Executive Summary

As requested by the Environmental Monitoring Advisory Board (EMAB), Slater Environmental Consulting (SEC) reviewed the *Closure and Reclamation Plan – Version 4.0 (the "CRP V4.0")* for the Diavik Diamond Mine, focusing the review on proposed closure criteria. The review also considered the discussions at the Wek'eezhii Land and Water Board (WLWB) closure and reclamation workshop held on November 20-21, 2017.

Closure planning for the Diavik Diamond Mine (DDM) is following the objectives-based approach that is defined in Mackenzie Valley Land and Water Board guidelines. Closure criteria are the performance indicators and thresholds that are used to determine whether the closure and reclamation activities have met the Diavik Diamond Mine closure objectives approved by the WLWB. Diavik Diamond Mines Inc.'s (DDMI's) proposed closure criteria are listed in Appendix V of the CRP V4.0.

SEC reviewed the closure criteria in the previous version of the CRP (Version 3.2) and provided review comments (June 2016) and specific recommendations for revising criteria (March 2017). Bill Slater participated on behalf of EMAB at the December 2016 and November 2017 WLWB closure workshops. Some of the criteria in CRP V4.0 have been updated, in several cases helping to address the comments and recommendations provided. In many cases however, previous comments and recommendations have not been fully addressed.

Water quality criteria for protecting aquatic life have been revised to address concerns about the overall approach. The criteria now rely on aquatic effects benchmarks, an appropriate approach because the benchmarks were developed to protect aquatic life. However, significant issues remain with how these benchmarks have been used to calculate water quality standards and establish criteria. For example, dilution factors and locations of applying aquatic effects benchmarks leave some areas of Lac de Gras subject to potential adverse effects. The resulting proposed water quality criteria are generally much less stringent than the criteria proposed in the previous CRP version. The criteria should be further revised to reduce the area of Lac de Gras that could be subject to adverse effects on aquatic life.

Consistent with previous comments, many of the criteria remain process or procedure based, rather than focusing on performance. In many cases, the proposed criteria are designed to assess whether an approved design has been implemented, rather than to assess whether the performance defined by specific objectives have been achieved. In some cases, DDMI has provided more clarity about how to measure whether the design has been achieved, but the criteria still don't focus on whether the designs achieve the actual expected performance, or when it expects to achieve that performance.

Monitoring for mine closure projects needs to address the performance of closure conditions over a long period of time. Even once closure activities are complete, performance is not guaranteed. The monitoring proposals in the CRP V4.0 are limited to a period of about five years after completion of

major closure activities. This time period does not demonstrate a commitment to long-term site stability and maintenance, nor does it provide sufficient time to evaluate whether some closure objectives will be achieved in the long-term. Monitoring programs should continue until facilities demonstrate stable performance for long enough to substantially reduce uncertainty about long-term performance. If facilities must achieve critical performance outcomes permanently (e.g., dams) then monitoring and maintenance requirements are also permanent.

Memorandum

To: John McCullum, Allison Rodvang – Environmental Monitoring Advisory Board

From: Bill Slater – Slater Environmental Consulting

Date: December 10, 2017

Re: Diavik Diamond Mine
Closure and Reclamation Plan, Version 4.0

1.0 Introduction

This memorandum provides the results of Slater Environmental Consulting's (SEC's) review of the closure criteria presented in Diavik Diamond Mines (2012) Inc.'s (DDMI's) *Closure and Reclamation Plan – Version 4.0* (the "CRP V4.0"). An initial review of CRP V4.0 documents was completed in September 2017 and then revised following submission of the updated Site-Specific Risk-Based Closure Criteria (SSRBCC) reports (Appendices X-8.1 and X-8.2) of the CRP V4.0. The review also considered relevant documents related to the *Final Closure Plan – Waste Rock Storage Area – North Country Rock Pile – Version 1.1*, including responses to comments submitted through the Wek'eezhii Land and Water Board (WLWB) review process, up to November 19, 2017.

This final review memo was prepared after considering the discussions at the November 20-21 Closure and Reclamation Planning Workshop held by the WLWB. Justin Straker (Integral Ecology Group) assisted SEC in the initial review, following up on review comments and recommendations provided as part of an earlier SEC review.

SEC has provided three previous documents for the Environmental Monitoring Advisory Board (EMAB) addressing the closure criteria for the Diavik Diamond Mine. These include:

1. A review of closure criteria in the overall *Interim Closure and Reclamation Plan, Version 3.2*, and the *Final Closure Plan – North Country Rock Pile (NCRP) – Version 1.0*. Results were provided in a memo dated June 15, 2016.
2. Recommendations for revised closure criteria for the overall closure plan and the NCRP. Results were provided in a memo from SEC and Integral Ecology Group, dated March 21, 2017.
3. A review of revised closure criteria for the NCRP in the *Final Closure Plan – Waste Rock Storage Area – North Country Rock Pile – Version 1.1.* Results were provided in a memo dated June 25, 2017.

Bill Slater also participated on behalf of EMAB at the December 2016 closure WLWB closure workshop, to discuss comments and recommendations for closure criteria.

For each of the closure objectives Table 2 of this memo lists DDMI's proposed closure criteria from Versions 3.2 and 4.0 of the Closure and Reclamation Plan. The Table also describes the differences between the two versions of the criteria, where DDMI has proposed changes. Finally, the Table provides specific comments and recommendations about criteria.

In addition to the content in the table, there are some broader issues that arose during the review, and some recommendations about criteria that could not be addressed in the Table. These are described in the following sections of this memo:

- Section 2.0 addresses the water quality objective for protecting the aquatic ecosystem (Table V-7 in Appendix V and associated Objectives).
- Section 3.0 addresses the water quality objective for humans and wildlife.
- Section 4.0 addresses general challenges with criteria for landscape and wildlife objectives.
- Section 5.0 addresses the need to reconsider Objective SW5 related to re-vegetation.
- Section 6.0 addresses objectives where DDMI proposes that conformance with the design is a suitable closure criterion.
- Section 7.0 addresses long-term monitoring and maintenance requirements and the timing for achievement of closure objectives.
- Section 8.0 provides general comments about updated Site-Specific Risk-Based Closure Criteria reports (Appendices X-8.1 and X-8.2)

2.0 Water Quality – Protection of Aquatic Life

Objective SW2 is intended to ensure that surface runoff and seepage water quality will not cause adverse effects on aquatic life or water uses in Lac de Gras or the Coppermine River. Table V-7 in Appendix V of the CRP lists DDMI's proposed criteria for protection of aquatic life. As described in the same appendix, DDMI's proposed criteria are calculated based on the aquatic benchmarks defined in the approved Aquatic Effects Monitoring Program (AEMP). The calculation assumes a dilution ratio of 85:1 within Lac de Gras, and applies that dilution at a distance of 1 km from the shore of East Island. The calculation also assumes that no effects at these locations would occur unless contaminant concentrations exceed the benchmarks by 20% or more. With these assumptions, DDMI back-calculates criteria that would define the concentrations of contaminants at the point of release from the site. The proposed criteria are, with the exception of uranium and zinc, much less stringent than the criteria proposed in the ICRP Version 3.2. Table 1 provides a comparison of the criteria proposed in the two CRP versions for water entering Lac de Gras. Grey shading in the table identifies CRP V4.0 criteria that are more than double the criteria in CRP V3.2. The revised criteria, if applied, could result in substantially greater loading in Lac de Gras than envisioned by the criteria in the previous version of the CRP.

Table 1: Water Quality Criteria (Objective SW2) for Water Entering Lac de Gras

Parameter	Criterion – ICRP Version 3.2[1]	Criterion – CRP Version 4.0[1]
Aluminum	0.179	8.6

Table 1: Water Quality Criteria (Objective SW2) for Water Entering Lac de Gras

Parameter	Criterion – ICRP Version 3.2[1]	Criterion – CRP Version 4.0[1]
Antimony		3.4
Arsenic	0.110	0.5
Cadmium	0.0015	0.01
Chromium	0.0292	0.1
Copper	0.0207	0.4
Lead	0.0184	0.1
Manganese	1.11	
Molybdenum	1.64	
Nickel	0.437	1.0
Selenium	0.0207	0.1
Silver		0.06
Thallium		0.1
Tin		7.5
Uranium	2.3	1.5
Zinc	0.552	1.0
Nitrate		310
Nitrite	1.31	6.1
Ammonia	49.8 (Total) = 0.02 Un-ionized at pH 6.5 and 5 C[2]	1.0 (Un-ionized)
Total Phosphorus	1000 kg/yr	
pH	5-8.4	5-8.4
Total Suspended Solids	92	
Turbidity	46 NTU	

Shading: CRP V4.0 criteria more than double ICRP V3.2 criteria.

Note 1: All units in mg/L except pH (pH units), Turbidity (NTU), Total Phosphorus (kg/yr)

Note 2: Calculated based on Table 3 in Canadian Water Quality Guidelines for the Protection of Aquatic Life – Ammonia (CCME, 2010)

DDMI's decision to rely on aquatic effects benchmarks as the basis for development of water quality criteria for Objective SW2 makes sense. The aquatic effects benchmarks are based on the Canadian Water Quality Guidelines for Protection of Aquatic Life (CCME) and Procedures for Deriving Site Specific Water Quality Objectives (CCME). The CCME Guidelines and Procedures are national guidelines and methods that are specifically aimed at defining conditions that are protective of

aquatic life. Thus, they are directly relevant to Objective SW2. As described in the AEMP Study Design, these benchmarks "*represent levels of water quality variables below which a body of water is expected to be suitable for its designated use*" (Golder Associates, 2016).

Although the aquatic effects benchmarks define contaminant concentrations that are relevant to Objective SW2, the method for applying the benchmarks cannot be the same as that in the AEMP. Changes in effluent discharge locations, quantities and qualities between operational and closure phases make the operational locations and methods largely irrelevant.

DDMI relies on an 85:1 dilution factor that was developed during the CEAA assessment and that it was "*determined based on modelling of runoff to Lac de Gras and represents the expected level of dilution that would occur within 1 km^2*." Details of modelling are not provided with the CRP V4.0. However, I have reviewed the "*Environmental Effects Report, Fish and Water, Appendix A, Water Quality – Supporting Information*" (Diavik Diamond Mines Inc., September 1998). In my view, there are a number of reasons why these methods should not be applied for establishing criteria for mine closure.

First, the conceptual site model and the associated numerical modelling completed in 1998 may not accurately represent the expected closure conditions at the site. For example, the numerical model evaluates surface discharges generically, assuming rectangular surface outfalls 1m wide and 0.5 m deep, with a slope of 7% and a continuous flow rate of 0.5 m^3/s. It also assumes water lake depth of 30 m at the discharge point. Diavik does not provide any evidence that this type of conceptual model is representative of a closed site with multiple points of surface discharge, with variable flows that are likely small most of the time. As a result, it is not clear that the dilution ratio or other modelling aspects are relevant to the post-closure conditions.

Effluent discharge volumes after mine operations cease and after implementation of the closure plan are likely to be much less than during operations. Dewatering of mine areas contributes a significant portion of the current mine effluent and will not be present during the post-operations period. This lower volume of mine effluent that will also be dispersed in several locations (none of which will likely have continuous flows that approach 0.5 m^3/s) should provide for achievement of aquatic effects benchmarks at locations much closer to East Island.

The criteria provided in CRP V4.0 are the same as those included in the Final CRP for the NCRP. Calculations and proposed criteria considered the expected water quality from the NCRP but the CRP V4.0 does not include comprehensive predictions of water quality and loading from all mine components, or even identify the locations of expected loading. Section 5.2.2 of the CRP V4.0 states "*at this time achievability was only considered for the NCRP-WRSA closure criteria because it is the only closure area where final estimates of water quality are available."* The closure plan and the modelling used to develop closure criteria must be based on a reasonable conceptual model (and numerical modelling that represents the conceptual model) that is representative of expected conditions during the closure period, including discharge locations and predictions of water quality from the site.

The establishment of appropriate closure criteria for water quality would benefit significantly from a comprehensive understanding of the expected water releases during the post-closure period, including the locations, qualities and quantities of releases. In my view, the current stage of closure planning should be supported by water quality predictions and contaminant load models that allow prediction of future water quality conditions. Such predictions are generally included as part of mine planning and the predictions are updated and refined as mining and closure planning progress. Predictions that are consistent with the current understanding of closure conditions and research results should be provided as part of the closure plan. The research status tracking table provided as Appendix VIII-1 indicates that work has been done that would support updating of predictions. Relying on pre-development conceptual models and water quality predictions after many years of mining is insufficient in my view. Modelling more relevant to the post-closure conditions should be developed to support the derivation of water quality criteria.

Second, DDMI asserts that the criteria for evaluating suitable closure conditions should be the same as those applied in 1998 to determine whether the proposed project would have "significant adverse effects" in accordance with the *Canadian Environmental Assessment Act*. In my view, the purpose of these two thresholds is fundamentally different, and application of the CEAA significance threshold to support closure criteria would not lead to acceptable closure conditions. The CEAA threshold was intended to define conditions above which effects would be significant, while closure criteria need to define desirable and expected post-closure conditions. Effective closure criteria should provide a reasonable margin of safety well below the threshold for significant effects, so that the aquatic ecosystem maintains long-term resiliency.

The proposal to apply the aquatic effects benchmarks at a distance of 1 km from the shore of Lac de Gras leads to the conclusion that the stated SW2 objective, water quality that is protection of aquatic life, may not be achieved for substantial areas near East Island in Lac de Gras. Areas with water quality exceeding the benchmark may even extend beyond the 1 km zone because DDMI calculated the proposed criteria based on a threshold that allowed exceedance of the benchmark by 20%.

DDMI argues that the 1 km zone is appropriate because this was considered as the local assessment area during the *Canadian Environmental Assessment Act* (CEAA) environmental assessment in 1999. As stated in Section 9 of the CRP V4.0, the CEAA assessment considered an effect to be significant if it "*has a high probability of a permanent or long-term effect of high magnitude, within the regional area.*" For water quality, a high magnitude effect is one in which the concentration of a contaminant "*exceeds the drinking water and/or the aquatic life guideline by more than 20%*" (CRP V4.0, Table 9-2). With these assessment thresholds, water quality changes – no matter how large – within 1 km of East Island would never constitute a significant effect.

While CEAA assessors may have established a significance threshold that was based on the boundary between the local and regional study areas, the location has no ecological relevance. The boundary should not be equated to a suitable threshold for achieving the closure objective which is an ecological objective. The closure plan should be aiming to provide water quality that will not

adversely affect aquatic life, rather than aiming to avoid "significant" effects. Closure criteria should be defined to encourage effective achievement of the SW2 objective – avoiding adverse effects on aquatic life.

Third, it is not clear that DDMI's interpretation of the 1998 modelling has been applied correctly, even in the absence of consideration of the relevance of modelling. DDMI's calculations apply a 85:1 dilution at a distance of 1 km from shore in order to back-calculate effluent discharge standards for the NCRP. Table A-7 in the "*Environmental Effects Report, Fish and Water, Appendix A, Water Quality – Supporting Information*" (Diavik Diamond Mines Inc., September 1998) identifies a dilution factor of 85:1 for an assessment area of 1 km^2, assuming a semi-circle shaped plume around the inflow location. In this case, the 85:1 dilution factor would apply at a distance of approximately 0.8 km, not 1 km.

Overall, when considering the acceptability of the numerical criteria for objective SW2, it is important to remember the purpose of closure criteria – to define an acceptable closure outcome. I do not recommend supporting numerical criteria that define long-term exceedance of aquatic effects benchmarks within Lac de Gras for distances more than 1 km from shore as acceptable closure performance. Exceedance of aquatic effects benchmarks in much smaller mixing zones (e.g., 100 m or less) adjacent to shore or discharge streams may warrant consideration, provided that discharges are not toxic and don't present unacceptable risks within these smaller areas. This would be more consistent with the recently finalized *Guidelines for Effluent Mixing Zones* (MVLWB/GNWT. September 2017).

Updated modelling that considers the dispersed discharge locations, lower flow rates, and proposed measures (e.g., waste rock cover) that are part of closure, may demonstrate that the currently proposed closure plan can achieve such criteria. However, it remains important to recognize that the closure criteria should be defined based on what the mine closure is expected to achieve (taking into consideration practicality), not on what the currently proposed closure measures can achieve.

3.0 Water Quality – Safe for Humans and Wildlife

Objective SW1 aims to ensure that surface runoff and seepage water quality is safe for humans and wildlife. Tables V8, V9 and V10 in Appendix V-1 of the CRP V4.0 list DDMI's proposed criteria respectively for drinking water, birds and mammals. These are based on the SSRBCC reports.

As stated in SEC's March 2017 memo, DDMI's methodology for developing the criteria for SW1 appears reasonable for defining maximum concentrations of contaminants in water for the purpose of protecting humans, birds and wildlife. Because these criteria were developed using a risk-based approach, the site should be managed to avoid exceeding these criteria. To do this, the application of the criteria should be supported by monitoring and adaptive management plans that monitor source and receiving water conditions, and define action thresholds that will trigger timely

response actions. The thresholds and actions must be designed to curtail any water quality trends before the maximum criteria are reached.

The updated CRP provides improved definition of the location where the criteria would be applied. For humans,

> *"These criteria are applicable where water could be consumed by people. This would include direct consumption of seepage/runoff or consumption of Lac de Gras water in proximity to where the seepage/runoff was released.." (Appendix V-1)*

For birds and wildlife, the criteria would be applicable where birds or mammals would be exposed to water, including possible direct exposure to seepage and runoff as well as in Lac de Gras.

DDMI predicts that, with the exception of uranium, the human health criteria can be achieved "locally" within Lac de Gras, though the extent of likely exceedance is not specified. For uranium, DDMI predicts that the criterion can be achieved in Lac de Gras within 1 km of East Island, and that "*measures may be required to restrict human access to the runoff/seepage to avoid direct consumption*." If the exceedances extend beyond a small local area in Lac de Gras, as the predictions indicate they may for uranium, then measures may also be required for Lac de Gras. While measures to restrict human access to direct consumption of runoff/seepage are likely practical, they may be unrealistic for an area that extends up to 1 km around East Island in Lac de Gras, especially if the restrictions are required for the long-term. The proposed criterion for uranium should be reconsidered unless practical measures can be identified to mitigate potential effects.

The predictions of contaminant concentrations are based on current baseline conditions and do not appear to consider accumulation of contaminants in Lac de Gras over an extended period of time. If mine-related loading increases lake concentrations over time, then the dilution available in Lac de Gras may decrease, leading to exceedance of acceptable contaminant concentrations. This highlights the importance of ongoing evaluation of performance after the closure plan is complete.

Since the proposed criteria for humans and wildlife already define maximum concentrations based on risk assessment principles, exceedance should be avoided. Instead, the response to any exceedance should entail actions to improve the situation, rather than reassessing the risks.

4.0 Criteria for Landscape and Wildlife

Although many of the proposed criteria for landscape and wildlife objectives have associated measurement protocols, they lack thresholds or values that would allow testing to evaluate whether an objective has been met. These criteria, which generally do not include formal "indicators," are not effective for evaluating performance outcomes or addressing the range of important facets of associated each of the closure objectives. In addition, they do not allow for timely response; for instance, Objective M8, "Wildlife safe during filling of pits" has the criterion "no mortalities to wildlife VEC during filling of pits". In the event that measurements indicate that this criterion has not been met, it is too late to respond to allow full achievement of the objective.

The criteria associated with objectives SW4 (dust and wildlife) and SW9 (landscape features that match aesthetics and natural conditions) are particularly deficient:

- As proposed, the criterion for SW4 assumes that if wildlife are present, then vegetation must be palatable and not affected by excess dust. While the presence of wildlife is measurable, there is no meaningful definition to allow testing for successful achievement of the objective about palatability. Clearly palatability will be difficult to measure. In the absence of a direct measure, it would be beneficial to provide criteria that rely on proactive and precautionary indicators like dust levels.
- The criteria associated with SW9 do not directly address the objective which envisions a final landscape that matches surrounding areas. The proposed criteria do not focus on achieving the objective, but instead on what the current closure plan proposes to deliver. The criteria do not demonstrate any substantive effort to achieve the stated objective. Some criteria, for example "change in biodiversity (richness and diversity units) of Regional Study Area less than 1%" are effectively meaningless in the context of the closure project. This criterion was developed so assess significance of effects for the 1998 CEAA assessment. However, the entire mine footprint is less than 1% of the CEAA Regional Study Area – meaning that leaving a completely disturbed mine site without reclamation would achieve the criterion. Using this as a criterion is not effective for evaluating performance of a closure landscape.

5.0 Objective SW5 - Re-vegetation

Objective SW5 is stated as "re-vegetation targeted to priority areas." This objective is difficult to assess, as it simply directs DDMI to revegetate to areas identified as priorities. In the absence of defined priorities, the objective has no real application.

There is no objective that compels DDMI to maximize the extent of practical re-vegetation. If the objective is retained in its current form, then it should be clear that the establishment of priorities cannot rest solely with DDMI, and some process should be defined for establishing priorities. Even if priorities were defined, the objective lacks definition about which priority levels would receive re-vegetation efforts.

It is worth considering whether a more appropriate objective (with corresponding criteria and indicators) would be reclamation targeted to returning pre-development conditions over time, including pre-development vegetation conditions across the disturbance footprint. This would be more consistent with previously stated community desires for returning the site as much as possible to pre-development conditions, while avoiding establishing conditions that would attract wildlife to dangerous areas or facilitate unacceptable contaminant uptake (McCullum J., pers. comm. 2017). Some vegetation communities will take time to re-establish and evolve to pre-development conditions, but that should not preclude efforts to initiate these trajectories. An appropriate criterion for this modified objective would be that vegetation conditions on the mine footprint (e.g., richness, cover) are shown to become more similar to reference conditions over time following closure.

At the November 20-21, 2017 WLWB workshop, participants discussed re-vegetation plans and targets. DDMI's current plans envision that re-vegetation efforts will be limited to relatively small portions of the site, primarily processing plant areas and roads. DDMI proposes establishment of landscape conditions in many areas that would discourage wildlife by retaining barren areas (e.g., Processed Kimberlite Containment Facility, fuel storage areas). However, DDMI acknowledges that vegetation will likely colonize many areas of the site over long periods of time.

Rationales provided for the limited re-vegetation effort include: (1) views and preferences expressed by the Traditional Knowledge Panel, (2) potential increased infiltration of precipitation into mine wastes due to trapping of snow and precipitation on vegetation, and (3) potential uptake of contaminants.

In many cases, vegetation growing on covers and waste materials can decrease the amount of infiltration. It can also change the energy balance in waste materials. In the absence of modelling, it is difficult to predict what impacts vegetation may have on the performance of closed waste management facilities. *Modelling the Critical Interactions between Cover Systems and Vegetation, MEND Report 2.21.6* (O'Kane Consultant Inc., March 2014) discusses the uncertainties about relationships between cover performance and vegetation and highlights the importance of site-specific modelling to understand expected performance.

With respect to contaminant uptake, DDMI stated at the workshop that it has information about uptake in plants growing directly on processed kimberlite. However, it has not investigated uptake of contaminants from other materials, and has not addressed the risks associated with any contaminant uptake. Vegetation on mine waste facilities closed in accordance with well-designed closure plans usually does not present unacceptable risks to wildlife or humans: as stated in *Cold Regions Cover System Design Technical Guidance Document, MEND Report 1.61.5c* (O'Kane Consultants Inc., July 2012), "When designed properly, vegetation established on covered waste deposits will have low contaminant uptake."

Overall, a more effective definition of acceptable post-closure re-vegetation expectations seems warranted. The current objective that requires re-vegetation of priority areas, with no definition of priorities, does not seem consistent with my understanding of community expectations for site reclamation. At the very least, some effective process should be defined for how the priorities for re-vegetation will be established.

6.0 Conformance with Design

For several objectives, DDMI proposes a single criterion for evaluating success of the closure and reclamation activities: that the "*as-built conforms adequately with approved design*." DDMI suggests in Section 5.2.2 of the CRP V4.0 that other parties can review the design which provides an opportunity for "*reviewers to confirm the acceptability of the design, including the acceptability of how well the design aligns with objectives*."

Unfortunately, the designs do not necessarily provide information to conclude that all of the objectives have been considered in developing the design, or for reviewers to evaluate the extent to which the objectives will be achieved if the design is implemented as proposed. Also, even if the design is implemented as proposed, final performance may be different than what is predicted in the design.

The criterion as stated is process-based or procedural rather than being performance-based – it is designed to assess whether an approved design has been implemented, rather than to assess whether the performance stated by or implied by specific objectives have been achieved by the constructed design. In some cases, process-based criteria may be appropriate, but in many cases they are not.

The primary function of closure criteria is to evaluate whether the closure activities are complete and have achieved the closure objectives. For mine closure projects, measuring performance is generally not a one-time event – i.e., confirming that things were built in accordance with the design. Even once closure activities are complete, performance is not guaranteed. Some components require time to develop (e.g., re-vegetation) or reach an equilibrium (e.g., frozen cover), and others have uncertainty for long-term performance (e.g., water quality conditions). As a result, it will likely be several years after completion of closure activities before an initial evaluation of some closure criteria will be possible. For others, continued evaluation will be needed over time.

Where evaluation over time is required, for example for water quality and physical stability, there will never be certainty that the closure criteria have been achieved. Instead, continued satisfactory performance over time will provide increasing confidence that the closure landscape and system will continue to provide such satisfactory performance. The ongoing evaluation of performance may also identify areas of uncertainty, but hopefully the range of uncertainty will narrow as the extent and duration of experience increases. Any agreement that the closure outcomes have achieved closure criteria and objectives will have to address outstanding uncertainty, even if there are clear, objective criteria for measuring success.

In Section 5.2.2 of the CRP V4.0, DDMI argues that design criteria and closure criteria are different. While they can be different, it is often reasonable that both design criteria and closure criteria are focused on the same key indicators of performance. In some cases, the thresholds of acceptable performance may be similar or the same, and in other cases they may be different. However, it is not unreasonable to expect that closure criteria include key indicators and thresholds that would: (1) define the specific performance outcomes that are considered acceptable for the closure project, and (2) allow future reviewers to clearly interpret whether the expected, acceptable conditions have been reached. In the absence of establishing clear, measurable criteria beyond compliance with a design, the achievement of the objective is assigned to current and future designers. In my view, these designers should be guided by established criteria that reflect the communities' expectations for closure performance, rather than designers being left to interpret what will meet community expectations. These criteria would be addressed by designers in combination with other factors (e.g., best practice, professional requirements, industry guidance) when preparing a

design. DDMI's proposes that evaluation of performance can be addressed in inspection reports and a reclamation completion report. This makes sense, but clear, measurable criteria with appropriate thresholds would provide future reviewers with a good understanding of what factors to evaluate when conducting inspections and preparing reports.

DDMI argues that some of the criteria may be narrative. This is also not unreasonable, provided that the narrative criteria are focused on relevant indicators and measures. Simple compliance with a design does not define an acceptable outcome – unless the design itself sets clear post-construction performance indicators and thresholds. As stated in the June 2016 SEC review of closure criteria:

> *"While construction of facilities in compliance with designs is important, it is only one aspect in a series of actions that will lead to achievement of objectives. Design of mine closure has many uncertainties and compliance with the design does not guarantee satisfactory performance. Criteria should be developed that address the specific types of performance that are desired. Based on these criteria, it will be possible to develop appropriate methods to evaluate whether they have been achieved immediately following construction and that they continue to be achieved throughout the closure and post-closure phases. A final inspection by an engineer is not a criterion, but part of a monitoring program. It offers a one-time characterization of performance, but should be recognized as one part of a monitoring program that will need to evaluate actual performance over time."*

7.0 Long-term Monitoring and Maintenance

Appendix VI describes DDMI's proposed post-closure monitoring and reporting. DDMI has assumed that monitoring will continue until 2032, approximately 5 years after major closure implementation work is complete. This assumption appears to be based primarily on physical performance of the facilities, but does not necessarily consider broader environmental performance.

Monitoring programs should continue until facilities demonstrate stable (i.e., not trending or erratic) performance (both chemical and physical) over a reasonable time period. The period should be long enough to substantially reduce uncertainty about long-term performance. If facilities must achieve critical performance outcomes permanently (e.g., dams) then monitoring and maintenance requirements are also permanent.

For Diavik, the key performance outcomes that require long-term consideration are related to physical stability, cover integrity (e.g., thermal performance) and water quality.

- The PKC Facility will be permanently contained by dams. These will likely require permanent monitoring and periodic maintenance to ensure their permanent performance.
- The key performance outcome (limiting water movement through Type III rock) of the thermal cover proposed for the NCRP relies on permanently frozen conditions in the till

layer and the Type III rock. Stable thermal conditions will take many years to develop, and will be subject to changing long-term climate conditions. Understanding performance will require long-term monitoring of the cover. Monitoring of seepage quality will not provide timely results that would provide for effective response to unacceptable performance.

- Potential migration of contaminants from mine components into water is a primary driver for the closure plan. The release of contaminants can be a slow process due to the time for oxidation reactions to happen, consumption of neutralizing materials, and contaminant transport. Water quality conditions could take many years to stabilize, and they could also change after many years of stable conditions. Water quality monitoring for all mine waste storage facilities will be required for at least several decades until conditions are stable and there is a good understanding of expected long-term water quality outcomes.

In addition to these long-term monitoring needs, medium term monitoring of more than 5 years is also likely warranted for sediment quality (specifically in the North Inlet), re-vegetation success and possibly dust (i.e., long enough to demonstrate return to ambient conditions).

The evaluation of whether closure criteria have been achieved will, of necessity, be tied to the monitoring programs. Given the current monitoring proposal, and discussions at the November 20-21, 2017 workshop, it is my understanding that DDMI hopes to demonstrate by 2032 that it has achieved closure criteria and objectives. This seems unrealistic in the face of the uncertainty associated with some criteria and objectives.

For some objectives/criteria (e.g., SW7 – Areas in and around the site that are undisturbed during operation of the mine should remain undisturbed during and after closure), achievement can be measured immediately after completion of activities. For others, successful achievement can only be measured after some demonstrated performance over a period of time (e.g., SW11 – Mine areas are physically stable and safe for use by people and wildlife). Finally, for some objectives/criteria, the best possible outcome is a reduction of the level of uncertainty with respect to our understanding of achievement.

To address these differences in the level of certainty about achievement of objectives and criteria, the definitions of criteria should address expected timing for achievement.

8.0 Site-Specific Risk-Based Closure Criteria

DDMI provided revised Site-Specific Risk-Based Closure Criteria (SSRBCC) Reports (Phase 1 and Phase 2) prepared by ERM as Appendices X-8.1 and X-8.2 in September 2017. Some specific comments about the recommended SSRBCC as they relate to closure objectives are provided in Table 2. In addition, there are some additional comments provided below that are not specifically related to individual closure objectives.

1. In response to comments provided about the initial SSRBCC reports and associated proposed numerical closure criteria, DDMI has chosen not to apply the results of the

updated SSRBCC reports for establishing criteria for water quality for the protection of aquatic life. Instead, the proposed closure criteria are calculated on the basis of the Aquatic Effects Benchmarks. See comments in Section 2.0 of this memo for details.

2. It would be beneficial to understand whether changes are needed in CRP V4.0 to address the revised SSRBCC Reports, or if the changes are already incorporated.
3. The calculation of SSRBCC is based on "Protection Goals" that define what ecological or human effects would be acceptable. With the exception of listed species (e.g., threatened, endangered or special concern), the ecological SSRBCCs define goals that focus on effects on populations, communities and ecosystems. For listed species and humans, the goals focus on effects on individuals. These goals can result in SSRBCC for most ecological receptors that are not necessarily protective of all individuals within a species. As ERM states in Section 2.2 of the Phase 2 Report, "*there is an understanding that low level effects may be tolerated by a proportion of individuals in populations and communities without causing significant change in the population or community effect metrics*."

   In part, ERM appears to use the Protection Goal as a rationale for relying on toxicity tests with more severe endpoints, for example lethal toxicity testing or effects tests affecting high proportions of the test population, when establishing SSRBCC. Section 2.2 of the Phase 2 Report states, "*The EC_{50} and LC_{50} toxicity thresholds applied in the SSRBCC derivations are not expected to produce population or community level effects (e.g., abundance) in the receptor groups where they were applied*." It appears that reliance on such toxicity thresholds could result in SSRBCCs that are not adequately protective. Additional rationale should be provided for this conclusion. In some cases, ERM applies an uncertainty factor to these types of toxicity tests, but it is not clear that this is always the case.

   For example, the June 2016 *Review Response to EMAB-72* provides a response with respect to reliance on an EC_{50} for establishing an aquatic benchmark for arsenic. The toxicity test found growth inhibition (50% less growth compared with control, based on chlorophyll a) for an aquatic plant, but ERM argues that this is not expected to produce community-level effects, referring specifically to abundance. It is unclear how a change causing reduced growth of 50% would not result in a community-level effect.

4. Table 3.2-1 lists the recommended SSRBCCs for water. The table combines criteria derived for (1) protection of aquatic life, with those aimed at (2) providing water that is safe (i.e., drinking) for wildlife, birds and humans. These two types of criteria may not both apply at all locations (e.g., drinking water criteria will likely apply to locations on site, while aquatic life criteria may not). As a result, it is important to identify separate criteria for both purposes. Where both types of criteria apply (e.g., in receiving water), then the most stringent criterion would apply for each contaminant. Table 3 in this memo lists the most stringent SSRBCC calculated for safety of water for wildlife, birds and humans.
5. The proposed SSRBCC for mercury in water (Table 3.2-1) is 0.000084 mg/L, significantly higher than the Aquatic Effects Benchmark of 0.000026 mg/L. The table indicates that the

proposed SSRBCC is based on information from toxicity studies for zooplankton. Studies used for establishing aquatic SSRBCC for the aquatic ecosystem are provided in an Excel spreadsheet as Appendix H to the Phase 2 Report. However, it is not clear which study forms the basis for the proposed criterion. Overall, it would be useful if there were improved transparency about which specific studies are used to define the criteria.

6. The proposed SSRBCC for potassium in water is 440 mg/L and Table 3.2-1 in the Phase 2 Report indicates that this is based on a toxicity study for zooplankton. Appendix H only cites one toxicity study for zooplankton/potassium, a LC_{50} test with a mean effect concentration of 30.1 mg/L. Some additional rationale for the proposed SSRBCC is needed.
7. The proposed SSRBCC for zinc in water is 0.088 mg/L and Table 3.2-1 in the Phase 2 Report indicates that this is based on a toxicity study for fish. Table G-1 in Appendix G of the same report identifies a Toxicity Reference Value of 0.328 mg/L for zooplankton. It is not clear what the source of the zooplankton value is. Appendix H lists studies for toxicity of zinc for zooplankton, but all are lethal toxicity tests and all show concentrations much lower than 0.328 mg/L, and also lower than 0.088 mg/L. Lethal effects at lower concentrations suggests that the proposed SSRBCC will not be protective of the aquatic ecosystem.
8. The approach taken for identification of contaminants of potential concern (COPCs) results in a narrow definition that may have implications on the SSRBCC. ERM defines COPCs as those parameters that exceed both environmental quality guidelines (e.g., CCME) and baseline concentrations. While this is a reasonable definition for the purposes of identifying which parameters may require SSRBCC (i.e., ones that exceed guidelines), it does not actually identify all parameters that may have increased environmental loading as a result of mine activities. The definition excludes those parameters where the mine causes loading, but does not (or is not predicted to) cause exceedance of guideline values.

   The SSRBCC Reports state that generic guidelines will apply for parameters that do not have SSRBCC: also a reasonable approach. However, the SSRBCC Reports are not transparent about which parameters show elevated concentrations in comparison to baseline conditions. As a result, it is not clear what parameters should have criteria established in addition to those with SSRBCC.

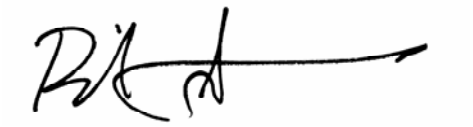
   A further implication of the narrow definition of COPCs is apparent in the calculations of SSRBCC. The calculations assume that the mine does not add additional contaminant dose or load from any component where a contaminant is not specifically identified as a COPC. For example, the calculation of SSRBCCs for metals (other than mercury) for humans, peregrine falcons and bald eagles does not include any mine-related loading from fish because metals were not identified as COPCs for fish. However, the contaminant concentrations in fish may be higher than baseline (we cannot tell because the information is not provided), in which case the source would contribute to receptor doses. An additional dose from fish would reduce the resulting numerical SSRBCC for other sources (e.g., soil, water).

9. Section 2.4.5.2 refers to "project specific drinking water benchmarks" which are cited in Table 2.4-12. It would be useful to understand the source of these benchmarks.
10. The calculation of SSRBCCs for humans does not consider any contaminant sources associated with medicinal plants. ERM argues that there is uncertainty about bioavailability of COPCs in medicinal plants, how the plants are prepared, how much of these plants people use, and how often they use them. Based on these uncertainties, ERM excludes them from consideration.

9.0 Closing

Thank you for the opportunity to continue working with the EMAB on this project. If you have any questions about the findings or recommendations, I would be happy to discuss them with you.

Sincerely,



Bill Slater

Table 2: Closure Criteria – Diavik Diamond Mine Closure and Reclamation Plan, Versions 3.2 and 4.0

Closure Objective	DDMI Version 3.2 Criteria	DDMI 2017 Version 4.0 Criteria	Changes and Recommendations
Site Wide Objectives			
SW1. Surface runoff and seepage water quality that is safe for humans and wildlife.	Human- Table V-7 (in Appendix V in DDMI, 2011) drinking water criteria or site-specific risk-based criteria met. Wildlife – Site-specific risk-based criteria met.	Human – Table V-8 Birds – Table V-9 Wildlife – Table V-10 Or the results of a detailed Risk Assessment.	See comments in Section 3.0 of this memo. Updated SSRBCC reports provided in September 2017. Tables V-8, V-9 and V-10 in Appendix V of the CRP V4.0 re: water quality criteria for humans, birds and wildlife have not been updated to address changes in the SSRBCC reports. In order to meet the objective, I assume that the criteria for humans, birds and wildlife would be applied directly at all locations where humans may access water for drinking. Phase I SSRBCC report assumes this may include water in pits, waste rock seepage and PKC facility pond, as well as water in natural waterbodies (e.g., Lac de Gras). Appendices I, J and K of the Phase 2 SSRBCC report provide proposed SSRBCC respectively for wildlife, birds and humans. I assume that DDMI would apply the lowest concentration identified for each contaminant from the analyses for wildlife, birds and humans, though this is not explicitly stated in the SSRBCC reports. My interpretation of these is provided in Table 3 of this memo. Wildlife (Appendix I): Snowshoe Hare and Common Shrew were added to the species evaluated in the SSRBCC Reports, to address concerns expressed by EMAB's reviewers about consideration of small mammal herbivores and insectivores. The analysis indicates that the Common Shrew is the most sensitive wildlife species with respect to contamination of water. Birds (Appendix J): Proposed numerical criteria have been updated to address errors in previous calculations, but changes are minor. Humans (Appendix K): Proposed criteria for Arsenic, Chromium, Molybdenum and Uranium are the same as Canadian or British Columbia drinking water guidelines. Criteria for Antimony, Manganese, Mercury, Nitrate, Nitrite, Selenium and Sulphate would allow concentrations that exceed drinking water guidelines. DDMI predicts that these concentrations will not harm to humans based on risk calculations. Errors from previous versions appear to have been addressed. Criteria for Manganese and Sulphate are substantially higher than drinking water guidelines (Manganese: 1.3 mg/L vs. 0.05 mg/L, Sulphate: 1,146 mg/L vs. 500 mg/L). These guidelines are aesthetic (e.g., water taste or appearance) and water that has concentrations in the range proposed will be undesirable for drinking regardless of its potential health effects. In many cases, the proposed criteria have been established based on a risk-based approach. As a result, there does not appear to be flexibility to refine criteria further based on an additional risk-based approach.
SW2 Surface runoff and seepage water quality that will not cause adverse effects on aquatic life or water uses in Lac de Gras or the Coppermine River.	Table V-7 water entering LDG criteria or site-specific risk-based criteria met.	Table V-7 Or the results of a detailed Risk Assessment.	Proposed criteria in Version 4.0 are almost all significantly less stringent than those proposed in Version 3.2. Criteria are the same as those proposed in the Final Closure Plan for the NCRP. The development of criteria for the NCRP relies on back calculation and assumptions about flow rates and dilution. These calculations are only relevant for the NCRP and do not consider flow rates and dilution from other locations, or combined locations. Detailed water quality predictions for all mine components for post-closure conditions are needed, along with modelling of dilution in LDG. See Section 2.0 of memo. The SSRBCC Reports include updates of SSRBCC for aquatic life, but DDMI has not provided any information about how or if these will be used for addressing the closure objective. CRP V4.0 indicates that aquatic effects benchmarks will be used instead of the SSRBCC. Clarification about the role, if any, of these SSRBCC would be useful.
SW3. Dust levels safe for people, vegetation, aquatic life, and wildlife.	Mean TSP concentrations less than 60 *u*g/m^3 annual and 120 *u*g/m^3 24 hr maximum acceptable (Canadian Ambient Air Quality Objectives and NWT Ambient Air Quality Standards).	Mean TSP concentrations less than 60 ug/m^3 annual and 120 ug/m^3 24 hr maximum acceptable (Canadian Ambient Air Quality Objectives and NWT Ambient Air Quality Standards) or site specific risk-based criteria met.	Criteria should focus on post-closure concentrations of dust within and around the mine footprint. Criteria specified in the Canadian Air Quality Standards are health-based air quality objectives and address the objective with respect to safety for humans, but do not address the aquatic life or wildlife components of the objective. DDMI has added "or results of a detailed Risk Assessment". The assumption is that this pertains to vegetation, aquatic life, and wildlife, as the cited air-quality objectives/standards are applicable to human health. We believe that measured return to pre-mine/reference conditions is an approach preferable to reliance on risk assessment, but if DDMI prefers a risk-based approach then the criterion should be based on detailed risk assessment for agreed-on vegetation, aquatic-life, and wildlife species. While this approach may allow for future development of criteria that can be measured and verified independently, currently the criterion as stated does not supply sufficient detail to support this process, and thus cannot be used to evaluate achievement of the objective. Criteria for PM2.5 added because it is relevant for human health. Criterion is taken from the Canadian Ambient Air Quality Standards as adopted in the NWT Ambient Air Quality Standards. Our preferred approach is that the following criteria should apply.

Table 2: Closure Criteria – Diavik Diamond Mine Closure and Reclamation Plan, Versions 3.2 and 4.0

Closure Objective	DDMI Version 3.2 Criteria	DDMI 2017 Version 4.0 Criteria	Changes and Recommendations
			1. Total Suspended Particulate (TSP) • 24-hr average: 120 µg/m^3 • Annual mean: 60 µg/m^3 2. Fine Particulate Matter ($PM_{2.5}$) • 24-hr average: 28 µg/m^3 • Annual mean: 10 µg/m^3 3. Return dust concentrations in the mine footprint and surrounding area to levels that are not significantly different from concentrations in relevant reference areas.
SW4. Dust levels do not affect palatability of vegetation to wildlife.	Monitoring evidence of post-closure wildlife use of area.	Monitoring evidence of post-closure wildlife use of area.	See comments in Section 4.0 of this memo. No change in the proposed criterion. The criterion as stated lacks any stated threshold for testing whether the criterion has been successfully met, and thus cannot be applied. In addition, as stated the criterion implies that any evidence of post-closure use by wildlife would be sufficient to demonstrate successful achievement of the objective. Criteria associated with objective SW4 should be focused on two different factors, noting that caribou are a focal receptor: 1. Measurements of post-closure deposition of fugitive dust. This is already proposed in association with objective SW3. For objective SW4 thresholds for the criterion should be based on reference conditions (pre-mine levels or measurements from outside the fugitive-dust footprint). The expectation would be a return to levels equivalent to pre-mining within a certain period from closure, with regular monitoring and reporting on observed trends. Although Golder (2013) report declining dust levels from dustfall monitoring, they also state that dust levels are still five times higher than reference values. Another indicator for this criterion could be concentrations of elements of interest in lichen tissues within the mine's zone of influence. Golder report: 1) an observation by Elders from the Tłı̨chǫ and Łutsel K'e communities that lichens adjacent to the mine (near-field sampling locations) are of poorer forage quality for caribou than those in far-field sampling locations, which they attribute to dust deposition; 2) an observation by Elders that caribou use of the near-field sites is absent or reduced compared to pre-development conditions; and 3) significantly higher element concentrations in near-field lichen samples as compared to far-field samples (for aluminum, antimony, bismuth, cadmium, chromium, cobalt, copper, lead, molybdenum, nickel, strontium, thallium, uranium, and vanadium). Sampling at three-year intervals should be continued, and the criterion should be a return to concentrations in the majority of the above listed elements for near-field samples that are not significantly higher than those in far-field samples, using the current sampling design. 2. Assessment of post-closure habitat use. Current and historic work at Diavik has used a zone-of-influence (ZOI) approach, where a reduction of use is documented by wildlife species in a defined area around the operating mine site. DDMI indicates that this ZOI exists primarily due to sensory disturbances such as noise and odours that will cease following closure (e.g. the NCRP Final Closure Plan V1.0, p. 66). Therefore a criterion for wildlife use, including avoidance of use due to dust deposition, could be based on the ZOI decreasing to a stated area over a stated post-closure timeframe. Additional work would be required to develop this criterion and its associated indicators and thresholds. The ZOI approach will not be causally linked to individual factors such as vegetation palatability, but will be required to assess overall use/avoidance of the site by wildlife. Note that in the event that post-closure monitoring indicates the need for mitigation with respect to this objective, it may be relatively easy to implement additional dust-control measures, but effects of dust deposition during operations and closure, if present, may persist for some time following implementation of such mitigation.
SW5. Re-vegetation targeted to priority areas.	• Final re-vegetation procedures applied to priority areas as established with communities and approved by WLWB. • Change in biodiversity (richness and diversity units) of Regional Study Area less than 1%.	• Final re-vegetation procedures applied to priority areas as established with communities and approved by WLWB. • Change in biodiversity (richness and diversity units) of Regional Study Area less than 1%.	No change in proposed criteria. As described in Section 5.0 of this memo, the objective appears to warrant further discussion and potentially revision. If the objective remains unchanged, the first criterion is a "milestone" or process-based criterion, and could be acceptable if agreed to by all parties – it simply states that DDMI will revegetate areas as mutually agreed. At this point, DDMI has proposed re-vegetation only for infrastructure areas, setting this as the priority (Table 5-8 of CRP V4.0), but there is no clear rationale for why this is the priority, or why this limited area of re-vegetation is sufficient. The second criterion still appears to lack any meaningful application. If the Regional Study Area is 1,400,000 ha, then the mine would have to be shown to affect ≥14,000 ha for the criterion to not be met. Given that the mine footprint itself is only 1,300 ha, DDMI could conduct no revegetation whatsoever, and no other mitigation activities, and still meet this criterion. This indicates that the proposed criterion is not useful in evaluating successful achievement of the objective. A more meaningful, quantifiable criterion should be developed.

Table 2: Closure Criteria – Diavik Diamond Mine Closure and Reclamation Plan, Versions 3.2 and 4.0

Closure Objective	DDMI Version 3.2 Criteria	DDMI 2017 Version 4.0 Criteria	Changes and Recommendations
SW6. Ground surface designed to drain naturally follow predevelopment drainage patterns.	• Pre-development drainage channels re-established at Ponds 1,2, 3, 4, 5, 7, 10, 11, 12, and 13. • Satisfactory final inspection of drainage construction by a professional engineer.	• Pre-development drainage channels re-established at Ponds 1,2, 3, 4, 5, 7, 10, 11, 12, and 13. • Satisfactory final inspection of drainage construction by a professional engineer.	No change in proposed criteria. The first criterion addresses drainage patterns at ponds, but not for remaining mine facilities. Neither the NCRP Closure Design nor the PKC Facility Revised Closure Concept specifically address the need to re-establish pre-development drainage patterns. • The Design Basis for the North Country Rock Pile Closure Plan (Golder Associates, 2016a) does not acknowledge this objective as a design criterion, and provides no details on drainage design to drain naturally or to follow predevelopment patterns. Based on these facts, objective SW6 is not met by the NRCP design, and the proposed criterion is not appropriate, in that construction to a design that does not consider an objective cannot be taken as evidence that the objective has been met. • The PKC Facility Revised Closure Concept lists objectives that are relevant to closure design, but SW6 is not included. Addressing failures associated with surface-water management will be difficult if they require further re-grading. This will be observable within the first few years during post-construction inspections. Addressing episodic failures that result in post-closure changes in drainage patterns will likely be possible but expensive. These are most likely to occur after flood events. Recommended approach is as follows: 1. DDMI should revise the NCRP design and closure designs for other mine features to explicitly demonstrate how this objective will be incorporated into closure planning. If this work is completed, then conformance of As-Built Reports to designs could constitute Construction Criteria for this objective. 2. In addition, it would be beneficial if the Closure Designs provided performance criteria by which successful achievement of the objective in the actual post-closure environment, rather than simply in the design environment, would be demonstrated. Examples could include monitoring evidence of runoff being restricted to designed runoff structures, and/or erosion not exceeding predicted and acceptable levels. Thresholds for these performance criteria could be incorporated as design bases or criteria.
SW7. Areas in and around the site that are undisturbed during operation of the mine should remain undisturbed during and after closure.	Mine footprint area less than 13 km^2 post-closure. (Footprint is the directly disturbed area as used in the Wildlife Effects Monitoring Program for direct habitat/vegetation loss.)	Mine footprint area less than 13 km^2 post-closure. (Footprint is the directly disturbed area as used in the Wildlife Effects Monitoring Program for direct habitat/vegetation loss.)	No change in criterion. The CRP acknowledges the intention to minimize the increase in footprint as a result of mine closure activities. The design basis for the NCRP Closure Design identifies the need to minimize the NCRP footprint, but the PKC Facility Revised Closure Concept does not identify this objective. There does not appear to be any specific quantification of the extent of additional footprint expected as a result of mine closure activities. DDMI should provide specific measures to support the objective, and base the criterion or criteria on these measures. For example, DDMI should provide a total projected footprint area (ha) for the mine at full build-out, and the closure criterion associated with this objective should be based on a quantified threshold, e.g., during and after closure, the total project footprint will increase by no more than x% or y ha. Designs and As-Built Reports can then be evaluated against this threshold. Proposed thresholds could be based on a maximum additional disturbance which could be used to limit design modification during implementation. This criterion must be addressed in initial design and implementation. Failure to meet the objective cannot be addressed later.
SW8. No increased opportunities for predation of caribou compared to pre-development conditions.	Caribou predation directly attributable to a landscape feature unique to this area does not result in increased overall predation on the herd.	Caribou predation directly attributable to a landscape feature unique to this area does not result in increased overall predation on the herd.	No change in criterion. DDMI should provide additional information to support development of an effective criterion that links directly to the agreed-on objective, including: 1. An analysis of specific opportunities for caribou predation in the pre-development environment, and of how these might be expected to change following closure. 2. A corresponding proposed criterion that includes indicators, measurement methods, and thresholds against which indicators can be tested to demonstrate achievement of the criterion. This analysis will have to be conducted with reference to wildlife-use/ZOI studies, as lack of predation may result from lack of site use, rather than or in addition to from appropriate design. SW8 site-wide closure objective and associated closure criteria as described currently do not have effective indicators that are measurable, do not have identified thresholds, and do not appear to support a timely response.

Table 2: Closure Criteria – Diavik Diamond Mine Closure and Reclamation Plan, Versions 3.2 and 4.0

Closure Objective	DDMI Version 3.2 Criteria	DDMI 2017 Version 4.0 Criteria	Changes and Recommendations
			It should be noted that some closure design elements appear to be potentially contradictory to objective SW8. Specifically, the NCRP Closure Plan proposes to build steep, snow-accumulating areas to provide denning opportunities for a variety of species, including wolves. Design of habitat elements for the primary caribou predator – if effective – may not be compatible with the objective of not increasing predation opportunities on the post-closure landscape.
SW9. Landscape features (topography and vegetation) that match aesthetics and natural conditions of the surrounding natural area.	• Surface of scarified native material (rock or till) • Mine footprint area less than 13 km^2 post-closure • Final re-vegetation procedures applied in priority areas • Change in biodiversity (richness and diversity units) of Regional Study Area less than 1% • No surface visible buildings, equipment or non-local materials	• Surface of scarified native material (rock or till) • Mine footprint area less than 13 km^2 post-closure • Final re-vegetation procedures applied in priority areas • Change in biodiversity (richness and diversity units) of Regional Study Area less than 1% • No surface visible buildings, equipment or non-local materials	See comments in Section 4.0 of this memo. No change in criteria. These criteria are insufficient to evaluate whether the objective has been met, as they do not address the objective in any direct way. In addition, see comments on SW5 and SW7. It is not clear whether DDMI intends to meet this objective with current closure designs. For example, the Final Closure Plan for the North Country Rock Pile (DDMI. 2016b) states (p. 45): *"TK Panel members desire to see the land returned to a state that resembles how it looked prior to development is a primary factor guiding their recommendations. While it is acknowledged that the mine site area will never be the same again, efforts to reclaim an area in a way that resembles natural features is preferred. The Panel recommended using nearby hills as a reference for the material to be used to cover the rock pile. It is not practical to simulate the natural environment on the NCRP. The final design is to use available mine materials and thereby reducing further impacts to the environment during reclamation."* This statement – as well as the Golder 2017 design, which does not acknowledge design for natural appearance – indicates that in fact this objective will not be met for the NCRP. The NCRP Closure Design does not address the aesthetics of the final closed facility, for either topography or vegetation. Section 5.2.1 of the FCP-NCRP makes it clear that re-vegetation is not part of the closure plan for the NCRP. Similarly, Section 2.4 states that "it is not practical to simulate the natural environment on the NCRP." These statements seem to indicate that DDMI does not intend to achieve objective SW9 with the NCRP closure design. Similarly, the closure concept for the PKC Facility does not provide for features that match aesthetics and natural conditions in the surrounding area. In the context of balancing multiple closure criteria and objectives, and addressing other project drivers (e.g., cost), DDMI's conclusions may not be unreasonable. However, the CRP should be explicit in having considered the objective, and the rationale(s) for choosing not to address it. If this approach is what is proposed, then re-consideration of the closure objective may be warranted. If the objective remains relevant, DDMI should propose criteria that actually allow for an evaluation of whether it has been met. Such criteria could consider specifying range of slopes; shapes, sinuosity, and heights of features; types of visible vegetation from important viewscapes; and other aesthetic features, with characteristics on the post-closure mine footprint compared to characteristics of the pre-development and/or reference environment. In the event that the objective cannot be met for some features, but can for others, criteria should be proposed for the instances where the objective will be met. In addition, as noted for Objective SW5, the 4th proposed criterion for Objective SW9 appears to be problematic, as the Regional Study Area is understood to be 1.4 million ha, while the mine disturbance footprint occupies only 1,300 ha. Therefore the criterion has the appearance of stating that the mine could result in a change in richness and biodiversity units of almost 14,000 ha – more than ten times the size of the mine footprint – and still be within target limits. DDMI should be requested to provide more information to support the criterion as stated, or to amend it to specify a more appropriate proportion of the RSA.
SW10. Safe passage and use for caribou and other wildlife.	No repeated harm to caribou as a direct result of passage through or use of the NCRP. (i.e. if a feature of NCRP is confirmed as being a hazard based on more than one incident then objective is not met for that feature/area)	No repeated harm to caribou as a direct result of passage through or use of the NCRP. (i.e. if a feature of NCRP is confirmed as being a hazard based on more than one incident then objective is not met for that feature/area)	No change in criterion. 1. DDMI's proposed criterion appears to be appropriate, but should be linked to an explicit identification of potential hazards to passage and use for caribou and other wildlife, and a detailed plan for assessment and monitoring of these hazards. In addition, an assessment of safe passage and use should be coupled with the analysis of ZOI proposed for objective SW4, which will provide landscape-level data on wildlife use of the post-closure site. 2. The criterion (or criteria) and its (their) attendant indicators should be explicitly linked to adaptive-management responses. The proposed criterion indicates how to assess whether or not the objective has been met for a feature, but not what mitigation will be applied in the event of such an assessment. The design of a monitoring program associated with this objective will require a well-conceived experimental/monitoring methodology and statistical rigor.

Table 2: Closure Criteria – Diavik Diamond Mine Closure and Reclamation Plan, Versions 3.2 and 4.0

Closure Objective	DDMI Version 3.2 Criteria	DDMI 2017 Version 4.0 Criteria	Changes and Recommendations
SW11. Mine areas are physically stable and safe for use by people and wildlife.	Satisfactory final inspection by a professional engineer	Satisfactory final inspection by a professional engineer	See comments in Section 6.0 of this memo. No change in criterion. Criteria should specifically reference the performance of physical stability attributes. The design is intended to achieve physical stability, but its effectiveness is only confirmed by actual performance. Physical stability design criteria (e.g., Factors of Safety, design seismic events) could be used as criteria. Post construction performance criteria should likely be defined, for example slope movement, settlement or erosion rates. Where slopes are expected to develop permafrost, thermal criteria may be warranted. Performance of physical stability is observable, but may change over time. Instrumentation will likely be required for some slopes and facilities. A "final inspection" following construction only provides a one-time observation. Confirmation of performance will require a geotechnical observation program, for which the frequency may diminish over time based on continued satisfactory performance. In most cases, significant changes or failures are likely to occur within the first five years. Provided performance over the initial observational period is consistent with expectations, future failures would likely be a result of climatic or seismic events. Measurement approach in CRP V4.0 refers to "Geotechnical Inspections" suggesting that ongoing inspections may be considered.
Open Pit, Underground and Dike Areas Objectives			
M1. Water quality in the flooded pit and dike area that is similar to Lac de Gras or at a minimum protective of aquatic life.	Table V-7 (in Appendix V in DDMI, 2011) aquatic life and drinking water criteria or site-specific risk-based criteria met.	AEMP Benchmark Or the result of a detailed Risk Assessment.	Applying the AEMP Benchmark as the primary criterion does not achieve the objective. The objective clearly establishes a priority whereby water quality that is similar to that in Lac de Gras is the preferred objective, while reliance on conditions that are protective of aquatic life are established as a minimum objective if conditions similar to reference conditions cannot be reached. The AEMP benchmarks were derived to define water quality that would be protective of aquatic life – not to define water quality in comparison to reference conditions. A criterion that defines expected water quality relative to the reference conditions should be established. The concept of relying on a detailed risk assessment is similar to the approach taken for the SSRBCC and would lead to criteria that define an upper limit beyond which effects would likely occur. Note that Section 5.2.4.3.5 of the CRP V4.0 states that water licence criteria may be used to initiate joining of the pool area in the filled pits to Lac de Gras. This is not consistent with the criteria specified in Appendix V and should be clarified. Re-connecting pits to Lac de Gras when water quality reaches water licence criteria would likely lead to greater effects on Lac de Gras.
M2. Pit and dike closure do not have adverse effects on aquatic life or water uses in Lac de Gras, the Coppermine River or on groundwater use.	Water license discharge criteria (EQC) or site-specific risk-based criteria met.	AEMP Benchmark Or the result of a detailed Risk Assessment.	AEMP Benchmarks are reasonable criteria for defining expected performance for this objective because the objective is focused on protection of water uses. The location for application of the AEMP Benchmarks should be more clearly defined. Will they apply to areas in the refilled pits and immediately adjacent to dikes? If they apply within the pits, at what depths? The concept of relying on a detailed risk assessment is similar to the approach taken for the SSRBCC and would lead to criteria that define an upper limit beyond which effects would likely occur. The SSRBCC Reports include updates of SSRBCC for aquatic life, but DDMI has not provided any information about how or if these will be used for addressing the closure objective. CRP V4.0 indicates that aquatic effects benchmarks will be used instead of the SSRBCC. Clarification about the role, if any, of these SSRBCC would be useful.
M3. Enhanced lake-wide fish habitat to off-set fish habitat temporarily lost during operations.	Ratio of fish habitat units gained to fish habitat units lost of 1.2:1 or better as per Fisheries Authorization.	As-built of fish habitat conforms adequately with designs. Appendix X-1 A154 area Appendix X-2 A418 area Appendix X-3 A21 area	Previous criterion was clear and measurable with an established threshold based on the Fisheries Authorization. The new criteria are defined by conformance with designs. The designs (Appendices X-1 to X-3) do not appear to reference the 1.2:1 ratio of compensation for fish habitat units. However, the calculations presented in the design appear to confirm the fish habitat performance attributes that the designs are intended to achieve. The effectiveness of fish habitat compensation is likely observable through a monitoring program. The designs for fish habitat compensation describe monitoring programs, but these do not include monitoring to confirm effectiveness of the fish habitat – i.e., are fish using the habitat as expected. The monitoring program should be described to support closure criteria.
M4. Safe small craft navigation through dike and pit area.	Breaks in dikes to be a minimum of 30 m wide by 2 m deep as per Transport Canada approval.	Breaks in dikes to be a minimum of 30 m wide by 2 m deep as per Transport Canada approval.	No change in criterion. Criterion appears reasonable.

Table 2: Closure Criteria – Diavik Diamond Mine Closure and Reclamation Plan, Versions 3.2 and 4.0

Closure Objective	DDMI Version 3.2 Criteria	DDMI 2017 Version 4.0 Criteria	Changes and Recommendations
M5. Physically stable pit walls and shorelines to limit risk of a failure impacting people, aquatic life or wildlife.	Satisfactory final inspection by a professional engineer.	Satisfactory final inspection by a professional engineer.	See comments in Section 6.0 of this memo. No change in criterion. Criteria should specifically reference the performance of physical stability attributes. The design is intended to achieve physical stability, but its effectiveness is only confirmed by actual performance. Physical stability design criteria (e.g., Factors of Safety, design seismic events) could be used as criteria. Post construction performance criteria should likely be defined, for example slope movement, settlement or erosion rates. Performance of physical stability is observable, but may change over time. Instrumentation will likely be required for some slopes and facilities. A "final inspection" following construction only provides a one-time observation. Confirmation of performance will require a geotechnical observation program, for which the frequency may diminish over time based on continued satisfactory performance. In most cases, significant changes or failures are likely to occur within the first five years. Provided performance over the initial observational period is consistent with expectations, future failures would likely be a result of climatic or seismic events. Measurement approach in CRP V4.0 refers to "Geotechnical Inspections" suggesting that ongoing inspections may be considered.
M6. Pit fill rate that will not cause adverse effects on water levels in Lac de Gras and Coppermine River.	Water levels in Lac de Gras remain above 415 m elevation to ensure Lac de Gras and Coppermine River remain within natural fluctuations.	Water levels in Lac de Gras remain above 415 m elevation to ensure Lac de Gras and Coppermine River remain within natural fluctuations.	No change in criterion. Water levels in Lac de Gras follow a seasonal pattern with annual minimums occurring in late spring and annual maximums occurring in summer. This pattern should be maintained, to support natural hydrographs in the Coppermine River. While minimum annual water levels of 415 m as proposed by DDMI may fall within the range of natural fluctuation, such levels are not common and this level should be applied with caution, and should only apply during normal low-water seasons. During natural high water seasons, a higher water level should be established as a threshold. The threshold should be aimed to maintain annual high water levels that are no lower than natural minimums for high water conditions.
M7. Pit fill rate that will not cause adverse effects on fish or fish habitat in Lac de Gras and Coppermine River.	Water levels in Lac de Gras remain above 415 m elevation to ensure Lac de Gras and Coppermine River remain within natural fluctuations.	Water levels in Lac de Gras remain above 415 m elevation to ensure Lac de Gras and Coppermine River remain within natural fluctuations.	No change in criterion. Water levels in Lac de Gras follow a seasonal pattern with annual minimums occurring in late spring and annual maximums occurring in summer. This pattern should be maintained, to support natural hydrographs in the Coppermine River. While minimum annual water levels of 415 m as proposed by DDMI may fall within the range of natural fluctuation, such levels are not common and this level should be applied with caution, and should only apply during normal low-water seasons. During natural high water seasons, a higher water level should be established as a threshold. The threshold should be aimed to maintain annual high water levels that are no lower than natural minimums for high water conditions.
M8. Wildlife safe during filling of pits.	No mortalities of wildlife VEC caused by filling of pits.	No mortalities of wildlife VEC caused by filling of pits.	No change in criterion. Criterion appears reasonable. Criterion and monitoring should be applied in conjunction with other wildlife related criteria.
Waste Rock and Till Area Objectives			
W1. Physically stable slopes to limit risk of failure that would impact the safety of people or wildlife			Objective addressed in NCRP Final CRP. Comments provided in June 2017 SEC review of NCRP Final CRP. Also see comments in Section 6.0 of this memo.
W2. Rock and till pile features (shape and appearance) that match aesthetics of the surrounding natural area			Objective addressed in NCRP Final CRP. Comments provided in June 2017 SEC review of NCRP Final CRP. Also see comments in Section 5.0 of this memo.

Table 2: Closure Criteria – Diavik Diamond Mine Closure and Reclamation Plan, Versions 3.2 and 4.0

Closure Objective	DDMI Version 3.2 Criteria	DDMI 2017 Version 4.0 Criteria	Changes and Recommendations
W3. Contaminated soils and waste disposal areas that cannot contaminate land and water			Objective addressed in NCRP Final CRP. Comments provided in June 2017 SEC review of NCRP Final CRP. See comments on chemical criteria, including comments on SSRBCC, under SW1, P1 and NI2.
Processed Kimberlite Containment Area Objectives			
P1. No adverse effects on people, wildlife or vegetation.	Human – Table V-8 criteria or site-specific risk-based criteria met. Wildlife – Site-specific risk-based criteria met.	Table V-8; Table V-9; Table V-10; Table V-11; Or the result of a detailed Risk Assessment.	Objective can be interpreted very broadly, and should likely consider both chemical and physical effects people, wildlife and vegetation. The DDMI criteria are all focused on chemical effects, but potential physical effects may be more relevant for the revised closure concept that includes a pond located on exposed PK. While effects related directly to physical stability are addressed by Objective P2, there are potential physical effects (e.g., entrapment in the pond) that should be considered under Objective P1. The following types of criteria may be worth considering: 1. Grading and Settlement: Grading avoids unplanned creation of ponded water and differential settlement does not result in unplanned ponded water. 2. Erosional Stability: No gullies or significant rills on disposal areas during post-closure phase. Total suspended solids (TSS) < 15 mg/L monthly average in all mine discharges. 3. Dam Stability: Compliance with Dam Safety Guidelines including application for mining dams (Canadian Dam Association) for all dams. 4. Safety and Wildlife Hazards: There is no hazard to human safety or potential for wildlife entrapment in the processed kimberlite containment area. Dust generation may also be relevant, though this can be addressed adequately through the side wide objectives (SW3 and SW4). For comments on DDMI's proposed chemical criteria for water including revisions to the SSRBCC Reports, refer to comments on closure objective SW1. DDMI's proposed SSRBCC for soil are listed in Table 3.1-1 of the Phase 2 SSRBCC Report. These are based on criteria listed respectively in Appendices I, J and K of the same report for wildlife, birds and humans. The criteria are the same as those listed in Table V-11 of the CRP V.4.0, and in the 2016 version of the SSRBCC reports. The proposed criteria for Barium, Manganese and Molybdenum are the same as the CCME Soil Quality Guidelines for Residential/Parkland or Agricultural uses. The proposed criterion for Chromium is slightly higher than the CCME Guideline and is based on potential human intake (toddler). The SSRBCC Phase 1 Report identifies aluminum as a contaminant of potential concern based on the assumption that pH for Type 1 rock (i.e., covers on waste rock and processed kimberlite) is less than 5.5 (Table A-1, Phase 1 Report). However, the Phase 2 Report makes the opposite assumption, that pH of Type 1 rock is 5.5 or greater (Table 1.1-1, Phase 2 Report), and therefore proposes that no aluminum criterion for soil is needed because the CCME guideline only applies for soil with a pH less than 5.5. This seems to be an optimistic assumption because the SSRBCC Phase 2 report cites pH values for Type 1 rock ranging from 3.80 to 9.41 but argues that these numbers support an assumption of neutral pH. In their report on plant uptake of metals from PK (Appendix VIII-1A), researchers from the University of Alberta state: "*The limited association between substrate and plant tissue metal concentrations for the 33 metals analyzed suggest that substrate concentrations are not an effective method for predicting trace metal accumulation in plants.*" This finding indicates that a soil-concentration-based criteria alone are not sufficient for evaluating adverse effects to wildlife consuming vegetation growing in mine-waste materials. In particular, the University of Alberta research found that although Mo concentrations are not higher in processed kimberlite than in reference substrates, plant-tissue Mo concentrations in plants grown in PK were 10 times higher than plant tissues grown in lakebed sediments[1]. The University of Alberta research does not provide data on what these concentrations were, but Mo is an element known to contribute to secondary copper deficiencies in ungulates when found in elevated concentrations. This reinforces the importance of developing criteria based on plant element concentrations as well as soil element concentrations.

[1] National Research Council. 2005. Mineral tolerance of animals, second revised edition. National Academies Press, Washington, DC.

Table 2: Closure Criteria – Diavik Diamond Mine Closure and Reclamation Plan, Versions 3.2 and 4.0

Closure Objective	DDMI Version 3.2 Criteria	DDMI 2017 Version 4.0 Criteria	Changes and Recommendations
P2. Physically stable processed kimberlite containment area to limit risk of a failure that would affect safety of people or wildlife.	Satisfactory final inspection by a professional engineer.	As-built conforms adequately with approved design. Final geotechnical inspection by engineer of record.	See comments in Section 6.0 of this memo. Reference to conformance with the approved design provides some initial criteria to evaluate performance and the addition of this component to the criterion in an improvement. Design criteria specified in the design, and closure criteria are often focused on the same key indicators of performance. In some cases, the thresholds of acceptable performance may be similar or the same, and in other cases they may be different. For clarity, the closure criteria would benefit from identification of key indicators and thresholds because it would allow future reviewers to clearly interpret whether acceptable conditions have been reached, not simply rely on a general conclusion from a geotechnical inspection. Some of the criteria may be narrative, provided that the narrative criteria are focused on relevant indicators and measures. As with several other criteria, the proposed criterion for this objective is process based rather than performance based. The criterion, as proposed, is designed to assess whether an approved design has been implemented, rather than to assess whether the performance stated by or implied by specific objectives have been achieved. Simple compliance with a design does not mean that the outcome is successful – unless the design itself sets clear post-construction performance indicators and thresholds. As stated in the June 2016 SEC review of closure criteria: *"While construction of facilities in compliance with designs is important, it is only one aspect in a series of actions that will lead to achievement of objectives. Design of mine closure has many uncertainties and compliance with the design does not guarantee satisfactory performance. Criteria should be developed that address the specific types of performance that are desired. Based on these criteria, it will be possible to develop appropriate methods to evaluate whether they have been achieved immediately following construction and that they continue to be achieved throughout the closure and post-closure phases. A final inspection by an engineer is not a criterion, but part of a monitoring program. It offers a one-time characterization of performance, but should be recognized as one part of a monitoring program that will need to evaluate actual performance over time."*
P3. Prevent processed kimberlite from entering the surrounding terrestrial and aquatic environments	Erosion protection placed over PK material Filter drain constructed. Satisfactory final inspection of erosion protection and filter drain construction by a professional engineer.	As-built conforms adequately with approved design. Final geotechnical inspection by engineer of record.	Previous criteria described methods rather than performance expectations, but the revised criterion is designed to assess whether an approved design has been constructed, not whether the design is meeting performance expectations. See comments on Objective P2. Criteria that define performance expectation should be developed. Relevant criteria should evaluate performance of the proposed cover for stabilizing PK in place, and potential for mobilization of PK in the pond or PKC facility outflow.
North Inlet Area Objectives			
NI1. Reconnect the North Inlet with Lac de Gras	North Inlet east dam deconstructed to leave a minimum 30 m wide by 2 m depth of water opening.	None	DDMI has proposed that this objective is no longer relevant – that it specifies a closure approach rather than defining a closure objective. As a result, it has not proposed any closure criteria. While the objective can be identified as a closure measure, at the same time, it could also be a closure objective. The reconnection of the North Inlet to Lac de Gras is a preferable long-term outcome and an objective related to this outcome should be retained. If it is decided that the objective as stated is not appropriate, then the interests that drove development of Objective NI1 should be defined in a more appropriate objective developed to address these interests. For example, an objective could express a preferred outcome related to increasing overall fish habitat or providing fish access to the North Inlet. It is my understanding that achievement of the objective is not realistic in the short-term because contaminant concentrations in sediments within the North Inlet may present risks to fish if they were present in the area. However, the contaminant source is primarily from mine dewatering and concentrations could change over time. As a result, an objective related to reconnection of the North Inlet should be retained, while recognizing that it would only be achievable upon establishment of suitable aquatic habitat conditions in the Inlet.

Table 2: Closure Criteria – Diavik Diamond Mine Closure and Reclamation Plan, Versions 3.2 and 4.0

Closure Objective	DDMI Version 3.2 Criteria	DDMI 2017 Version 4.0 Criteria	Changes and Recommendations
NI2. Water quality and sediment quality in the North Inlet that is safe for aquatic life, wildlife and people.	Water and sediment quality that meets site-specific risk-based criteria for water and sediment.	AEMP benchmark for water quality; Table V-12; If sediment quality is within Table V-13 criteria the NI can be rejoined with Lac de Gras; Or the result of a detailed Risk Assessment.	Proposed use of AEMP benchmarks addresses water quality for aquatic life. Locations for application of these benchmarks should be clarified. No criteria are identified for water and sediment quality for protection of people and wildlife. For comments on DDMI's proposed chemical criteria for water including revisions to the SSRBCC Reports, refer to comments on closure objective SW1. Table V-12 provides criteria for sediment quality for birds and Table V-13 provides criteria for sediment quality for protection of aquatic life. Both tables reflect the criteria presented in the updated SSRBCC Reports. For metal contaminants, the SSRBCC for birds are substantially more stringent than those for aquatic life. DDMI has proposed that the less restrictive criteria for aquatic life, which are all equal to the CCME Interim Sediment Quality Guidelines, should apply "*due to the high level of uncertainty in [the] derivation*" of the criteria for birds. This is probably reasonable now that the SSRBCC have been revised to rely on the CCME Interim Sediment Quality Guidelines rather than the CCME Probable Effects Levels. The SSRBCC modelling suggests that these concentrations could lead to some risk of effects on some birds. The objective clearly aims to provide conditions that are safe for aquatic life. This includes sediment conditions that are safe for aquatic life. "If sediment quality is within Table V-13 criteria then NI can be rejoined with Lac de Gras" is not a criterion – but a conditional response. Table V-13 defines conditions for sediment quality that are safe for aquatic life – and these should be specified as criteria. The closure schedule in the CRP V4.0 seems to suggest DDMI will make a decision shortly after cessation of operations about whether to re-connect the NI to Lac de Gras. This decision likely needs to be evaluated over a longer period of time, based on monitoring results for sediment from the NI. Until it is demonstrated that the objective of sediment quality that is safe for aquatic life is not achievable, criteria should be maintained. The criteria and objective can be reconsidered based on monitoring results in the closure and post-closure periods. Regardless of the criteria and actions taken by DDMI, it seems likely that fish may become established in the NI in the very long term.
NI3. Suitable fish habitat in the North Inlet.	Water and sediment quality that meets site-specific risk-based criteria for water and sediment.	AEMP benchmark for water quality; Table V-12; If sediment quality is within Table V-13 criteria the NI can be rejoined with Lac de Gras; Or the result of a detailed Risk Assessment.	See comments on Objective NI2. Also, suitable fish habitat is related to physical, chemical and biological conditions. The proposed criteria only address chemical conditions. Criteria should be defined for physical and biological characteristics, with biological characteristics likely being more important in this case. For example, criteria requiring stable benthic communities that are comparable with reference areas may help to define expected outcomes. Application of criteria for Objective NI3 could be linked to the criteria and outcomes for NI2. Suitability of fish habitat conditions may only be relevant if sediment quality allows re-connection with the lake. See comments on NI2 with respect to criteria for sediment.
NI4. Water quality in the North Inlet that is as similar to Lac de Gras as possible.	Monitoring results indicate that drawing more Lac de Gras water into the North Inlet and treating and releasing more North Inlet water will not significantly improve water quality.	Monitoring results indicate that drawing more Lac de Gras water into the North Inlet and treating and releasing more North Inlet water will not significantly improve water quality.	Closure Objective NI4 is fundamentally a non-degradation objective, with some recognition that complete restoration of the NI to conditions the same as Lac de Gras is unlikely. The DDMI criterion addresses non-degradation to the extent possible. However, more quantifiable criteria are warranted, especially for water quality where conditions can be readily measured. Consider the following criterion: • Water quality that meets criteria for NI2, and is trending towards non-degradation as compared to reference conditions in Lac de Gras. NI water quality should be compared to reference conditions for both central tendency and maximum concentrations. Specific criteria should be defined in a continuous improvement plan for water quality in the NI. The proposed criterion supports the objective by directing activities towards continuous improvement of water quality. As the closure implementation progresses, it may be possible to set specific targets for the scope of acceptable/possible recovery of NI water quality as compared to Lac de Gras.

Table 2: Closure Criteria – Diavik Diamond Mine Closure and Reclamation Plan, Versions 3.2 and 4.0

Closure Objective	DDMI Version 3.2 Criteria	DDMI 2017 Version 4.0 Criteria	Changes and Recommendations
NI5. Water and sediment quality in the North Inlet that will not cause adverse effects on aquatic life or water uses in Lac de Gras or the Coppermine River.	Water and sediment quality that meets site-specific risk-based criteria for water and sediment.	AEMP benchmark for water quality; Or the result of a detailed Risk Assessment.	Proposed use of AEMP benchmarks for water quality provide reasonable thresholds. Locations for application should be clarified. Criteria should be added to address the issue of sediment quality. See comments on NI2 about criteria for sediment quality.
NI6. Physically stable banks of the North Inlet to limit risk of failure that would impact the safety of people or wildlife.	Satisfactory final inspection by a professional engineer.	As-built conforms adequately with approved design. Final geotechnical inspection by engineer of record.	The revised criterion is designed to assess whether an approved design has been constructed, not whether the design is meeting performance expectations. See comments on Objective P2. Criteria that define performance expectation should be developed. Relevant criteria should evaluate slope stability and erosion potential.
Mine Infrastructure Areas Objectives			
I1. Opportunities for communities to re-use infrastructure, allowable under regulation, and where liability is not a significant concern.	Conditions of Socio-Economic Monitoring Agreement and Participation Agreements met.	Conditions of Socio-Economic Monitoring Agreement and Participation Agreements met.	Criteria associated with socio-economic agreements not evaluated.
I2. On-site disposal areas are safe for people, wildlife and vegetation.	CCME contaminated sites guidelines or site-specific risk-based criteria are met.	Table V-7; Table V-8; Table V-9; Table V-10; Table V-11; or the result of a detailed Risk Assessment.	Proposed criteria address chemical safety including water quality for aquatic life (Table V-7), humans (Table V-8), birds (Table V-9) and wildlife (Table V-10) and soil quality (Table V-11). It would be useful to understand where these criteria will apply, especially those for water quality. See comments on chemical criteria, including comments on SSRBCC, under SW1, P1 and NI2. Criteria do not address physical safety of the site. The following criteria would help to evaluate physical performance for this objective: • Grading and Settlement: Grading avoids creation of ponded water and differential settlement does not result in ponded water. • Erosional Stability: No gullies or significant rills on disposal areas during post-closure phase. Total suspended solids (TSS) < 15 mg/L monthly average in all mine discharges. Dust generation may also be relevant, though this can be addressed adequately through the side wide objectives (SW3 and SW4). In their report on plant uptake of metals from PK (Appendix VIII-1A), researchers from the University of Alberta state: "The limited association between substrate and plant tissue metal concentrations for the 33 metals analyzed suggest that substrate concentrations are not an effective method for predicting trace metal accumulation in plants." This finding indicates that a soil-concentration-based criteria alone are not sufficient for evaluating adverse effects to wildlife consuming vegetation growing in mine-waste materials. In particular, the University of Alberta research found that although Mo concentrations are not higher in processed kimberlite than in reference substrates, plant-tissue Mo concentrations in plants grown in PK were 10 times higher than plant tissues grown in lakebed sediments. The University of Alberta research does not provide data on what these concentrations were, but Mo is an element known to contribute to secondary copper deficiencies in ungulates when found in elevated concentrations. This reinforces the importance of developing criteria based on plant element concentrations as well as soil element concentrations.

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Closure Objective	DDMI Version 3.2 Criteria	DDMI 2017 Version 4.0 Criteria	Changes and Recommendations
I3. Prevent remaining infrastructure from contaminating land or water.	CCME contaminated sites guidelines or site-specific risk-based criteria are met.	Table V-7; Table V-8; Table V-9; Table V-10; Table V-11; or the result of a detailed Risk Assessment.	Proposed criteria address potential contamination of water and soil. It would be useful to understand where these criteria will apply, especially those for water quality. Contamination by dust is not addressed, but is likely adequately considered by site-side objectives (SW3 and SW4). In general, Objective I3 should be adequately addressed by appropriate criteria for SW1, SW2 and SW3 which all address chemical contamination issues. See comments on chemical criteria, including comments on SSRBCC, under SW1, P1 and NI2.

Table 3: Water Quality Criteria for Wildlife, Birds and Humans

Parameter	DDMI Criteria[2] (mg/L)	Controlling Receptor	Notes
Antimony	0.0286	Toddler	Revised to address calculation error.
Arsenic	0.01	Human	GCDWQ
Chromium	0.05	Human	GCDWQ
Cobalt	7.78	Semi-palmated Sandpiper	Revised to address calculation error.
Manganese	1.30	Toddler	26 times higher than GCDWQ (0.05 mg/L).
Molybdenum	0.25	Human	BC Drinking Water Quality Guidelines
Nickel	1.98	Common Shrew	Revised to address addition of Common Shrew in analysis
Nitrate	76.3	Toddler	Revised to address calculation error. Assume criterion is for nitrate as nitrate.
Nitrite-N	4.77	Toddler	Revised to consider toddler instead of adult, which is more conservative. Assume criterion is for nitrite as nitrite.
Selenium	0.0591	Toddler	Revised to apply SSRBCC instead of GCDWQ (0.05 mg/L).
Sulphate	1,146	Adult	Revised to apply SSRBCC instead of GCDWQ (500 mg/L). Note that the SSRBCC for adults is lower than that for Toddlers, which is not intuitive. Rationale is provided in Section 1.5.13 of Appendix G in the Phase 2 Report, but remains unclear why toddlers would tolerate greater daily intakes of sulphates than adults on a per unit mass basis. The values should be confirmed for correctness.
Uranium	0.02	Human	GCDWQ

[2] Criteria cited are the lowest SSRBCC for each COPC for any of wildlife, birds or humans, identified in the updated Phase 2 SSRBCC Report, Appendices I, J, and K, (Including notes to tables).