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Cambridge Bay
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Richard Dwyer

Manager of Licensing
Nunavut Water Board
P.O. Box 119
Gjoa Haven, Nunavut
X0B 1J0

October 18th, 2022

Re: Review of Back River Project Primary Pond Engineering Design Report.

Dear Richard Dwyer, the KIA's geotechnical engineering consultant, BGC Engineering Inc., has reviewed Sabina's Back River Project Primary Pond Engineering Design Report. The following is our consultant's summary of his review which also contains sixteen (16) specific comments and recommendation on the Primary Pond Design.

Dam Design Summary

This section has been summarized from the Design Report provided.

The Back River Project property is located in an area of continuous permafrost with scattered occurrences of high salinity pore water. The Primary Pond is located in an area with an existing small pond.

The Primary Pond is designed as a water-retaining structure with an active water pond for the duration of mine operations. In the initial years of pre-development and mine operations, it will be used as to assist with lake dewatering and the stored water will be used to assist with the initial mill start up. Water retention is provided by the Primary Pond Dam, which is designed as a zoned rockfill embankment with an HDPE geomembrane liner that is tied into a frozen foundation (overburden and bedrock permafrost) as the primary (and only) barrier to seepage. The dam is approximately 900 m long and has a maximum height of 9.0 m. At maximum capacity, the pond covers an area of approximately 25 ha.

The Primary Pond Dam has been classified as having a "High" hazard, as elected by Sabina, because of the potential for the sudden discharge of non-compliant water quality at the time of the breach that may impact fish habitat.

Stability and thermal design criteria were described for the dam.

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The facility includes an emergency overflow channel (emergency spillway) that is designed to convey the Inflow Design Flood and has been sited to be constructed in bedrock.

The facility has a design life of approximately twenty years and is proposed to be breached at closure.

BGC Geotechnical Review

Overall, BGC considers the proposed dam design concept reasonable, but as it relies on a geomembrane liner system as its barrier to seepage, it is critical that the drawings and technical specifications clearly describe how it can be installed without damage during liner installation and fill cover. In addition, details of the engineering assessments that were conducted to support the design were not presented, clarification is requested for some design aspects, and some key technical specifications were missing. These points are summarized in **Table 1** below.

It is further expected that as a dam that is classified as having a "High" hazard, the facility is expected to be routinely inspected and monitored throughout operations. This would include both the dam structure and associated spillway. Performance monitoring details are expected in an Operations, Maintenance, and Surveillance (OMS) Plan that should be prepared after construction.

Table 1 enclosed:

Thank you

John Roesch

John Roesch, P.Eng.

Senior Hope Bay Project Officer
Kitikmeot Inuit Association, Department of Lands and Environment

Cc Wynter Kuliktana, Acting Director, KIA, Department of Lands and Environment

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Table 1. Summary of BGC's comments and recommendations on the Primary Pond - Goose Site, Design Report and Drawings.

ID No.	Comments	Recommendation / Request
1	Although stability design criteria have been described, and the document states that the minimum design factors of safety have been achieved or exceeded, details of the stability analyses were not presented or referenced. The design includes an HDPE geomembrane liner sandwiched between two layers of non-woven geotextile, which will have a low interface shear strength. It is unclear whether the stability analyses considered a potential failure surface along this interface, during both construction and operations.	Sabina to provide details on the stability assessment completed, to support that the design minimum factors of safety reported have been achieved.
2	Although a thermal design criteria has been described, and was stated to have been considered and achieved, no thermal assessment was presented or referenced. Further, the presence of the enlarged pond may result in the development of a talik within the flooded area. The extent of a potential talik has, based on the information available, not been evaluated.	Sabina to provide details on the geothermal analysis completed, demonstrating that thermal design criteria have been achieved.
3	Climate conditions shown in Table 2 of the design report, which are the 1981 – 2010 Climate Normals, are outdated and should not be used for design. According to the design report, Sabina has used updated design values that include climate change. However, details are not provided in the design report for the Goose Site Primary Pond. The document refers to SRK 2021 (Updated Feasibility Study – Hydrology Update. Draft memo prepared for Sabina Gold & Silver Corp. Project No. 1CS020.020. Last updated July 2021), which has not been reviewed by BGC. Considering that the design of the dam is based on climate data, including these values in the design report would be helpful. For example, climate change projection scenario and year that was used for the IDF peak flow provided in Section 2.7 are unknown.	Sabina to provide details on the climate design parameters, including climate change scenarios used and the year for which the annual probability was evaluated, i.e., the 1 in 100-year and 1 in 1000-year events, respectively.
4	BGC agrees with the recommendation regarding the timing of the excavation of the key trench stated in Section 2.6. This recommendation should be explicitly stated in the Technical Specifications (Appendix B of the design report).	Sabina to update the technical specification and indicate winter criteria stated in Section 2.6 of the design report.

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5	The design report, drawings and technical specifications use different terms when describing ground ice. For example, the term “massive ice” is used in drawings to specify excavation requirements, but the foundation preparation section (6.2.3 – 1) does not make any reference to ice or frozen soil, but just states that “Contractor shall prepare an acceptable foundation surface to receive the specified fill material. An acceptable foundation surface is a surface which is clean, sound and firm, and which does not contain any loose, softened or disturbed foundation material as determined by the Engineer.” Further, in the construction material specification the criteria states that no “snow and ice” should be in the construction material (5.1.2 – 2). Later, under the transition material, the specification indicate that the material should be free of “frozen soil, snow and ice” (5.2.4 – 1). Finally, under fill placement, the specifications indicate that the fill should be “free of stratifications, ice chunks, lenses or pockets, …”. The different terms and specifications used in the design report, the drawings and the technical specifications may be confusing and could result in inconsistency during site preparation and construction.	Sabina to review the language regarding ground ice in the drawings and technical specifications, and clearly specify criteria, e.g., acceptable volumetric ice content, for foundation and construction material to be placed.
6	Drawing UM-PP-200 refers to “hypersaline soil” being an unsuitable foundation material, but it is not defined in the technical specifications, nor are quality control/quality assurance (QC/QA) specifications presented to assess the presence of saline soil during foundation preparation.	Sabina to update the technical specification by defining hyper-salinity and provide details on the QC/QA process for foundation preparation with respect to salinity.
7	The drawings describe percolation testing to be completed at specified locations, but the technical specifications do not describe when they are to be completed relative to the overall construction schedule, how the test results are intended to inform construction and specifically, foundation approval, and how the test holes are to be decommissioned.	Sabina to provide details in the technical specifications on the percolation testing procedure, how the results inform foundation approval, and how the percolation test holes will be decommissioned after testing.
8	The drawings include HDPE geomembrane liner and non-woven geotextile, and some construction details for liner installation are presented as notes to Drawing UM-PP-201. However, the material, installation, and QC/QA specifications for the geosynthetic products have not been included with the technical specifications.	Sabina to include sections on the material, installation and QC/QA process for the HDPE geomembrane liner and the non-woven geotextile in the technical specifications.
9	The drawings include “bedding” as a fill material type, but the material and placement specifications have not been included in the technical specifications.	Sabina to include details on the bedding material and placement procedures in the technical specifications.
10	The drawings show the liner system being covered with 0.3 m thickness of bedding material, but Note 6 in Drawing UM- PP-206 states that “a minimum thickness of 600 mm is required to be placed over any area where heavy equipment will be trafficking over the liner”. The technical specifications provide no guidance for how the bedding cover can be placed without inducing shear stresses that could damage the liner system.	Sabina to clarify in the technical specifications how the bedding material is to be placed over the liner system.
11	The technical specifications for riprap are based primarily on particle gradation. Material specifications for durability are not included in the technical specification.	Sabina to provide additional specifications regarding the durability in the technical specifications.

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12	The drawings do not indicate where riprap may be placed, nor provide any details regarding its use.	Sabina to show the use of riprap in the construction drawings.
13	The spillway is planned to be excavated in bedrock. It is unclear whether the bedrock has been confirmed as non-potentially acid generating (NPAG), and the technical specifications provide no details about whether it will be. The typical spillway section (F) on Drawing UM-PP-301 shows the spillway berms being constructed of run-of-quarry (ROQ) rock that appears to be approximately 0.5 m thick. Section 5.2.3 of the technical specifications specifies that the maximum boulder size of ROQ is 500 mm when the fill thickness is less than 0.85 m.	Sabina to confirm that bedrock at spillway location is to be NPAG. Sabina to clarify that ROQ rock with the proposed specifications are planned to construct the berms.
14	Drawings and technical specifications do not provide details on the temperature monitoring equipment, such as sensor type and accuracy, reading frequencies, data loggers; nor how they should be installed and protected during construction. In addition, the construction drawings do not provide information regarding the location of the terminal boxes for data logger or how the thermistor strings are leading to those boxes.	Sabina to provide details on the thermistor strings and the installation in the technical specifications.
15	No details are provided on the two, ~150 m long horizontal thermistor strings shown in Drawing UM-PP-501 that are placed on the east and the west sections of the dam. It is further noted that no horizontal thermistor string is proposed under the highest section of the dam, i.e., in the middle. The intent of the two horizontal thermistor strings is unclear based on the information provided.	Sabina to provide details on these horizontal thermistor strings including the monitoring objective and rationale for their specific locations, e.g., upstream vs. downstream, and sides vs. centre.
16	Drawing UM-PP-01, Details 07 and 08, describes the use of bentonite or fly ash amended sand fill, but the document does not describe its purpose, and material, preparation (mixing), and placement specifications for the bentonite, fly ash, and sand fill were not described in the technical specifications. Furthermore, material quantities are not listed on Drawing UM-PP-209 with the rest of the construction materials.	Sabina to provide details on the material, preparation, placement, and QC/QA procedures for the bentonite, fly ash, and sand fill in the technical specifications.