

**Natural Resources Canada's Technical Submission**

**for**

**Gahcho Kué Project, NT**

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**submitted to**

**Mackenzie Valley Environmental Impact Review Board**

**Gahcho Kué Panel**

**October 22, 2012**

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**Non-Technical Summary**

Natural Resources Canada's (NRCan) participation in the environmental impact review of the Gahcho Kué Project is both within the context of our regulatory role under the *Explosives Act*, and in our capacity as a source of science and technology expertise in the fields of minerals and metals and the earth sciences.

De Beers' Gahcho Kué Project proposes explosives manufacturing and storage at the mine site. NRCan has advised the Review Panel that the department may be a regulatory authority and represent a responsible minister for the purposes of the impact review under the *Mackenzie Valley Resources Management Act*.

Key scientific and technical experts from the department have been involved throughout the impact review process. NRCan provided advice on the Environmental Impact Statement (EIS) Terms of Reference, EIS and supplementary information requests with respect to mine waste management (acid rock/mine drainage and metal leaching, environmental hydro-geochemistry and mine reclamation, decommissioning and closure), permafrost, terrain sensitivity, geotechnical science, and bedrock geology.

In this report, NRCan has specific comments on mine waste management (metal leaching), permafrost and terrain conditions and stability of project components such as mine waste management facilities and dykes. Where applicable, NRCan has provided recommendations for the Panel's consideration to assist in the decision making process. Those recommendations are intended to provide guidance on factors that should be considered in detailed and final project design and in subsequent monitoring plans.

## **1. INTRODUCTION**

NRCan has participated in the impact review of the Gahcho Kué Project, both in our regulatory role for an explosives manufacturing and storage licence under the *Explosives Act*, and in our capacity as a source of science and technology information and advice in the fields of minerals and metals science and the earth sciences.

### **1.1. Regulatory Role**

NRCan is responsible for administering the *Explosives Act* and regulations, and pursuing the advancement of explosives safety and security technology. Our principal priority is the safety and security of the public and of all workers involved in the explosives industry in Canada. Through the Explosives Regulatory Division, NRCan provides services and support to the explosives industry, including manufacturers, importers, distributors, and users of explosives.

The Gahcho Kué proposal includes explosives manufacturing and storage at the mine site. The Proponent's explosives supplier will apply to NRCan's Explosives Regulatory Division for a Licence under the *Explosives Act* paragraph 7(1)(a) for the construction, operation and decommissioning of an explosives factory and magazine. The Supplier will be required to follow NRCan guidelines and standards for explosive manufacturing and storage including compliance with the Quantity-Distance Principles Manual which gives the minimum permissible distance between a site containing a quantity of explosives and a susceptible site requiring protection. Licence conditions will include a spill contingency plan, an emergency response plan and operating and maintenance procedures.

### **1.2. NRCan Expertise and Technical Participation**

Specific areas of NRCan expertise that have been engaged in this review include:

- Mine Waste Management;
- Permafrost, Terrain Sensitivity and Geotechnical Science; and
- Bedrock Geology.

NRCan's reviewers in the minerals and metals sciences focussed on issues related to mine waste management, including acid rock/mine drainage and metal leaching, environmental hydro-geochemistry and mine reclamation, decommissioning and closure. NRCan reviewers in the earth sciences focussed on issues in the physical environment including characterization of permafrost and terrain conditions, geotechnics and geology, impacts of the project on permafrost and terrain, and impacts of the physical environment on the project.

NRCan has participated in:

- Review of the Draft and Final Terms of Reference, July – Oct. 2007;
- Participation in De Beers' EIS Workshop, Yellowknife, Oct. 26-27, 2011;
- Review of the EIS and Supplemental Information, Jan. - Dec. 2011;
- Submission of Information Requests (IRs), Dec. 2011 and July 2012;
- Review of Proponent's IR Responses (April and Aug., 2012); and
- Participation in Technical Meeting, Yellowknife, May 22-24, 2012.

During its initial review of the EIS, NRCan indicated that additional information was required to complete its technical review. In particular, IRs were submitted (Dec. 2011 and July 2012) to the Proponent on subjects relating to:

- dewatering of Kennady Lake;
- groundwater management from open pit developments;
- mine rock and kimberlite metal leaching and acid/alkaline drainage;
- lakebed sediments as possible construction material;
- baseline terrain and geotechnical conditions in the project area (including alignments for dams and dykes); and
- impact assessment and project design.

NRCan is appreciative of the additional information and clarifications provided by the Proponent in response to our IRs and also during the discussions at the May 2012 technical meeting. NRCan is satisfied with the Proponent's responses.

The remainder of this report offers recommendations for the Panel's consideration that are intended to provide guidance on factors that should be considered in detailed and final project design and in subsequent monitoring plans. In particular, these relate to two issues: groundwater management from open pit developments; and permafrost and terrain conditions and stability of project components (mine waste management facilities, dams and dykes).

## **2. SPECIFIC ISSUES**

### **2.1 Permafrost and Terrain Conditions and Stability of Project Components (Mine waste management facilities, dams and dykes)**

#### **2.1.1. Relevant Sections of the Terms of Reference**

Section: 3.1, 3.13, 4.1.2, 4.1.4, 5.2.5, 5.2.6; Key Line of Inquiry, Water Quality; Subject of Note - Permafrost, Groundwater and Hydrogeology.

#### **2.1.2. Documents Reviewed**

Environmental Impact statement (EIS) Section 3 (3.7, 3.9), 8, 10, 11 (11.5, 11.6), Annex D, 2012 EIS Supplemental Section 3, 8, 11;

Conformity Response to Item 1 and 2;

Technical Session Transcripts July 2012;

IR Response to NRCan 1-9, 1-10, 1-11, 1-12, 1-14 and associated appendices; NRCan 2-1;

IR Response to Aboriginal Affairs and Northern Development Canada (AANDC) 1-5, 1-22 and associated appendices;

Technical Memo on Project Works.

### **2.1.3. General Comments**

Stability of engineered structures including dams, dykes, and mine waste management facilities will be dependent on the properties of the underlying foundation materials and construction materials. In the permafrost zone, the thermal condition of subsurface materials (and how this may change over time) and ground ice conditions must also be considered in facility design to ensure maintenance of integrity and minimal environmental effects.

### **2.1.4. Proponent's Conclusion**

The Proponent has indicated that frozen conditions will not be relied upon for performance of the mine waste management facilities (processed kimberlite facilities and waste rock pile) and the various dams and dykes required for water management (e.g., EIS Sec. 11.6, Conformity Response Sec. 4, Response to IR AANDC 1-22). The Proponent concludes that impacts on water quality will be minimal (EIS Sec. 8, 11). Dams and dykes that may be constructed on permafrost foundations are not intended to be long-term water retaining structures and there are no issues anticipated with respect to stability (e.g., Response to IR NRCan 2-1). The Proponent has indicated that the information with respect to foundation materials and the analysis conducted to date is adequate at this stage (e.g., Technical Memo on Project Works). The Proponent however acknowledges that additional geotechnical investigations and analyses are required to support the final design for waste management facilities and dams and dykes (e.g., Response to IR NRCan 1-12, 2-1, Technical Memo on Project Works Part 2).

### **2.1.5. NRCan's Conclusion and Rationale**

NRCan generally agrees that the information collected during initial geotechnical investigations in 2004 (results summarized in EIS Annex D and Response to IR NRCan 1-9 and accompanying appendix) are sufficient at this stage for conceptual/preliminary design of mine facilities including mine waste management facilities and dams and dykes. However, more detailed geotechnical investigations will be required to characterize foundation materials (including frozen ground at Dyke A1 and D alignments) to support final design, and ensure that the infrastructure performs as intended to minimize environmental effects. NRCan is supportive of plans for further geotechnical investigations (e.g., Response IR NRCan 1-12) and the recommendations made by EBA Consultants Ltd. (e.g., Technical Memo on Project Works, response to questions in technical sessions). Instrumentation such as temperature cables would also be installed to better characterize the ground thermal conditions.

According to information collected by the Proponent, permafrost at the mine site is generally warmer than -2.5°C (EIS Sec. 11.6.2.1, Annex D) and frozen conditions may also exist beneath some of the dyke and berm alignments. NRCan agrees with the Proponent that given the relatively warm permafrost conditions and potential for thawing under a changing climate, dams, dykes and mine waste management facilities should not be designed to rely solely on frozen conditions over the long-term to ensure integrity and prevent seepage. For example dams and dykes will incorporate geomembrane liners to limit seepage. However, permafrost conditions are likely present beneath some dam alignments and the Proponent indicates that liners (for example for Dyke A1 and D) will be keyed into permafrost. Consideration of permafrost thaw including that in response to increased water levels on the upstream side of the dyke (as will be the case at Dyke A1)

will need to be included in the design. In addition to further geotechnical investigations at dyke alignments, thermal analysis utilizing the site specific data will also be required to determine whether permafrost thaw will be an issue for foundation stability and dyke performance. The Proponent has indicated that the detailed design will include an evaluation of foundation conditions and their thermal performance including consideration of climate change (Technical Memo on Project Works, Response to IR NRCan1-12). Placement of additional till fill on the downstream side of dykes to reduce potential for seepage has been identified as a mitigation technique should the thermal evaluation indicate that permafrost below the key trench will thaw (Sec. 4.4 of Conformity Response).

The Proponent has stated that with respect to mine waste management, frozen conditions are preferred but not required and the seepage and water quality modelling was conducted assuming unfrozen conditions exist in the processed kimberlite and waste rock piles (Response to IR NRCan 1-14, EIS Sec. 11.5, Conformity Response Sec. 4). NRCan agrees that the Proponent has taken a conservative approach in their analysis. However, freezing may occur as fine processed kimberlite (PK) is placed at the containment site (Area 2). NRCan raised concerns (NRCan IR-14) that placement of fine PK in winter and summer could lead to the existence of frozen and unfrozen layers within the pile with consolidation of unfrozen layers or frost heave and pore water expulsion during freezing potentially having an effect on seepage and pile stability. In response to IR NRCan 1-14, the Proponent has indicated that consolidation may occur and pore pressure may increase due to restriction of flow by frozen layers but based on experience from other mining projects, this is not expected to affect the stability of the PK pile. Over the long-term, thawing of the pile may also occur but it is expected to be slow enough that instability will not occur and the flexible cover will conform to the consolidating surface with no effects on infiltration. The Proponent's conclusions appear to be reasonable based on experience and frost heave testing of PK for other mining projects. [NRCan would however, suggest that monitoring of the condition and stability of the PK piles could ensure there is no excessive deformation of the cover and they perform as intended.]

#### **2.1.6. NRCan's Recommendations**

NRCan is supportive of the approach proposed by the Proponent for detailed design of dykes and mine waste management facilities. The following recommendations are offered for consideration during the detailed and final design stage.

With respect to dykes, in particular those that will remain at closure such as Dyke A1 and D, NRCan recommends:

- 1. The Proponent conduct the identified further geotechnical investigations including collection of information on ground thermal conditions along dyke alignments to better characterize foundation materials;**
- 2. The Proponent conduct the identified thermal analysis to evaluate the long-term thermal behaviour of permafrost foundations. The analysis should incorporate the site specific geotechnical data and consider the effect of increases in water level (such as that that will occur on the upstream side of Dyke A1) and potential effects of a changing climate; and**

3. **Monitoring plans be developed to monitor thermal performance and stability of dyke foundations to determine if mitigation is required.**

With respect to mine waste management facilities, NRCAN recommends that:

4. **The Proponent develop a monitoring plan for the processed kimberlite facility to assess the condition and stability of the pile and to determine the need for mitigation should there be instability or deformation of the cover affecting the performance.**

## **2.2. Mine Waste Management (Metal Leaching and Acid Rock Drainage) – Groundwater from Open Pit Developments**

### **2.2.1. Relevant Sections of the Terms of Reference**

Section: 4.4; Key Line of Inquiry, Long-term biophysical effects - closure and reclamation; Subject of Note, Groundwater Monitoring

### **2.2.2. Documents Reviewed**

Section 3.9.6.3 – Managing Groundwater from Open Pits (Documents Reviewed: Section 3.9 – Water Management /Project Development).

De Beers (De Beers Canada Inc.). 2010. Environmental Impact Statement for the Gahcho Kué Project. Volumes 1, 2, 3a, 3b, 4, 5, 6a, 6b, 7 and Annexes A through N. Submitted to Mackenzie Valley Environmental Impact Review Board. December 2010.

De Beers. 2012. Environmental Impact Statement Supplemental Information Submission for the Gahcho Kué Project. Submitted to the Mackenzie Valley Environmental Impact Review Board. April 2012.

Price, William A. 1997. Draft Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Minesites in British Columbia.

### **2.2.3. General Comments**

During pit dewatering operations, groundwater flowing into open pits is expected to range from a minimum of ~ 770,000 m<sup>3</sup>/y at the end of construction (Year -1), to about 1,500,000 m<sup>3</sup>/y in Year 6 when total inflow to the open pits reaches maximum. While a majority of the incoming groundwater would be managed through the Water Management Pond (WMP) and recycled, a portion of it would be discharged to Lake N11.

NRCAN had asked (IR -1(ii)) whether the deep formation groundwater had been or would be tested for dissolved radionuclides components such as radon gas (Rn-222) and its parent and progeny radionuclides.

### **2.2.4. Proponent's Conclusion**

Existing groundwater information collected as part of the 2010 EIS (De Beers 2010) formed the basis for characterizing the deep formation groundwater quality at the Project.



Radionuclides, such as radon gas were not analysed in samples collected during this study.

The geochemical baseline data provided in Appendix 8.III of the 2012 EIS Supplement (De Beers 2012) indicates solid phase uranium and thorium concentrations were at or slightly greater than the typical crustal abundance of elements in the Earth's crust, as described in Price (1997). Geochemical testing indicates these parameters do not exhibit a propensity to be mobilized at the Project. For example, as reported in Appendix 8.III of the 2012 EIS Supplement, thorium concentrations were below the analytical detection limits of 0.0005 and 0.0001 milligrams per litre (mg/L) for all materials. To confirm radionuclides are not leachable in the groundwater, these parameters can be included in the parameter suite as part of ongoing groundwater quality monitoring programs.

#### **2.2.5. NRCan's Conclusion and Rationale**

NRCan agrees with the Proponent's commitment to confirm that radionuclides are not leachable in the groundwater, and to include these parameters in the parameter suite as part of ongoing groundwater quality monitoring programs.

#### **2.2.6. NRCan's Recommendation**

- 5. As part of the Proponent's ongoing groundwater quality monitoring programs, NRCan recommends that the proponent include U, Th and possibly Ra-226 as screening parameters.**

### **3. SUMMARY OF NRCAN'S RECOMMENDATIONS**

The following recommendations are offered to be considered as measures for the detailed and final design stage.

#### **Permafrost and Terrain Conditions and Stability of Project Components (Mine waste management facilities, dams and dykes)**

NRCan is supportive of the approach proposed by the Proponent for the detailed design of the dykes and mine waste management facilities.

With respect to dykes, in particular those that will remain at closure such as Dyke A1 and D, NRCan recommends:

- 1. The Proponent conduct further geotechnical investigations including collection of information on ground thermal conditions along dyke alignments to better characterize foundation materials;**
- 2. The Proponent conduct thermal analysis to evaluate the long-term thermal behaviour of permafrost foundations. The analysis should incorporate the site specific geotechnical data and consider the effect of increases in water level (such as that that will occur on the upstream side of Dyke A1) and potential effects of a changing climate; and**

- 3. Monitoring plans be developed to monitor thermal performance and stability of dyke foundations to determine if mitigation is required.**

With respect to mine waste management facilities, NRCan recommends that:

- 4. The Proponent develop a monitoring plan for the processed kimberlite facility to assess the condition and stability of the pile and to determine the need for mitigation should there be instability or deformation of the cover affecting the performance.**

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**Mine Waste Management (Metal Leaching and Acid Rock Drainage) -  
Groundwater from Open Pit Developments**

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NRCan agrees with the Proponent's commitment to confirm that radionuclides are not leachable in the groundwater, and to include these parameters in the parameter suite as part of ongoing groundwater quality monitoring programs:

- 5. As part of the Proponent's ongoing groundwater quality monitoring programs, NRCan recommends that the proponent include U, Th and possibly Ra-226 as screening parameters.**

#### **4. CLOSING**

NRCan appreciates the opportunity to participate in this review and is willing to respond to any questions regarding our technical report by the Review Panel, the Proponent, and other parties involved in the project in support of the environmental assessment process.