April 11, 2023

Kelli Bergh
Vice President, Environment and Permitting
BMC Minerals Ltd.

By Email: kelli.bergh@bmcminerals.com

Re: Quartz Mining License Application, Phase 1 Information Request

Dear Ms. Bergh,

On March 24, 2023, Mineral Resources Branch (MRB) sent BMC Minerals Ltd (BMC) a letter outlining the regulatory process and considerations for the Kudz Ze Kayah project (the "Project") in relation to the quartz mining license application (the "application"). In the table appended to that letter, we indicated that an information request with respect to Phase 1 of the application would be forthcoming shortly.

We have completed our adequacy review of the Waste Rock and Overburden Management Plan and Tailings Management Plan, and have determined that we require additional information to support our complete review of this aspect of the Project. During our February technical discussion, we raised many of our pending questions. I have now provided specific information requested to support your application, attached to this letter.

As a general note, it is anticipated that mining companies use the most recent available guidance material and best management practices when developing a quartz mining license application. This includes territorial, federal, national and international guidance. Specifically for this phase of review for the Kudz Ze Kayah project, the following guidance material are available to support your responses.

- Plan Requirement Guidance for Quartz Mining Projects, Yukon Government and Yukon Water Board, 2013;

- Reclamation and Closure Planning for Quartz Mining Projects, Yukon Government and Yukon Water Board, 2013;
- Guidelines for Developing Adaptive Management Plans in Yukon: Water-related components of quartz Mining projects, Yukon Government 2021;
- Guidelines for Developing Water Quality Objectives and Effluent Quality Standards for Quartz Mining Project, Yukon Government, 2021;
- Guidelines for Mine Waste Management Facilities, Yukon Government, 2023;
- Site Characterisation for Dam Foundations in BC,All APEGBC professional practice guidelines;
- Projected Climate Data and resources for calculating Design Flood Hydrology, Engineers and Geoscientist British Columbia;
- Guidelines for Mine Waste Dump and Stockpile Design, Hawley and Cunning, 2017;
- The 6th Generation seismic hazard model of Canada, Natural Research Council of Canada, 2020;
- Guide on Climate Change Adaptation for the Mining Sector, Mining Association of Canada, 2021;
- A Guide to the Management of Tailings Facilities, Version 3.2, Mining Association of Canada 2021; and
- Developing an Operations, Maintenance, and Surveillance Manual for Tailings and Water Management Facilities, Mining Association of Canada, 2021.
- Climate Atlas for Yukon climate modeling and high-level climate change predictions; and
- Technical Guide: Development, interpretation and use of rainfall intensity-duration-frequency (IDF) information: Guideline for Canadian waster resources practitioners, CSA Group, 2019.

Yukon government has committed to ensuring all critical mine infrastructure is planned, designed and built to withstand current and projected impacts of climate change. This commitment is in Our Clean Future, A Yukon strategy for climate change, energy and a green economy. The Guidelines for Mine Waste Management Facilities outlines Yukon governments expectations with respect to climate change considerations in mine planning and design. We have used this during our review of the application; information requests specific to climate change considerations have been included in this document.

The requests made in the attached information request are pertinent to our ability to complete the review of the application. Once you have taken the time to consider the requests, please confirm your estimated timeline for response.

MRB remains committed to meeting with BMC on a regular basis to discuss both technical matters and process of the application review. Should you have any questions or concerns, I am available at (867) 667-3126 or todd.powell@yukon.ca.

Sincerely,

T. Powell

Todd Powell
Director, Mineral Resources Branch

CC: Allan Nixon, VP External Affairs, BMC Minerals Ltd.
Keith Maguire, Director, Major Projects Yukon
Caleb Light, A/Director, Yukon Water Board Secretariat
Chief Charlie, Liard First Nation
Chief Loblaw, Ross River Dena Council
Chief McCook, Kwadacha Nation
Chief Manygreyhorses, Dease River First Nation

Enclosed: Information Request 1: Tailings and Waste Rock

Information Request 1: Tailings and Waste Rock

For: BMC Minerals Ltd. QML application for the Kudz Ze Kayah Mine

Issued by: Mineral Resources Branch, Yukon government

Date: April 11, 2023

Site characterization

The Site Characterization Plan is completed only as a high-level summary, does not appear to be holistic, and is missing some detailed information, which is necessary to understand the technical details of the site characterization. This includes information on geotechnical soil and rock units, ground temperatures, groundwater levels and laboratory testing data. The site characterization plan does not appear to adequately summarize some regional characterization information like meteorology and the description of the current climate.

Adequate baseline data to characterize the project site is integral to understanding input parameters for risk-based design decisions. Many of the below information requests are based on a comparison with Appendix A and B of the Guidelines for Mine Waste Management Facilities (YG, 2023), which provides guidance for baseline data collection and site characterization. At this stage of project development, targeted site-specific geotechnical and hydrotechnical field investigations should be available to inform design parameters of all mine facilities.

Acid rock drainage and metal leaching potential is of significant concern at mine sites. It dictates design criteria for storage facilities and carries high risk of environmental contamination, particularly to water. Therefore, it is of the utmost concern when assessing and licensing mining projects.

Thorough and accurate site-specific geochemistry characterization is essentially the baseline data equivalent for mining-specific processes, such as water treatment, mineral processing, material extraction and segregation and determining risk of acid rock drainage, metal leaching, and other contamination to the environment. Understanding the geochemistry is directly linked to understanding the constituents of potential concern for the project and what measures will effectively mitigate their potential effects.

BMC is required to provide the following information with respect to the site characterization:

1. Develop and submit a conceptual site model as described by Appendix A of the Guidelines for Mine Waste Management Facilities (Yukon, 2023) and in the Guidelines for Developing Water Quality Objectives and Effluent Quality Standards for Quartz Mining Project (Yukon, 2021). This should include, but is not limited to, the consideration of:
    - **a.** Geology and geochemistry;
    - **b.** Atmospheric environment;
    - **c.** Hydrology;
    - **d.** Hydrogeology;
    - **e.** Aquatic ecosystem;
    - **f.** Climate change; and
    - **g.** Terrestrial ecosystem and resources.

    Rationale: A conceptual site model provides a framework for identifying interactions between the environment and the proposed project and describing pathways for potential effects. The framework can be used to define the questions that baseline monitoring and site characterization programs need to address and identify what information is currently known or not known about the environment and the site. This will delineate any limiting factors and gaps in data for the proponent to address moving forward. It will also be useful to guide subsequent stages of design and to support the identification of potential risks in future risk assessments.

2. Update climate modelling in accordance with updated guidance including the guidelines for mine waste management facilities (Yukon, 2023) and Guide on Climate Change Adaptation for the Mining Sector (MAC, 2021).

    Rationale: The climate modeling presented in the application is not in accordance with updated and acceptable guidance, which is required to inform mine planning and designs.

3. Prepare and submit a geotechnical report for the mine site that includes the details of previous investigations, including detailed borehole logs, laboratory test results, and instrumentation installation details.

    Rationale: The Site Characterization Plan contains baseline geotechnical information but does not provide details on the site investigation conducted, particularly methodology of data collection and how it has been interpreted.

4. Provide a list of all geotechnical instrumentation on site (e.g., ground temperature cables, piezometers, inclinometers, etc.) including a plan showing their locations relative to the mine waste and overburden facilities.

   Rationale: The information provided makes it challenging to determine the location of geotechnical instruments in relation to mine site infrastructure and should be delineated further to create a clearer picture of what is on site.

5. Prepare and submit a site geological model in accordance with EGBC 2016 guidance, *Site Characterization for Dam Foundations in BC*, to a level of detail appropriate to see the extent of different surficial geological, bedrock geological, geotechnical, hydrogeological and seismotechnic conditions within the foundations of the mine waste management facilities. This should include, at least, a soil stratigraphy plan and multiple sections for each mine waste management facility.

   Rationale: A site geological model is to develop a clear 3-dimensional understanding of the foundation for engineered structures and general site conditions. The model should be done for the entire site but is of particular importance for the foundation areas of large engineered structures requiring dams that will remain in perpetuity such as the mine waste management facilities proposed by BMC.

6. Prepare and submit a site-specific site characterization report for each mine waste facility in accordance with EGBC 2016 guidance, *Site Characterization for Dam Foundations in BC*. This should also include instrumentation reports for all geotechnical instruments showing all data collected to date.

   Rationale: BMC has already compiled a lot of this information in their current site characterization report, but it should be updated to include all information recommended by the ECBG 2016 guidance. Specifically missing from the current site characterization report is how the site data was interpreted by the designer, representative geological and hydrogeological plans, and cross-sections showing the extent of site investigation data, geological and geotechnical units and groundwater conditions. The completion of the site-specific characterization reports will support the review of design information and assumption for the mine waste management facilities.

Planning and Design of Mine Waste Management facilities

The proposed Tailings and Waste Rock storage facilities for the KZK mine site are large engineered structures that will exist in perpetuity. As is characteristic of all engineered structures, there is inevitable risk associated with the design, construction, operation and closure. Due to the general and site-specific risks associated with these structures, they require rigorous review and a high level of certainty prior to permitting.

Terms used in this section for level of design are based on the definitions within the Yukon government 2023 Guidelines for Mine Waste Management Facilities (GMWMF). In general, Yukon government expects the design to be conducted to either Feasibility or Preliminary design level for the quartz mining license, dependent on the risk associated with each facility.

It is also expected that updated results from baseline monitoring programs for key dynamic type parameters (water quality, climate, hydrology, etc.) will be incorporated into supporting documents and updated designs for the quartz mining license. It does not appear that any site-specific additional planning studies, such as further site-specific geotechnical characterization programs, and analytical exercises (e.g., advanced water balance and water quality modelling exercises) were completed for the regulatory submission.

The completion of site-specific characterization reports will support the review of design information and assumption for the mine waste management facilities. At this stage of project development, the design parameters should be developed from targeted specific geotechnical and hydrotechnical field investigations.

Generally, the mine layout is restricted due to topography of the area. This has left large engineered structures in close proximity and up/down gradient of each other. For example, any failure of the Class A or B mine waste facilities would pose significant risk to water management structures down gradient and therefore to the environment. The geochemistry (particularly ARD/ML potential) of material contained in each classified facility, stability (foundations controls) of these structures, and site-specific baseline data competency and certainty are crucial to ensure mitigation of risks through design, construction, operation and closure.

7. Use the Guidelines for Mine Waste Management Facilities to:
    a. Classify all mine waste management facilities;
    b. Determine the level of design detail for each facility based on the guides hazard classification; and
    c. Compare the requested design detail in the guide with the submitted design packages to identify gaps that may exist.

Rationale: In order to determine risk and classify facilities according to the GMWMF, site-specific data must be available to delineate input parameters for the engineers to manage performance risk and determine appropriate design levels for each facility.

8. Following the collection and analysis of the required information, the engineered designs for all mine waste management facilities at the Kudz Ze Kayah mine should be updated as appropriate and resubmitted for review.

- **a.** Updated designs must consider YG guidance and updated baseline and site characterization data, studies and reports (see IRs 1, 2, 3, 5, and 6).
- **b.** Provide construction specifics for each facility considering updated designs.

Rationale: The engineered designs submitted by BMC Minerals for the mine waste management facilities are pre-feasibility or feasibility level. The level of design expected for licensing is generally based on the level of risk associated with each facility. Overall, it is expected that the level of confidence in the predicted performance of the facility will be increased for submission to the regulatory phase, but this is not clearly demonstrated in the application submitted.

9. Discuss how artesian conditions and possible effects are being considered and mitigated in the design and placement of mine infrastructure.

Discussion: The information provided in the application does not discuss the potential effect of artesian pressure on mine infrastructure and the proposed mitigations even though artesian conditions are identified beneath the Class B and Class C mine waste facilities and elsewhere on site. This may also be of particular importance for the design of foundation drainage for the Class A facility where foundation drainage is routing groundwater towards an area of potentially artesian pressures.

10. Re-evaluate the foundation drainage system design for applicable mine waste management facilities and advance the design to account for site-specific topography. Including both natural gully and slope features, but also the areas where anticipated excavations of frozen soils are anticipated.

Rationale: The proposed drainage system for the Class A facility consists of two herring-bone pipe arrays to drain an area nearly 1,000 m wide. Successful drainage of the foundation relies upon only two down-slope pipes. Should either of these fail (due to blockage, construction damage) there may be water pressure on the underside of the foundation liner, and leakage into the Strongly Potentially Acid Generating (SPAG)

material. Furthermore, the pipe alignments do not appear to follow the lines of the shallow broad gullies on the slope.

11. Revise the geotechnical parameters after updated baseline and site characterization studies are complete (IRs 1, 2, 3, 5, and 6).

- **a.** Determine geotechnical parameters for permafrost conditions suggested in GMWMF.
- **b.** Determine geotechnical and seismic parameters for soils and bedrock based on field-collected data for the foundation of all engineered mine facilities.

Rationale: At this stage, the design parameters should be developed from targeted specific geotechnical and hydrotechnical field investigations. Furthermore, if permafrost exists beneath the mine waste management facilities, and is not removed to bedrock, then the permafrost must be understood to a significant degree to determine how it will behave under loading. There are several methods that can be use to approximate the strength of permafrost, to determine which method is best in each situation it is necessary to review details of the permafrost such as, the texture of the frozen soil, temperature of the permafrost, lateral and depth of frozen soils, ice-content and type of ice in the frozen soils. This requires more robust, site-specific data and analysis, as suggested by the site characterization studies recommended.

12. Conduct stability analyses on a series of cross-sections for each mine waste management facility. This analysis should include both operations and closure scenarios.

Rationale: The slope stability designs appear to have generalized cross-sections and foundation conditions. It is not evident that the sections analyzed are cross-sections at a specific location or of they are determined to be the critical section and if so, how that section was determined. In general, the analysis of all mine waste management facility slopes is conducted at a Feasibility Design level and needs to be advanced to a Preliminary Design level to provide confidence that the design is mitigating all risks.

13. Revise the Tailings Management Plan to include dedicated compaction equipment to ensure that the tailings and waste rock mixture is adequately compacted.

Rationale: The tailings management plan envisions co-disposal of filter tailings and Class A waste rock. There is little detail provided at this stage on how the co-disposal will function in practice, but is conceptually understood. Since there is a lack of details, BMC

has assumed the lower strength parameters of the tailings to represent the entire co-disposed pile.

However, the tailings disposal plan does rely on the tailings being placed in a compacted state and relies on compaction from haul truck traffic and bulldozers to achieve the compaction. In general, compaction specific equipment, like vibratory rollers, should be employed to ensure that the entire footprint of the tailings and waste rock life is adequately compacted.

14. Provide detail as to how off-specification tailings (both too wet and too dry) will be managed in both sub-freezing and above-freezing conditions.

Rationale: The tailings management plan indicates that moisture conditioning will be used to adjust the tailings moisture content when off-specification tailings are disposed of in the Class A facility. Addition of moisture is relatively easy to ensure that the tailings are within +/- 2% of the optimum moisture content and can be achieved in freezing conditions with some care. However, drying of material that is over the optimum moisture content by 2% will be more difficult. Typically, in this situation the surface of the material is scarified and allowed to dry before compaction, or the material is blended with a drier material to reduce the overall moisture content. Even in above-freezing temperatures this may be difficult to achieve if the haul path is over the off-specification tailings. In sub-freezing temperatures it not likely that enough time will be available to sufficiently dry and compact the tailings before they freeze in place.

15. Provide a dust monitoring, management and mitigation plan for the mine waste management facilities which demonstrates measures to control fugitive dust from the facilities. This plan should include.

- **a.** Monitoring plans for fugitive dust from all facilities, including Class A, B, C, and overburden.
- **b.** Mitigations to control dust from all facilities (Class A, B, C, and overburden) that can be employed if monitoring shows fugitive dust is escaping the facilities.

Rationale: The application is unclear on dust management practices for the mine waste facilities. Considerations for dust management are necessary for filtered tailings and waste rock piles. The tailings management plan acknowledges that dust monitoring is necessary but does not provide any mitigations to help control dust. Dust management is not included in the Class B or Class C facilities planning and designs. Dust can also escape from these facilities during the winter, especially if the surface is windblown and snow free.

Design events

Determining appropriate and risk-based design event scenarios for facility design is a pertinent piece of developing certainty in design and management of facilities. Hydrologic, climatic, and seismic design events are some of the most significant for mine infrastructure and must be conservatively considered for those structures and facilities that will remain in perpetuity.

The guidelines for mine waste management facilities (GMWMF) released by Yukon government in 2023 provide detail as to what design events are acceptable for facilities dependent on their classification and level of risk.

16. Design events should be updated in accordance with the GMWMF, current seismic modeling, current climate models, and industry best practices.

Rationale: It is possible that updates to design events will result in changes to design of mine waste management facilities and water management infrastructure.
The National Building Code of Canada has released their 6th generation seismic hazard model, which provide updated ground motions that are in the order of 20-30% higher than the previous generation model. The newer design values should be applied to all engineered design facilities. It is likely that the Class A and B facilities, in particular, will require higher seismic design events incorporated into their design.
BMC notes, in its Site Characterization Plan, that they used an envelop curve to estimate peak flow discharges for various return periods and compared to peak flows calculated from nearby Water Survey Canada station data. The calculated peaks were then increased by a 15% adjustment factor to account for climate change in accordance with Engineers and Geoscientists B.C. 2018 guidance. This likely underestimates the severity of 24h extreme events over the project life. It may also underestimate the rate of snowmelt in the future, and related changes in freshet timing and intensity. More detailed climate modeling guidance (GMWMF, 2023 and MAC, 2021) is now available and should be applied.

17. A site designation or shear wave velocity of soils and bedrock should be determined for each mine waste management facility based on the specific foundation conditions of each footprint.

Rationale: Both the 6th and 5th generation seismic modeling from National Building Code of Canada require a site designation, based on the shear wave velocity of the site soils to be determined in order to adjust the seismic values for the site conditions. It is not clear

which site designation that BMC used for the site, however, BMC states they have used a 1:2475 design event for all mine waste management facilities.

Covers for closure

The covers proposed for the mine waste management facilities have been incorporated into their design and have been reviewed prior to other closure measures. Although MRB has not completed the review of the Reclamation and Closure Plan, it has been cross referenced with the Tailings Management Plan and Waste Rock Management Plan to review closure measures for these facilities.

18. Develop sequencing for progressive reclamation of the Class A and B facilities to determine if progressive reclamation is in fact possible or practical for the facilities.

Rationale: Progressive reclamation is planned to be conducted at the Class A and B facilities. In areas where progressive reclamation is going to be conducted, it is important to ensure that the facility is constructed or easily regraded to meet its closure geometry during operations. Progressive reclamation of both the Class A and Class B facilities is encouraged, but early design work is necessary in order to ensure the progressive reclamation achieves the closure objectives. One of the key pieces of information that will be necessary to facilitate progressive reclamation is the final closure geometry, including both average and maximum slope as well as frequency and size of benches. This will allow the Class A and Class B facilities to be shaped during operations to their final geometry so that placement of the glacial till soil cover can commence early.

19. Develop design parameters for closure in accordance with closure objectives and the GMWMF.

- **a.** Review design and performance details from 2010 to 2016 for the Grum sulphide cell at the Faro mine and incorporate any lessons learned in to the design of this facility.

Rationale: The final covered slopes on both the Class A and B facilities are steeper than the completed, and very similar, cover on the Grum sulphide cell at Faro. At the Grum sulphide cell, there were both construction and post-construction issues with the slope and stability of the cover. There are a number of publicly available reports at the EMR library from BGC Engineering that will support this review, including cover control

measure from 2011, cover upgrades in 2012, and annual reviews of cover performance from 2013-2016.

20. Review the constructability of the cover system to ensure that the cover can be safely placed over the geomembrane and remain stable.

Rationale: Placement of Class C material over the geomembrane may pose to be difficult since the slopes are long and there may not be enough mid-slope benches. This should be considered in overall design of both the Class A and B facilities.

Risk Assessment and Emergency Management

Risk assessments are required not only to establish what the risks are, but also to put in place suitable risk treatment or management processes. Risk Assessment are conducted early in the mine planning stage and must be updated as a project proceeds through the assessment and regulatory processes. The Guidelines for Mine Waste Management Facilities (GMWMF) define requirements for risk assessments and Appendix E provides additional details about how they should be conducted.

21. Update the FMEA to include input received during assessment and additional information from any new site characterization and design advancement and include interested parties in the workshop for all structures. The FMEA should concentrate on the failure modes associated with the infrastructure that will used during operation and exist in perpetuity, beyond closure. The FMEA should be conducted with active participation and deliberation from regulators and affect First Nations as recommended in the GMWMF.

Items of note from elsewhere in this intervention to note for an updated FMEA:

- **a.** Include failure or blockage of foundation drainage pipes for the mine waste management facilities and design appropriate mitigations for the scenario.
- **b.** Include downslope movement in the piles on the mine waste management facilities and include suggested actions of defensive measures that are in place to mitigate the risk.
- **c.** Include updated climate projections.

Rationale: BMC conducted a qualitative failure modes and effects assessment (FMEA) as a part of their submission. The FMEA was conducted prior to the assessment phase. The FMEA for the Class A facility was updated in 2020 but was based on the 2016 design.

The FMEA and updates included only members of BMC and their design consultants and did not involve local First Nation groups, regulators or other stakeholders.
The FMEA should be undertaken to improve design with respect to improving design robustness, improved performance of long-term infrastructure and minimization of long-term operational maintenance and surveillance. The FMEA should also consider the constructability and long-term performance challenges of the Class A, B and C facilities associated with working in such a steep and narrow valley.