup in the WRF will be mobilized and pumped through the WRF treatment plant. One method to manage sediment buildup in the pond is to aggressively circulate water in the pond with the intention of re-suspending sediments. This procedure was successfully employed in 2019 during the pond relining process and re-suspended sediment was managed with the geotube filter bags. Baffinland considers any pond sediment and sludge captured to be PAG. Once the geotube bags utilized at the WRF treatment plant reach capacity, they are to be drained, removed and encapsulated within the WRF in a PAG deposition area, with immediate coverage with non-AG material to promote freezing within the frozen core of the WRF. Geotubes will be placed at a designated area within the WRF and their location surveyed. As the quantity of sludge and sediment is minimum as compared to the overall pile tonnage, no issues are expected with the management of this material of the life-of-mine.

Comment ID : QIA-WRMP-5	
Summary/Issue	Four (4) activities are recommended for improving the understanding of the WRF freezing patterns. Two of these recommendations need to be expanded upon as follows: 1) A more definitive schedule for monitoring the deposition sequences and measured temperature conditions needs to be committed to. In particular, during the minimum and maximum active layer depths in June August. 2) Installation of additional instrumentation in strategic locations should be committed to, In particular, in the planned PAG Area 1 and PAG Area 2 locations. Documenting the minimum and maximum depths of the active layer and the overall freeze back of the WRF is very important for updating the thermal model. Additional instrumentation will allow additional information from an area of the WRF where information on the thermal character is not fully understood.
Detailed Review Comment	Four (4) activities are recommended for improving the understanding of the WRF freezing patterns. Two of these recommendations need to be expanded upon as follows: 1) A more definitive schedule for monitoring the deposition sequences and measured temperature conditions needs to be committed to. In particular, during the Minimum and maximum active layer depths from June to August. 2) Installation of additional instrumentation in strategic locations should be committed to, In particular, in the planned PAG Area 1 and PAG Area 2 locations. Documenting the minimum and maximum depths of the active layer and the overall freeze back of the WRF is very important for updating the thermal model. Additional instrumentation will allow additional information from an area of the WRF where information on the thermal character is not fully understood.
Recommendation/ Request	It is recommended that the proponent commit to implementing a regular scheduled monitoring of the deposition sequences and active layer, in addition to, installing additional thermistors in the planned PAG Area 1 and PAG Area 2 locations.
Baffinland Response	The schedule for the monitoring of deposition and WRF instrumentation is outlined in the Waste Rock Facility QA/QC Monitoring Plan (Sections 3.3 and 3.4, Appendix C of the Phase 1 Waste Rock Management Plan, Revision 2). Baffinland will be implementing additional instrumentation in the expanded footprint of the WRF in 2020 and 2021. Locations and number of installations will be determined based on the material deposition schedule, material distribution, and sequencing to ensure integrity of the installation and continuous data collection without the potential need for re-location and re-installation due to operational constraints.

Comment ID : ECCC-1	
Summary/Issue	"The proponent has provided the following definition for Potentially Acid Generating (PAG) rock: “Potentially acid generating (PAG): rock-containing minerals, which potentially can produce acid or acidic water, with a total sulphur content greater than 0.2 wt% as S [Sulphur].”"
Detailed Review Comment	The generally accepted definition of PAG rock does not contain the percentage of sulphide minerals content (wt% as S). PAG rock is defined as a rock that, when oxidized by surface weathering, may form acid that can then leach metals. PAG rock can also be defined as rock with a neutralization potential/acid potential (NP/AP) ratio of less than 2, determined by static tests, as defined by Mine Environment Neutral Drainage (2009). PAG rock can also be defined operationally based on the results of static testing such as Acid Base Accounting (ABA) and Non-Acid Generating (NAG) testing.
Recommendation/ Request	ECCC recommends that the proponent revise the definition of PAG rock
Baffinland Response	Baffinland will modify definition of text to reflect use of S% >0.2 as analog for NPR<2 in order to classify material.

Comment ID : ECCC-2	
Summary/Issue	The proponent included samples of drill cuttings from the boreholes used for blasting ("blastholes") in the open pit in order to expand the geochemical database for samples with total sulphur slightly above and below 0.2 wt% as S in the 2019 geochemistry program. The inclusion of the borehole drill cuttings was done to assess the presence of soluble sulphate minerals in material with low total sulphur to inform the current waste rock segregation criteria.The proponent goes on to state that the geochemical results suggest that the overall existing waste rock pile design and placement, as presented in the December 2018 WRMP (Golder, 2018b), remains valid for the purpose of reducing potential for acid rock drainage (ARD) and metal leaching (ML), provided that the non-acid generating (Non-AG) material does not contain stored acidity. However, the proponent also recognizes that stored acidity within the waste rock pile is related to localized conditions in the ore currently mined in Deposit 1: "The geochemistry of the current WRF may be localized within the current area of Deposit 1. Stored acidity, particularly within material currently classified as Non-AG waste rock, appears to be primarily within the current Deposit 1 area and the potential appears to decrease based on available historical data". The proponent also indicated that: "7% of the 2019 geochemical samples with less than 0.20 wt% as S total sulphur had acidic pH values (<6) in either the paste pH from ABA or final pH from SFE." In appendix A of the WRMP, it is stated that: "when applied to the current dataset, the addition of paste pH to the PAG classification criteria would reduce the amount of low sulphur, Non-AG waste rock with potential
Detailed Review Comment	The proponent's above conclusions suggest that based on the classification method selected and the test conducted on potential samples, between 2 and 7% of the non-AG materials placed into the waste rock pile could be PAG. ECCC suggests that the proponent consider assessing all samples rather than using the 0.2 wt. % S criteria to segregate waste rocks samples as stated in section 6.2. This would alleviate potential bias caused by using only samples near the 0.2 wt. % S. ECCC has concluded that stored acidity and localized ARD and ML activities within the current waste rock facility is due to misclassification of PAG as non-AG rock. ECCC notes that even when the quantities of soluble sulphate to produce ARD and ML are predominately constrained to material with a total sulphur content greater than 0.20 wt. % as S, this does not mean that materials with less than 0.2 wt. % of S will not produce ARD/ML. This is the case where there is not enough neutralization potential (materials) to neutralize the acid. The fact that 7% of the 2019 geochemical samples with less than 0.20 wt. % as S total sulphur had acidic pH values (<6) in either the paste pH from ABA or final pH from SFE, means that the 0.2 wt% as S cut off for Sulphur is not adequately segregating materials that have potential to general acid. A wider range of samples could be assessed to alleviate the possibility that up to 7% of samples could be misclassified using the 0.2 wt % as S cutoff and therefore reduce the risk for stored acidity hotspots within the waste rock facility. Table 1 from Appendix A, Waste Rock Management Plan Rev 2 also indicates that even with the additional paste pH test, 1 out of 55 samples may be misclassified as non-AG rock. Hence, even with the addition of the paste pH test, about 2% of the entire waste rock could have been misclassified as non-AG. There is also no indication what the results (% misclassification) would be if the cut off is reduced to 0.1 wt % as S or less. ECCC supports the recommendation by Golder Associates Ltd, submitted by the proponent, that: "In addition to altering the PAG classification criteria, it is also recommended that supplemental blast hole samples of both PAG and Non-AG material be submitted for ABA and SFE testing on an ongoing basis opposed to the current practices of ABA analysis of PAG samples only" and "The supplemental samples should be representative of the material mined, including a representative range of sulphide content. A frequency of 10 samples per month (five of each PAG and Non-AG) is recommended through 2020 with the results and sample frequency reviewed on a six-month basis." The adoption of these recommendations would allow the proponent to develop a comprehensive geochemical database for the waste rock, and to diminish or eliminate the risk of PAG rock misclassification.

Comment ID : ECCC-2	
Recommendation/ Request	ECCC recommends that: - the proponent assess all samples with Acid Base Accounting (ABA) and Shake Flask Extraction (SFE); - the proponent assess a wide range of samples without relying on the 0.2 wt. % S cut off, in order to ensure that no PAG rock is misclassified as non-AG rock and - the Proponent adopt Golder's recommendation that all samples be submitted for ABA and SFE testing on an ongoing basis.
Baffinland Response	Correction to ECCC comment – Baffinland submits a sample from each blasthole for total Sulphur and paste pH as part of current segregation practices. Golder did not recommend ABA and SFE analysis on all blast hole samples collected. Golder recommended that a confirmatory program be implemented consisting of 10 samples per month (5 of each PAG and non-PAG). These confirmatory samples would be tested for a more comprehensive suite of analysis and correlated to existing data (from both operational monitoring and the Environmental Assessment geochemical analysis) to confirm that the proposed ARD criteria is appropriate. Baffinland commits to implementing the recommendation of confirmatory testing of blasthole samples for ABA analysis and SFE. Since the amount of waste rock excavated will vary on a month to month basis, the sampling frequency will include a minimum of one (1) sample every 40,000 tonnes. Additionally, Baffinland will collect confirmatory grab samples per the Waste Rock Facility QA/QC Monitoring Plan, which will include a minimum of ten (10) samples from different areas of the WRF and material classifications for a full suite of analyses.

Comment ID : ECCC-3	
Summary/Issue	A thermal assessment was undertaken to characterize the freezing patterns of deposited waste rock and to assess the Waste Rock Facility (WRF) thermal performance. A thermal model was run to assess the time that it takes for waste rock placed during summer and the subsequent winter to freeze back. The proponent's main conclusions from the thermal assessment are as follows: • "Review of data obtained from the site thermistors indicate that the WRF is almost entirely frozen, with exception of a 2- 3m thick active zone subject to seasonal freeze and thaw cycles. • Temperatures within the WRF are affected not only by air temperature, but also potentially by airflow, air convection and by internal heat generation connected to airflow through the WRF and variation in the geochemical behavior of the waste rock. Progressive increase in air temperatures slowly impacts ground temperature, while airflow and/or internal heat generation lead to sudden, localized and temporary variations in temperatures. • Results from thermal models suggest that between 5 m and 7m of waste rock could be placed in summer and the entire thickness of material would freeze during the following winter, assuming the summer placed material was not covered over during the winter. However, depending on the existence of heat sources within the WRF, a 7 m thick waste rock summer deposition could cause the development of a thawed zone in portions of waste rock previously deposited. Limiting the thickness of summer placed waste rock to 5 m would reduce the risk of creating a thawed zone at depth within the WRF. • If no internal heat source is present, the models indicate that the entire waste rock layer deposited in summer would freeze within a year, with or without additional deposition of waste rock in winter and the extent of the thawed zone in the interior of the pile would be very limited." As part of their modelling, the proponent conducted field work and installed thermistors inside the waste rock pile to obtain temperatures measurements. The readings from the thermistors showed that abrupt and localized temperatures changes were observed in the waste rock pile.
Detailed Review Comment	The proponent's conclusions from modelling and thermistor readings would indicate that internally, some portions of the WRF are not frozen due to possible hot spots within the WRF. These hot spots could have arisen because of misclassification of PAG as non-AG by using the 0.2 wt % as S cut-off. Sulphide oxidation is an exothermic reaction that generates heat. The generation of heat within the waste rock facility occurs when PAG rock is misclassified as non-AG rock. ECCC assumes that this is likely what was meant by the proponent when they referred to "existence of heat sources within the WRF".
Recommendation/ Request	ECCC recommends that the proponent: • not use sulphide content only to classify Potentially Acid Generation and non-Acid Generating rock; • verify whether there are layers of the lifts that are not frozen within the Waste Rock Facility.
Baffinland Response	Correction to ECCC comment – The reviewer has stated that Baffinland's conclusion from the thermal modelling indicates that portions of the WRF are not frozen. It is noted that reviewer's conclusion is not supported by the site instrumentation data or the thermal modelling. While calibration of the thermal model did require the presence of a heat source, this does not imply that the WRF has thawed areas. On the contrary, it is noted that the installed thermistors have not identified any thawed portions within the WRF with the exception of the seasonal active layer. The thermistors installed to date exhibit similar trends and are therefore considered representative of the WRF condition. Baffinland cannot state with absolute certainty the temperature profile throughout the WRF, nor could a sufficient large sample size to make this determination be reasonably obtained. Additional drilling and instrumentation would only further verify the WRF temperature profile at the local conditions to the instrument and would not achieve the requested objective of verifying that the WRF is frozen in entirety. Baffinland intends on installing additional thermistor strings to monitor the WRF temperature profile as the WRF expands. Baffinland is currently planning the number and location of the additional instrumentation.

Comment ID : ECCC-4	
Summary/Issue	In section 10.0 WRF Development Strategy, the proponent noted that stockpile exterior faces would have PAG waste rock placed at a minimum 4 m under a non-AG rock cover. The placement of PAG rock under 4 m of non-AG cover was recommended by Golder until more data points are obtained to define the permafrost active zone. Section 10.3, of the WRF Development Strategy mentions that the non-AG out layer during closure could be up to 50 m thick to ensure that the interior of the WRF remains frozen year-round.
Detailed Review Comment	Given the statements in sections 10.0 and 10.3 of the WRF Development Strategy, it is not clear whether the proposed cover thickness over PAG rock would be 4 m or 50 m.
Recommendation/ Request	ECCC recommends that the proponent provide clarification on the thickness of the cover proposed in the waste rock facility closure.
Baffinland Response	The cover thickness in final closure is 50 m of Non-PAG material. The 4 m buffer indicated in Section 10.0 of the Golder document refers to working faces of the pile and not final closure. For clarity, refer to Section 11 of the Phase 1 Waste Rock Management Plan “WRF Closure”.

Comment ID : ECCC-5	
Summary/Issue	The proponent provided water quality data measurements from 2019 in table format in Appendices AD, and Water Quality Modeling Results in Appendix E. Measured values for sulphate were as high as 72,187 mg/L in waste rock facility runoff and up to 3654 mg/L in the pond. Sulphate concentrations are modeled to average 3429 mg/L in 2019/2020 in the effluent. Appendix E presents predictions, but the table does not have a title which indicates what the predictions represent. Based on the text on page 11 of Appendix A4 Water Quality Memorandum it appears that these numbers represent runoff quality from the WRF with precipitation of metals taken into account. It's unclear if they are post-treatment, given that they are compared to the Metal and Diamond Mining Effluent Regulations (MDMER).
Detailed Review Comment	Current water quality measured in the ditch, pond and runoff have high levels of sulphate which for some species could be considered high enough to cause acute toxicity. Clarification on potential treatment and mitigation options for sulphate are required, as well as clarification on the predictions table from Appendix E.
Recommendation/ Request	ECCC recommends that the proponent provide clarification on potential treatment or mitigation measures for high sulphate, given the high levels of sulphate measured in the Waste Rock Facility in 2019 and given the use of ferric sulphate in the currently used treatment process.
Baffinland Response	Baffinland acknowledges elevated sulphate concentrations in the Waste Rock Facility (WRF) pond and is investigating process changes such as recycling of sludge and use of alternate coagulants and polymers to reduce sulphate concentrations in the WRF effluent. Baffinland conducted monthly acute lethality testing from the Waste Rock Facility water treatment plant effluent with compliant results in 2019. Water quality monitoring will continue in 2020 as per Baffinland's Water Licence and MDMER sampling requirements

Comment ID : CIRNAC (NIRB) Technical Comment #3	
Summary/Issue	PAG waste rock stored within the WRF at the Mary River mine site currently generates ARD/ML that is collected and treated before discharge. Baffinland has been conducting sampling and test work to better understand the nature of ARD/ML associated with the PAG waste rock. Key findings of the test work are incorporated into the updated Waste Rock Management Plan. The current method of identifying PAG waste rock that may generate ARD/ML relies on measuring the total sulphur content. Baffinland considers rock with total sulphur content below 0.2 weight percent (wt%) to be non-generating ARD/ML. The 0.2 wt % criteria is based upon a neutralization potential ratio (NPR) criteria of 2 which, according to the Mine Environment Neutral Drainage (MEND) program (MEND. 2009), can only be used where acid potential is associated with pyrite and there is readily available neutralization potential provided by Ca/Mg carbonate minerals (e.g. calcite and dolomite). CIRNAC is of the view that the lack of Ca/Mg carbonate minerals and presence ofsoluble sulphates, implies that an NPR value of 2 and associated 0.2 wt% total sulphur criteria may not be appropriate for identifying PAG waste rock at the mine site. In addition to 0.2wt% total sulphur criteria Baffinland proposed using paste pH test to identify rocks with soluble sulphates (paste pH<6). The proposed 0.2wt% S (plus NPR>2) and paste pH are inadequate because of the absence of Ca/Mg mineral carbonates, lack of clarity on the origin of soluble sulphates as well as estimates of soluble sulphate content of deposits, and lack of info on variation and uncertainty in ARD/ML behavior of different waste rock types. Clear and adequate derivation of appropriate PAG identification criteria is critical for effective management of waste rock at the mine site. If the NPR value and associated total sulphur wt% criteria are not suitably conservative (i.e. account for an absence of Ca/Mg carbonate minerals), Baffinland may substantially underestimate tonnages of PAG in the Block Model for Deposit 1. Greater than expected tonnages of PAG may result in the WRF design and water treatment sizing not being sufficiently adequate to prevent short or longer term adverse impacts to the watershed in which the WRF is located.
Detailed Review Comment	After review of the update Waste Rock Management Plan, CIRNAC has the following outstanding concerns regarding ARD/ML characterization. **1. Origin of the Soluble Sulphate minerals** Detailed analysis has been provided around the differences between acid-base accounting, elemental and Shake Flask Extraction results of the 2019 set of samples and both the 2014 and prior historical data set. However, the following aspects have not been addressed: • The possible geological origin of the soluble sulphates. • The possible spatial extent of waste rock containing significant soluble sulphates. • Tonnage estimates of potential soluble sulphate containing rock have not been be provided. **2. ARD/ML identification criteria** There is still no discussion on how the ARD/ML identification criteria suggested in AMEC 2014 report or the present Geochemistry Memorandum accounts for the absence of calcium/magnesium carbonates. The current report acknowledges the relatively low neutralization potential and the negligible contribution of carbonates present as they are iron carbonate minerals, but there is still no explanation as to how the current and now proposed 0.2% total S threshold for the effective segregation of materials is affected by virtually no net reactive Calcium /Magnesium carbonate mineral content. The AMEC 2014 report where the 0.2% total S threshold was derived, most certainly uses an NPR threshold of 2 to identify PAG materials and then asserts that the 0.2% total sulphur threshold is sufficiently conservative as it results in the identification of significantly more PAG material than use of an NPR threshold greater than 2 (109.5 Mt vs 62.7 Mt). However the report does not consider the scenario if comparison against an NPR of 2 is not sufficient, in the first place, to account for absence of Calcium /Magnesium carbonate mineral content and associated neutralization potential. Chapter 14 of MEND. 2009. Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials. Report 1.20.1. Mining Environment Neutral Drainage (MEND) Program, Natural Resources Canada. December 2009 states: “Material categories for future drainage pH are potentially acidic drainage generating (PAG) and not potentially acidic drainage generating (Non-PAG). For cases where [acid production potential] AP and [neutralization potential] NP are equally exposed and AP generates acid identical to pyrite and NP neutralizes acid like calcite, samples with an NPR less than 1.0 are PAG and samples with an NPR greater than 2.0 are non-PAG” This is clearly

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	not the case, since neutralization relates to predominantly silicate minerals which are unlikely to provide neutralization potential at a rate to maintain pH greater than 6. The current memo does not include information on the statistical variation and uncertainty in ARD/ML behavior of the different types of waste rock at Deposit 1. **3. Site based methods for identification of ARD/ML** Baffinland indicated that site based methods for identification of ARD/ML will be determined in consideration of the afore-mentioned aspects and would likely include a range of techniques (e.g. potentially paste pH, total S, Non-PAG pH). Regardless these techniques need to be supported by appropriate correlations and degrees of uncertainty. The ARD/ML criteria has been updated, however there still remains the issues with the 0.2% total sulphur cut-off for identification of Non-PAG waste rock and there does not appear to be incorporation of any degrees of uncertainty in the Geochemistry Memorandum of the Waste Rock Management Plan. **4. Design and operation of the WRF pond** In addition CIRNAC reviewed the Water Balance Technical Memorandum supporting the updated Waste Rock Management Plan and has the following clarification questions related to the design and operation of the WRF pond: • Baffinland should confirm if the 65,000 m3/month inflow indicated in the Memorandum was the total monthly accumulation or it included any release via the water treatment plant. • Baffinland should confirm if there is sufficient contingency within the pond, to prevent the potential of uncontrolled/untreated discharge to the environment if treatment is ineffective or a longer retention time in the pond is required.
Recommendation/ Request	To assess the potential significant adverse effects associated with ARD/ML, CIRNAC recommends that Baffinland: • Demonstrate the origin of the soluble sulphates, estimate possible spatial extent and a tonnage estimate of waste rock containing significant soluble sulphates. • Demonstrate that waste rock associated with the greater life of mine deposit does not have significant soluble sulphate content. • Provide further justification for the retention of 0.2% total sulphur cut-off threshold for identification of Non-PAG waste rock and using NPR of 2 as a cutoff for PAG identification considering the absence of Calcium / Magnesium carbonate mineral content. • Provide information on the variation and uncertainty in ARD/ML behavior of the different types of waste rock. • Develop effective criteria for identification of potentially acid generating rock following industry best practice and incorporate these criteria in an updated Waste Rock Management Plan and Interim Closure and Reclamation Plan. • Confirm adequate capacity of the WRF pond, including the sufficient contingency within the pond to prevent a potential of uncontrolled/untreated discharge to the environment.
Baffinland Response	***Demonstrate the origin of soluble sulphates, estimate possible spatial extent. Demonstrate waste rock associated with the greater LOM does not have significant soluble sulphate content*** Deposit No. 1 is characterized by a zone of massive, layered to brecciated hematite and magnetite, variably intermixed with banded oxide to silica facies iron formation. The deposit is stratigraphically underlain by quartz-feldspar-mica gneiss with minor bands of quartz-mica schist and quartzite (footwall) and overlain by chlorite-actinolite schist and garnetiferous amphibolite (hanging wall). Spatial extent and tonnage estimate of waste rock with soluble sulphates is currently limited by the available geochemical information for the waste rock with total Sulphur content less than 0.2% within the current Deposit 1 mining area. There is currently a database of over 1,500 samples that have been submitted for static testing with the results presented in previous reports (e.g. AMEC 2012, AMEC 2014, BIM 2014, AMEC 2016, AMEC 2017, Golder 2018) that was compared to the WRF and blasthole samples collected and presented in Golder, 2019 (Figures 10 to 12). Within the database, approximately 85% of samples (1,360 samples) have Total Sulphur content less than 0.2%. Of these samples, only two (2) samples (0.14% of samples) had paste pH or SFE pH less than 6 (See figure below). The results suggest that soluble sulphates are likely limited in extent to the current mining area. Baffinland plans to collect additional samples over the course of 2020 as part of their waste rock

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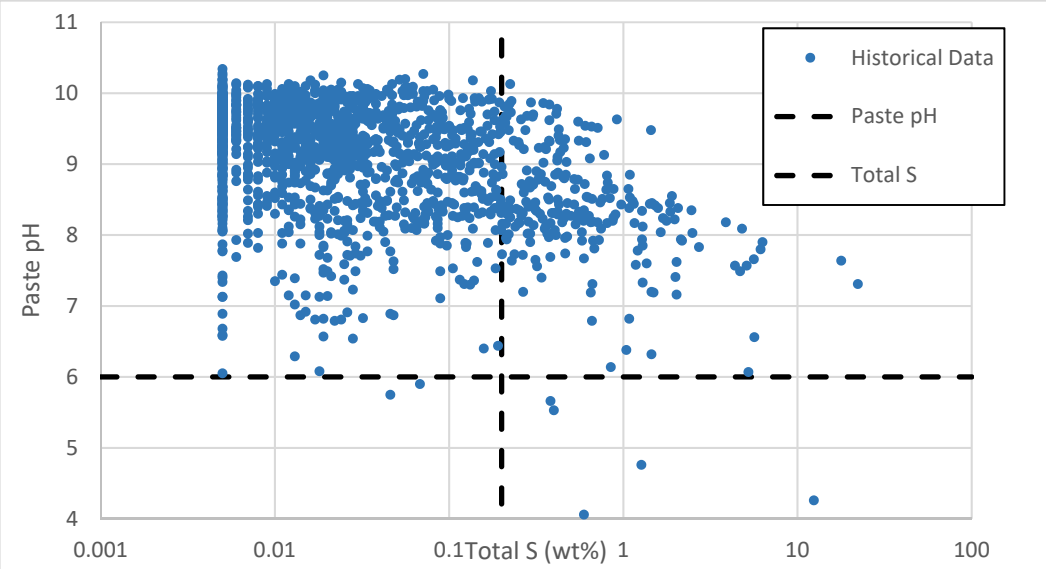
segregation program, as outlined in the WRMP. The data will be reviewed and will assist with further delineating soluble sulphates within the deposit.



One potential source of soluble sulphates in the deposit is melanterite. Melanterite ($Fe^{2+}(H_2O)_6SO_4 \cdot H_2O$) is a colourless to pale green soluble sulphate mineral. The primary geologic origin of melanterite is due to decomposition of sulphide minerals in the presence of water. This secondary mineral precipitation may result from surface weathering, or through hydrothermal alteration. In some cases melanterite can be found as a result of secondary mineral precipitation on mine walls or waste areas (https://www.mindat.org/min-2633.html). At Baffinland, crystals of melanterite are rare but can be observed in some waste rock samples, indicating that melanterite formed over time, either due to prolonged weathering, or possibly due to hydrothermal alteration. Melanterite formation in the Baffinland deposit is expected to primarily occur in broken structural zones where surface water has percolated through the deposit, although there may be some melanterite within hydrothermally altered zones along structures where sulphides would have been present. These sulphate salts have the capacity to store metals, acidity, and can be highly soluble in water. Visual observations of melanterite during mining in Deposit 1 will be reported to the Mine Geologist for further evaluation.

Provide justification for the retention of 0.2% cut-off for identification of Non-AG and using NPR of 2 for PAG identification considering absence of Ca/Mg mineral content.

Justification for the 0.2% total Sulphur cutoff was previously provided by AMEC (2014) based on a review of the available geochemical data. The cutoff was further supported by the results of the HCT testing (AMEC 2016, AMEC 2017, Golder 2018) which assessed silicate minerals as the primary source of neutralization potential (NP). Eight NP depleted humidity cells were operated between 154 and 340 weeks. Four of the test cells had total Sulphur below, or slightly above, the 0.2% total Sulphur cutoff (0.068 to 0.21 wt.% as S). Based on ABA results, two (2) of the samples were classified as Non-AG and two (2) were classified as having an uncertain potential to generate acidity.

To evaluate the long-term acid generation potential of the four samples, sulphide and NP depletion calculations were performed consistent with Price (1997) and MEND (2009). The NP depletion rates (based on sulphate production) were used here for prediction of acid generation potential and assume all sulphate produced within the HCTs is a result of sulphide oxidation. A summary of depletion calculations, as well as selected results from the ABA test work for the four cells of interest are provided below. Based on the depletion calculations (i.e. predicted acid production and neutralization rates for the four samples), the time to depletion of NP is greater than the time to depletion of sulphur for all four samples. The results suggest that silicate minerals in these samples are reactive enough to sufficiently neutralize acid generation in low sulphur material.

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Previous mineralogy results show that silica minerals generally consist of quartz, plagioclase (including Ca-rich anorthite), hornblende, biotite, muscovite and chlorite (BIM, 2014). Anorthite, biotite and hornblende have been shown in other studies to buffer sulphide oxidation especially at low sulphur levels (e.g., Jambor et al., 2006; Eary and Williamson, 2006; Karlsson et al., 2018). The mineralogy and results of the NP depleted humidity cells suggest that, even though there is limited carbonate bearing minerals in the waste rock material, there is neutralization potential due to the reactive silica minerals. The low temperatures and aggradation of permafrost within the WRF will limit oxidation reaction rates and further benefit neutralization via silicate mineral weathering.

While the NP depleted humidity cell and mineralogy supports current segregation practices, the 0.2% cutoff will continue to be assessed as additional data is collected and, if deemed necessary, adjusted.

Sample ID	Lithology	S(T) %	NP	NPR	Static ARD Designation	Time to Sulphur Depletion (yrs)	Time to NP Depletion (yrs)	Classi-fication
						$S_{sulphide}$	NP	
MR ARD-10-082	HW – Volcanic Tuff	0.12	42.1	11.2	Non-AG	7	221	Non-AG
MR ARD-10-048	FW - Schist	0.214	11.4	1.7	Uncertain	341	1323	Non-AG
5174	FW – Gneiss	0.068	3.7	1.7	Uncertain	655	769	Non-AG
5172	FW – Metasediment	0.137	10.4	2.4	Non-AG	1333	4416	Non-AG

Provide Information on variation and uncertainty in ARD/ML behavior of the different types of waste rock

Current primary mitigation for the pile is freezing of the pile. The design has further been adjusted to a layered system that will promote freezing and help limit migration of water and oxygen through the pile. The current waste rock pile can be considered a relatively small starter pile. Observed conditions in this pile have shown that the initial geochemical characterization (AMEC 2014) failed to consider soluble sulphate minerals and failed to adequately capture the range of geochemical conditions that could occur in the pile. Additional information and monitoring is underway as part of a larger design and mitigation program, and is providing valuable information into the behaviour of the materials.

It will be necessary to continue to monitor the pile water quality and geochemistry to evaluate if the imposed changes (thin lifts to promote freezing, and additional paste pH evaluation to define acid producing materials) are effective in mitigating acid release. Additional mitigation measures such as further reducing the total sulphur content cut-off must be practicable, and should only be implemented if necessary, based on the ongoing test work.

Although the current design basis is considered reasonable, the overall design will be updated as necessary based on the result of ongoing test work and monitoring.

Provide information on the variation and uncertainty in ARD/ML behavior of the different types of waste rock.

Current waste rock segregation practices employed by Baffinland are consistent with standard industry practices. A typical approach to waste rock management includes development of

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	segregation criteria that are simple to follow, can be deployed effectively, and results can be reviewed within a timely manner to avoid inefficiencies. Current practice by Baffinland allows for simple and timely identification of PAG and Non-AG waste zones prior to blasting. The total Sulphur cutoff of 0.2% has been used to sort PAG and Non-AG since production began. The addition of the paste pH criteria will allow for material with less than 0.2% total Sulphur containing stored acidity to be classified and treated as PAG waste rock. The revised segregation criteria will be reviewed on an ongoing basis as additional waste rock samples are collected and analyzed. ***WRF Pond Capacity*** Baffinland previously submitted a modification request and received subsequent approval for the expansion of the WRF pond in 2018 (Motion No. 2018-A1-015). At that time, intervenors including the QIA reviewed the validity of the climate and hydrology considerations accounted for in the design. The hydrological frequency analysis used to size the WRF Pond was based off the measured stream flows at a local station that was considered most representative of the site conditions. The water balance was not used for sizing of the WRF Pond and WRF ditch systems, and therefore, the current limitations in the calibration of the water balance does not impact the design of the WRF water management system. The design of the WRF pond expansion volume (50,000 m^3 operating capacity) utilized an Environmental Design Flood (EDF) design based on a 1:10 year 15-day storm event, and assumed a total catchment footprint of 584,000 m^2. This results in a total inflow over 15 days of 50,130 m^3/15 days, or when using a 1:10 year 24 hour event a total inflow of 12,000 m^3/day. These flow rates are significantly greater than the 65,000 m3/month indicated by the water balance, indicating there is sufficient conservatism in the sizing of the pond. The water treatment plant alone provides a capacity of 280m^3/hour, or approximately 200,000 m^3/month. Based on these factors the water management structures at the WRF contains sufficient conservatism to manage average inflows and flood conditions up to a 1:10 year 15 day event, which is greater than the results of the water balance.

Comment ID : CIRNAC (NWB) 1	
Summary/Issue	Sediment Management at the WRF
Detailed Review Comment	In treating water quality in the Waste Rock Facility (WRF) Contact Water Pond, the precipitation of metals and settlement of suspended solids will generate sediment that will need to be removed and disposed of. The removal of sediment generated from water treatment is discussed in the Phase 1 WRMP Rev 2. Section 9.2 of the main report of the updated WRMP discusses WRF runoff water treatment alternatives and specifically Sections 9.2.3 and 9.2.4 discuss procedures for the removal of metals and suspended solids, respectively. In both cases it is acknowledged that settlement of precipitated metals and suspended solids will generate sediment that will need to be removed and disposed of but no details are provided pertaining to the nature and extent of sediment removal efforts and disposal needs. It is not clear whether the Contact Water Pond would need to be drained, and if so, how incoming flows would be managed during that period of time as there is no standby capacity on site to manage ongoing water flows to the pond during the time of sediment removal. This could be a critical shortcoming during operations, which should be addressed.
Recommendation/ Request	CIRNAC recommends that BIMC provide further details on the anticipated procedures for sediment management at the WRF. Specifically, BIMC should provide details regarding: i. an estimate of volume of sediment to be produced; ii. an assessment of the need for standby pond capacity; iii. details regarding the procedures for sediment handling, transport, and disposal; and iv. monitoring and sediment disposal record keeping practices.
Baffinland Response	While in-pond treatment alternatives are discussed in Section 9.2.3 and 9.2.4 of the WRMP, these alternatives are not currently employed, therefore no consideration for volumes of sediment have been provided. Section 9.2.6 details sludge management options for the WRF pond in the event of in-pond treatment. Baffinland currently manages the sediment from the WRF through the geotube filter bags employed at the water treatment plant. Any excessive sludge or sediment buildup in the WRF will be mobilized and pumped through the WRF treatment plant. One method to manage sediment buildup in the pond is to aggressively circulate water in the pond with the intention of re-suspending sediments. This procedure was successfully employed in 2019 during the pond relining process and re-suspended sediment was managed with the geotube filter bags. Baffinland considers any pond sediment and sludge captured to be PAG. Once the geotube bags utilized at the WRF treatment plant reach capacity, they are to be drained, removed and encapsulated within the WRF in a PAG deposition area, with immediate coverage with non-AG material to promote freezing within the frozen core of the WRF. Geotubes will be placed at a designated area within the WRF and their location surveyed. As the quantity of sludge and sediment is minimum as compared to the overall pile tonnage, no issues are expected with the management of this material of the life-of-mine.

<table>
<tr><th colspan="3">Comment ID : CIRNAC (NWB) 2</th></tr>
<tr><td>Summary/Issue</td><td colspan="2">Recommendations from Supporting Studies</td></tr>
<tr><td>Detailed Review Comment</td><td colspan="2">A number of technical studies have been prepared in support of the Phase 1 WRMP update, including geochemical investigations and thermal, water balance and water quality modelling. These studies provide recommendations which are intended to help improve the outcome of each study, and to increase the current understanding of waste rock and WRF seepage and runoff characteristics, and inform water treatment requirements. This would help improve efforts in characterizing waste rock and WRF seepage and runoff and identifying needs for water treatment, which are all important for management of waste rock and mitigation of ARD/ML.
CIRNAC supports the implementation of all recommendations. BIMC's commitment or intention to implement these recommendations, however, is not always clear from the documentation, and in some cases in which BIMC's commitment to implement a particular recommendation is clearly stated, the extent to which BIMC has accepted the recommendation is not indicated.</td></tr>
<tr><td>Recommendation/ Request</td><td colspan="2">CIRNAC recommends that BIMC clearly incorporate all recommendations provided in the supporting technical studies into the primary documents, and provide specific references as to where they can be found in the supporting documents. For example, this could be achieved by creating a disposition table that includes all recommendations from all supporting studies along with an indication of BIMC's commitment to implement the recommendation and the status of implementation/ completion, or in another form which BIMC and the NWB deem to be appropriate.</td></tr>
<tr><td>Baffinland Response</td><td colspan="2">Baffinland has incorporated the recommendations of Golder Associates in the technical memos into the Phase 1 Waste Rock Management Plan. As requested, the below disposition table outlines where these recommendations have been incorporated.

<table>
<tr><th>Memorandum Recommendations</th><th>Section of WRMP</th></tr>
<tr><td colspan="2">Geochemistry Memorandum (Appendix A1)</td></tr>
<tr><td>The current waste rock segregation criteria requires minor modification to better identify Non-AG rock that does not contain stored acidity.
To reduce the amount of low sulphur rock classified as Non-AG that may have some potential to release acidity it is recommended that paste pH testing be implemented as part of the current segregation practices at site for samples that have less than 0.20 wt% as S.</td><td>6.2 Geochemical Sampling Program

To reduce the amount of low sulphur waste rock with stored acidity classified as Non-AG under the current criterion that may have some potential to release acidity, paste pH testing will be implemented as part of the current waste rock segregation practices for samples that have less than 0.20 wt% as S. The updated PAG and Non-AG classification criteria are provided in Table 1.</td></tr>
<tr><td>To develop a comprehensive geochemical database for the WRF, allow for the potential refinement of waste rock segregation practices, and support future updates to the WRMP, it is recommended that select blasthole samples of both PAG and Non-AG material are submitted for ABA and SFE testing on an ongoing basis. A frequency of 10 samples per month (5 of each PAG and Non-AG) is recommended through 2020 with the results and sample frequency reviewed on a six-month basis.</td><td>6.2 Geochemical Sampling Program

Select blasthole samples of both PAG and Non-AG material will be submitted for ABA and SFE testing on an ongoing basis. The purpose of this additional testing is to develop a comprehensive geochemical database for the WRF and allow for the potential refinement of waste rock segregation practices, if required in the future, and increase the level of confidence in the data set.</td></tr>
<tr><td colspan="2">Thermal Model Memorandum (Appendix A2)</td></tr>
<tr><td>Continue to monitor the evolution of temperatures and oxygen concentrations. This would allow for further assessment of the localized patterns of temperature variation that were observed along several thermistor strings.</td><td>Appendix C, Waste Rock Facility QA/QC Monitoring Plan, Section 3.4 Thermal Instrumentation Monitoring: Data Collection

Collection of Monitoring Data – Once Per Week</td></tr>
</table>
</td></tr>
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Comment ID : CIRNAC (NWB) 2		
		• Monitoring data to be collected based on the instrumentation reporting package
	Periodically update the thermal modeling based on monitored deposition sequences and measured temperature conditions.	***7.0 Thermal Assessment*** Updates to the thermal model will be carried out, as appropriate, to incorporate improved understanding of the WRF gained by the ongoing review of the WRF instrumentation data and as required to inform the waste rock deposition.
	Conduct periodic surveillance of the surface of the WRF as added waste rock on top of existing instrumentation will impact results, and it is important to know when and to what extent waste rock was placed to allow for meaningful interpretation of instrumentation data.	***Appendix C, Waste Rock Facility QA/QC Monitoring Plan, Section 3.4 Thermal Instrumentation Monitoring: Data Collection*** Waste Rock Placement Tracking Monthly reconciliation of Non-AG and PAG materials will occur during dump construction using the site database. This includes but is not limited to the following: • Reconcile truck tracking to survey data using historic, current, and future survey and truck tracking information to reconcile values. • Maintaining a database of all survey data and truck counts for the waste dump operations for future modeling and reconciliation purposes. • Survey information and material transaction database will be stored in a centralized location on the Baffinland network.
	Consider installation of additional instrumentation within future expansion of the WRF footprint.	WRMP text to be updated per responses to QIA-WRMP-5 and ECCC-3. Additional instrumentation to be placed in the expansion areas, with number and location of instruments yet to be determined.
	Water Balance Memorandum (Appendix A3)	

	The water balance could not be calibrated using the data provided by Baffinland due to missing inflow from the Deposit 1 sump that ultimately reports to the WRF Pond. The following recommendations are provided to assist with future calibration of the water balance:
	• Improve monitoring of the WRF water management system:
	  ○ Install a pressure transducer in the WRF Pond to provide a reliable and complete record of water level measurements;
	  ○ Install a staff gauge and develop a rating curve at the east and west ditches;
	  ○ Install a totalizer to monitor the inflow from the Deposit 1 sump; and,
		Not deemed relevant to the WRMP. Baffinland commits to the following, per response to QIA-WRMP-1;
		
		Improvements to the measurement of the WRF Pond inflow and outflows are required to calibrate the water balance, in addition to the continued monitoring of site meteorological conditions. The following improvements are planned for 2020:
		• Installation of a pressure transducer at the WRF Pond to provide continuous water level readings.
		• Continuous tracking of outflow from the WRF Pond to the Water Treatment Plant

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	○ Additional consideration of snowfall and snowpack within the WRF Pond catchment. • Continue collection of climate data at the Mary River station. • Update water balance calibration following collection of additional site data following the recommendations above.	(WTP) and potential recirculation from the WTP back to the WRF Pond. • Continuous tracking of inflows to the WRF catchment or treatment plant from other locations (e.g. mining operations). • Installation of a totalizer on the Deposit 1 discharge to the WRF Pond.
	Water Quality Memorandum (Appendix A4)	
	Future iterations of the water quality model should be completed as necessary. Updates to the model should include the use of mass loading rates based on the observed runoff flow, water quality and geochemistry of the WRF as well as better definition of other inputs to the WRF Pond.	Not deemed relevant to the WRMP. Baffinland commits to the following; All models used in the development of the WRMP (water quality, water balance, thermal, geochemistry) will be updated prior to the next revision of the WRMP in 2021 following the collection of additional relevant data.