DE BEERS
CANADA
GAHCHO KUÉ PROJECT

April 5, 2012 File: S110-01-08

Chuck Hubert
Environmental Assessment Officer
Mackenzie Valley Environmental Impact Review Board
P.O. Box 938
Yellowknife NT X1A 2N7

Dear Mr. Hubert:

Natural Resources Canada - Information Request
Responses - Gahcho Kué Project Environmental Impact Review

De Beers is pleased to provide the Mackenzie Valley Environmental Impact Review Board with responses to Information Requests submitted by Natural Resources Canada.

Sincerely,

Veronica Chisholm

Veronica Chisholm
Permitting Manager

Attachment

c: J. King, Senior Policy Analyst, Natural Resources Canada

A DIVISION OF DE BEERS CANADA INC.
SUITE 300, 5102 - 50TH AVENUE, YELLOWKNIFE, NT X1A 3S8 TEL 1 (867) 766 7344 FAX 1 (867) 766 7348
www.debeerscanada.com

Information Request Number: NRCan 1-1

Source: Natural Resources Canada -MMSL, Reviewer 1

Subject: Dewatering of Kennady Lake

EIS Section: Section 3.9.4 -Dewatering of Kennady Lake (Documents Reviewed: Section 3.9 -Water Management / Project Development).

Preamble

Water management is a key component of the Project as the diamond bearing kimberlite pipes are mainly located under Kennady Lake. The key water-related activity at the site that will take place during the project will be the dewatering of areas 2 to 7 of Kennady Lake and Lake I to gain access to the three kimberlite ore bodies.

Request

The Kennady Lake dewatering and water management scheme at the project site is not very clearly described in the water management section of the project description. Is this more clearly described in another document?

Response

Section 8.4 of the 2011 EIS Update (De Beers 2011) provides a more detailed description of the Water Management Plan as it applies to Kennady Lake watershed. Section 9.4 addresses the downstream effects as influenced by the water management plan. Appendix 8.I details of the water quality modelling which in turn includes a more technical description of the water management plan as it forms the basis of the model inputs.

The Water Management Plan (Section 3.9 of the 2012 EIS Supplement [De Beers 2012]) has been updated based on supplemental mitigation associated with the Fine Processed Kimberlite Containment (PKC) Facility. Updates to Sections 8.4, 9.4, and Appendix 8.I are provided in the 2012 EIS Supplement (De Beers 2012, Sections 8.2.2, 9.2.2, and Appendix 8.II).

References

De Beers (De Beers Canada Inc.). 2011. Environmental Impact Statement for the Gahcho Kué Project. Volumes 3a Revision 2, 3b Revision 2, 4 Revision 2, and 5 Revision 2. Submitted to the Mackenzie Valley Environmental Impact Review Board in Response to the Environmental Impact Statement Conformity Review. July 2011.

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.

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: NRCan 1-2

Source: Natural Resources Canada -MMSL, Reviewer 1

Subject: Groundwater from Open Pit Developments

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

Preamble

During pit dewatering operations, groundwater flowing into open pits is expected to range from a minimum of ~770,000 m^3/y at the end of construction (Year -1), to about 1,500,000 m^3/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.

Request

(i) As the total dissolved solids (TDS), salinity and some trace metal concentrations of the inflowing pit water are expected to increase with depth, how the discharge of this incoming pit water at depths would be handled and its impact on the receiving water quality managed? [We understand that Aboriginal Affairs and Northern Development Canada is submitting IRs that relate to this subject, focusing on water quality and quantity (see AANDC IRs 19-21).]

(ii) Has the deep formation groundwater been or would be tested for dissolved radionuclides components such as radon gas (Rn-222) and its parent and progeny radionuclides for developing the groundwater management plan accordingly?

Response

i) The water management plan is detailed in the Project Description in Section 3 of the 2012 EIS Supplement (De Beers 2012). During initial operations, pit water in the open pits, which includes groundwater inflows, will be directed to the Water Management Pond (WMP). The 5034 pit water will be allowed to accumulate in the pit after Year 5 when mining is complete. The Hearne pit water will directed to the WMP until Year 8 of operations. After Year 8 of the mine operation, groundwater inflow to the Tuzo pit, the only pit that will be mined at this stage of operations, will be pumped directly to the process plant or the mined out Hearne pit. Pit water recycled to the process plant will end up being deposited with the fine processed kimberlite (PK) in the Hearne pit. Water may continue to be pumped from the adjacent 5034 pit to the WMP to maintain the water level at 300 metres above sea level (masl) in the pit. Concentrations of total dissolved solids (TDS) and other parameters are expected to increase in the WMP as a result of pit dewatering.

Water from the WMP will be pumped and released to Lake N11 during the first four years of operations. Predictive water quality modeling of Lake N11, provided in Section 9 of the 2012 EIS Supplement (De Beers 2012), indicates that water pumped from the WMP during this period is expected to result in no adverse effects to aquatic health in Lake N11.

During mine operation, water quality in the WMP and in Lake N11 will be monitored. If this monitoring indicates the quality in the WMP becomes unsuitable for discharge, contingency plans are available to store pit water in other controlled areas of the Kennady Lake basin including the mined-out pits, as well as ability to store additional water in the WMP have been built into the water management plan.

ii) 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.

References

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.

April 2012

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: NRCan 1-3

Source: Natural Resources Canada -MMSL, Reviewer 1

Subject: Radionuclide Content and Radon Gas Emanation Potential of Mine Rock and Kimberlite Deposits

EIS Section: Section 8 -Geochemical Characterization -Metal Leaching and Acid/Alkaline Drainage (Documents Reviewed: Section 8, Appendix 8.II -Metal Leaching and Acid/Alkaline Drainage).

Preamble

Approximately 30 million tonnes of diamondiferous kimberlite and 226.4 million tonnes of host mine/country rock would be mined by open pit mining of the three kimberlite pipes. Because of their volcanic origin, the kimberlite pipes and their contact rock may contain uranium and thorium decay series radionulides, specifically Ra-226, its gaseous decay product Rn-222 (radon) and other components.

Request

Both the kimberlite and mine rock should be tested for uranium and thorium decay series radionuclides and radon gas emanation potentials.

Response

Section 8, Appendix 8.III, Attachement 8.III.5 of the 2012 EIS Supplement (De Beers 2012) provides solid phase analyses, including both Thorium and Uranium concentrations for each sample as determined through inductively coupled mass-spectrometry (ICP) analyses. In natural systems, daughter products are typically at secular equilibrium, hence they can be calculated based on the parent concentrations and do not need to be measured independently.

A review of the data shows that solid phase concentrations of both uranium and thorium are near or slightly above the typical crustal abundance of elements in the Earth's crust, as described in Price (1997) for all materials. Thorium and uranium do decay to radon; however, open pit mining will be used and the processing facilities will be well ventilated. These factors combined with generally low concentrations of the elements limits the potential for worker exposure.

With respect to leachate quality, uranium and thorium concentrations were low in both short term and kinetic leach tests. As reported in Tables 8.II-11a, 11b, 13a, 13b, 20a, 20b, 29a and 29b in Appendix 8.II of the 2010 EIS (De Beers 2010) and 2012 EIS Supplement (De Beers 2012, Appendix 8.III), thorium concentrations were below the analytical detection limits of 0.0005 and 0.0001 milligrams per litre (mg/L) for all materials.

References

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, W. 1997. Draft Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Minesites in British Columbia. B.C. Ministry of Employment and Investment (Ministry of Energy and Mines), Victoria, British Columbia

Information Request Number: NRCan 1-4

Source: Natural Resources Canada -MMSL, Reviewer 1

Subject: Mine Rock -Metal Leaching and Acid/Alkaline Drainage

EIS Section: Section 8 -Geochemical Characterization of Mine Rock-Metal Leaching and Acid/Alkaline Drainage (Documents Reviewed: Section 8, Appendix 8.11 -Metal Leaching and Acid/Alkaline Drainage).

Preamble

Approximately 6% or 13.6 million tonnes of the mine rock is classified as PAG and will be placed within the two waste rock piles and some in the mined out open pits. In the waste rock piles, the PAG materials would be incorporated and encapsulated within permafrost and covered with a layer of till on top to reduce precipitation infiltration. In the back-filled pits, the rock would be submerged under water upon reflooding of Kennady Lake at closure. This would also lead to some submergence of the P AG rock in the two waste rock piles.

Request

(i) Approximately what tonnage of the total PAG rock would be placed in each of the two waste rock piles and the mined out 5034 pit?

(ii) Upon reflooding of Kennady Lake, how much P AG rock would be above water in the two waste rock piles and if the desired till cover on top would be sufficient to prevent acid generation/metal leaching impacts? Could this excess rock be placed in the other two mined out pits?

(iii) Some mine rock has a paste pH of 5.5 that should have been classified as weakly acidic rather than neutral to alkaline pH.

(iv) Section 8.11.4.3.1: Static Testing

What is the upper value of NPR used for classification of PAG rock? In Figure 8.11-13, a significant number of mine rock samples have NPR of <3, are these included in the P AG classification?

(v) Section 8.11.4.3.2: Whole Rock Chemistry

Should the elevated concentrations of metals: Cr, Cu, Zn, and some Co, Mo, Mn Pb, Sb and U in the mine rock be of concern in the sub-aerial management scenario of such materials in the long-term with the anticipated climate change impacts?

(vi) Section 8.11.4.3.2: Humidity Cell Testing

For many PAG rock samples, the sulphide depletion time is significantly longer than the carbonate NP depletion and longer than the total NP depletion. Should sub-aerial management of such materials within the waste rock piles be problematic in the long-term given the short time frame of humidity cell testing?

(vii) Figure 8.1I-17 -The x-axis label for total sulphur should read 10 instead of 100.

(viii) Tables 8.II.29a and 29b -$S0_4$ conc. expressed as µg/L should have been mg/L.

(ix) Table 8-II-35 -For grandiorite and altered grandiorite samples, how the percentage of samples having total sulphur concentrations of 0.1 % and 0.3%, respectively, was calculated for sample sizes of n = 1 and 2? For n =1, the number should have been either 0% or 100% and for n = 2, it should have been 0%, 50% or l00%.

Response

Less than 1.5% of the mine rock has some limited potential to generate acidity based on both sulphide concentration exceeding 0.3% and neutralization potential / acid potential (NP/AP) ratios of less than 3 (Section 3, Appendix 8.III of the 2012 EIS Supplement [De Beers 2012]). However, it was conservatively assumed in 2010 EIS (De Beers 2010) that less than 6% (13.6 million tonnes [Mt]) of mine rock (based solely on NP/AP ratio) will have to be managed as being potentially acid generating (PAG) with metal leaching potential as a precaution, even at very low levels of sulphur (De Beers 2010, Section 3.7.3.2).

(i) Approximately what tonnage of the total PAG rock would be placed in each of the two waste rock piles and the mined out 5034 pit?

Table NRCan_1-4-1 Proposed Disposal Location of PAG Mine Rock

Proposed Disposal Location of PAG Mine Rock		Estimated Tonnage of PAG (Mt)
Mined-out 5034 Pit (with a minimum of 2.7 m water cover over backfilled mine rock after final closure)		7.1
West Mine Rock Pile	Below 418.7 m elevation (with a minimum of 2 m water cover over mine rock after final closure)	1.7
	Above the restored Kennady Lake water elevation of 420.7 m	0.5
South Mine Rock Pile	Below 418.7 m elevation (with a minimum of 2 m water cover over mine rock after final closure)	0.3
	Above the restored Kennady Lake water elevation of 420.7 m	4.0

Operational monitoring has proven effective in other mines to identify PAG rock and will be implemented at the project. Therefore the capability to properly identify and capacity to store PAG rock as it is encountered will be made available throughout the mine operations.

(ii) Upon reflooding of Kennady Lake, how much PAG rock would be above water in the two waste rock piles and if the desired till cover on top would be sufficient to prevent acid generation/metal leaching impacts? Could this excess rock be placed in the other two mined out pits?

The estimated tonnage of the PAG mine rock to be placed above the restored Kennady Lake water elevation of 420.7 m in the two mine rock piles is estimated to be 4.5 Mt (Table NRCan 1-4-1). This value is about 3% of the total mine rock to be stored in the two mine rock piles.

There is sufficient till material from the pit development available for use as cover/encapsulation material over and around the PAG storage cells within the mine rock piles. It is important to point out that the use of fine material such as till to encapsulate the PAG cells not only limits water infiltration, but more importantly limits oxygen availability to the PAG rock. The use of alternate cover/encapsulation materials to inhibit oxidation, such as coarse processed kimberlite (PK), which is planned to be placed in the mine rock piles, will also form part of the acid rock drainage (ARD) control program. Coarse PK not only would perform to limit oxygen availability to the PAG rock, but also exhibits an excess of neutralizing potential.

Re-handling the mine rock into the pits is not required. Mitigation of any high metal or acid drainage detected by monitoring is best mitigated in situ with covers, neutralization, or other techniques.

(ii) Some mine rock has a paste pH of 5.5 that should have been classified as weakly acidic rather than neutral to alkaline pH.

The use of the term "neutral" with respect to pH was used to differentiate where waters fell within a naturally occurring range of conditions that would not be considered indicative of anthropogenic derived acidity, or ARD derived acidity. It is consistent with respect to definitions provided in Table 10.3 of Price (1997) and by Environment Canada's when used with respect to definition of Acid Rain (Environment Canada 2012). See response to Information Request NRCan 1-7 (ii) for the pH scale as defined by Environment Canada.

(iii) Section 8.11.4.3.1: Static Testing

What is the upper value of NPR used for classification of PAG rock? In Figure 8.11-13, a significant number of mine rock samples have NPR of <3, are these included in the P AG classification?

As described in Appendix 8.II, Section 8.II.7 of the 2010 EIS, material is classified as PAG when reporting both NPR values below 3.0 and sulphide-sulphur concentrations exceeding 0.3% (De Beers 2010). For this site, given that the paste pH values are consistently greater than 5.5, it is considered that there is insufficient sulphide present at levels below 0.3% to produce appreciable acidity. The methodology for this assessment is consistent with industry standard guidelines (Price 1997; MEND 2009), which is described in Appendix 8.III, Section 8.III.4.1.1 of the 2012 EIS Supplement (De Beers 2012).

(v) Section 8.11.4.3.2: Whole Rock Chemistry

Should the elevated concentrations of metals: Cr, Cu, Zn, and some Co, Mo, Mn Pb, Sb and U in the mine rock be of concern in the sub-aerial management scenario of such materials in the long-term with the anticipated climate change impacts?

Metal leaching is dependent on several factors, including the solubility of the minerals bearing the key metal (element), the environmental conditions in which the material is stored, and the composition of the water interacting with the material. A high concentration of a particular element does not necessarily imply that this element will be mobilized; rather that additional follow-up work is required to evaluate the potential for chemical mobility. This follow up work was conducted as part of the geochemical and water evaluation test programs outlined in Section 8 of the 2012 EIS Supplement (De Beers 2012) as follows:

- Short term leach tests and kinetic leach tests are conducted using the same range of solid material composition as the elemental analyses. These leach tests include both submerged column tests and humidity cell tests, are used to determine the short and long term metal leaching potential of a material. These tests simulate possible conditions in which the material might be stored, including both seasonal wet-dry conditions and submerged conditions, and report the accelerated depletion rates of key parameters in contact waters.
- Once the leach tests are completed the resulting values are carried forward into the overall water quality modelling and assessment as described in the water quality modelling appendix (Section 8, Appendix 8.II of the 2012 EIS Supplement [De Beers 2012]).

As described in the site water quality model discussion (Section 8, Appendix 8.II of the 2012 EIS Supplement [De Beers 2012]), the assessment of effects to water quality is not dependant on temperature (i.e., we assume that the material is thawed), as such, it is considered that the solid phase concentrations are suitably evaluated and assessed using the current assessment techniques.

(vi) Section 8.11.4.3.2: Humidity Cell Testing

For many PAG rock samples, the sulphide depletion time is significantly longer than the carbonate NP depletion and longer than the total NP depletion. Should sub-aerial management of such materials within the waste rock piles be problematic in the long-term given the short time frame of humidity cell testing?

No. The current pile design calls for limiting the availability of oxygen to limit the potential for acid generation. There will be an operational monitoring program in place to identify PAG materials so that they can be appropriately segregated within the pile. The segregation of the PAG material combined with the overall distribution and make up of non-PAG materials and acid neutralizing materials (such as PK) is considered a suitable and appropriate mitigation strategy that will result in neutral drainage regardless of thawed, or frozen conditions.

(vii) Figure 8.1I-17 -The x-axis label for total sulphur should read 10 instead of 100.

The x-axis label for Figure 8.II-17 of Appendix 8.II in the 2010 EIS is correctly labelled with 100 to include all samples reporting greater than 1% sulphide-sulphur to the maximum of 100% sulphide-sulphur (De Beers 2010).

(viii) Tables 8.II.29a and 29b -S04 conc. expressed as µg/L should have been mg/L.

This typo has been corrected in Appendix 8.II of the 2012 EIS Supplement (De Beers 2012, Appendix 8.III).

(ix) Table 8-II-35 -For grandiorite and altered grandiorite samples, how the percentage of samples having total sulphur concentrations of 0.1 % and 0.3%, respectively, was calculated for sample sizes of n = 1 and 2? For n =1, the number should have been either 0% or 100% and for n = 2, it should have been 0%, 50% or l00%.

Appendix 8.II, Table 8.II-35 lists the percentage of each lithology reporting greater than 0.1% and 0.3% total sulphur (De Beers 2010). The table has been clarified in the 2012 EIS Supplement (De Beers 2012, Appendix 8.III). The number of samples (n) actually represents the number samples reporting those percentages of total sulphur (both 0.1% and 0.3%) within the entire sample set. The percentage is calculated based on dividing that number (n) by the total number of samples within that lithology. The updated table includes a column listing the total number of samples analyzed for each lithology to make the calculation clear.

References

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.

Environment Canada. 2012. Water Pollution - Acid Rain. http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=FDF30C16-1

Price, W. 1997. Draft Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Minesites in British Columbia. B.C. Ministry of Employment and Investment (Ministry of Energy and Mines), Victoria, British Columbia.

MEND (Mine Environment Neutral Drainage). 2009. Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials. MEND Report 1.20.1.

Information Request Number: NRCan 1-5

Source: Natural Resources Canada -MMSL, Reviewer 1

Subject: Process Kimberlite -Metal Leaching and Acid/Alkaline Drainage

EIS Section: Section 8 -Geochemical Characterization of Kimberlite -Metal Leaching and Acid/Alkaline Drainage (Documents Reviewed: Section 8, Appendix 8.1I -Metal Leaching and Acid/Alkaline Drainage).

Preamble

Up to 25% of the fine process kimberlite (PK) would be placed in a land-based, fine process PK management facility with a designed capacity of ~5.5 million tonnes and the rest in the mined out Hearne pit. The coarse PK would be placed in a coarse PK pile with a designed capacity of ~5.2 Mm^3 and in the mined out 5034 pit. Both facilities would be progressively reclaimed during operations as well upon closure.

Request

(i) Section 8.11.4.1.1.2: ABA Testing Figure 8.11.2 requires redrawing of 1:1 and 1:10 Ca NP vs. total NP fit lines as they are incorrectly plotted.

(ii) Section 8.11.4.1.2: Whole Rock and Trace Element Chemistry The bulk kimberlite has elevated concentrations of Cr, Mn, Ni and some Co, Cu and Zn. The shake flask tests showed some leaching of Al, Cr, Ni and Fe. Both coarse and fine PK have elevated concentrations of B, Co, Cr, Mn, Mo, Ni, and some Cu and Zn. Would the leaching and mobility of some of these metals be problematic in the long-term for land-based, sub-aerial waste management facilities?

(iii) Section 8.11.4.1.4.1: Humidity Cell Testing and Column Leaching

a) The humidity cell testing showed some decreasing pH and As leaching trends during the short 35 week monitoring period. The column leaching tests also showed As leaching with time for columns # 7 and # 9. Is this trend expected to continue in the long-term? Perhaps long-term monitoring of these columns is required.

b) All kimberlite samples tested showed depletion of Ca NP well in advance of total sulphide AP depletion. Should this be of concern as the remaining NP would only be realized upon acid generation, perhaps, contributing to metal mobility issues.

(iv) Section 8.11.4.2.6: Submerged Column Testing (Reviewer 1&2) The monitoring time frame of 7 -weeks for the submerged kimberlite column testing was too short to draw any conclusions. Long-term monitoring of these columns is required to establish water quality impacts of coarse and fine PK management under submerged conditions. Leaching of Mn, Fe, As and Se may be of concern under reducing conditions in the submerged state. The EIS indicates that the tests were ongoing at the time of its preparation; please provide the latest update.

Response

(i) The 1:1 and 1:10 Carbonate Neutralization Potential (CaNP) vs. total Neutralization Potential (NP) lines have been corrected in Figure 8.II-2 (De Beers 2010, Appendix 8.II). This corrected figure is presented in Section 8, Appendix 8.III, Figure 8.III-2 of the 2012 EIS Supplement (De Beers 2012).

(ii) Metal leaching is dependant on several factors, including the solubility of the minerals bearing the key metal elements, the environmental conditions in which the material is stored, and the composition of the water interacting with the material. A high concentration of a particular element does not necessarily imply that this element will be mobilized; rather that additional follow-up work is required to evaluate the potential for chemical mobility. This follow up work was conducted as part of the geochemical and water evaluation test programs as follows:

- Short term leach tests and kinetic leach tests were conducted using the same range of solid material composition as the elemental analyses. These leach tests included both submerged column tests and humidity cell tests and were used to determine the short and long term metal leaching potential of a material. These tests simulated possible conditions in which the material might be stored, including both seasonal wet-dry conditions and submerged conditions, and report the accelerated depletion rates of key parameters in contact waters.

Once the leach tests are completed, the resulting values were carried forward into the overall water quality modelling and assessment, as described in the water quality modelling appendix (Section 8, Appendix 8.II of the 2012 EIS Supplement [De Beers 2012]). As described in the site water quality model discussion (Section 8, Appendix 8.II of the 2012 EIS Supplement [De Beers 2012]), the assessment of Project effects to water quality is not dependant on temperature (i.e., we assume that the waste material [e.g., mine rock, coarse and fine processed kimberlite (PK)] storage facilities are thawed), and as such, it is considered that the solid phase concentrations are suitably evaluated and assessed using the current assessment techniques.

(iii) a) The results of kinetic testing, including both column testing and humidity cell testing presented in the 2010 EIS (De Beers 2010), have been updated with the supplemental data provided in the 2012 EIS Supplement. As well as the two ongoing PK saturated columns and humidity cells, an additional 13 tests were initiated for each test method (i.e., humidity cell and saturated column tests). Testing of these cells and columns are all ongoing and has passed 30 weeks, and are projected to continue until steady state conditions are reached. As reported in Section 8, Appendix 8.III of the 2012 EIS Supplement, arsenic concentrations have increased over time in several of the coarse PK columns (De Beers 2010). These results were applied to the update to the water quality model in the 2012 EIS Supplement for the prediction of arsenic concentrations at the site.

b) The CaNP is classified as a conservative estimate of the NP of a material based on the carbonate content of the material. The method employed by the Project for classification of the material includes a conservative use of Neutralization Potential Ratio (NPR), as well as the total sulphide content of the material. As described in Section 8, Appendix 8.III, Section 8.III.7 of the 2012 EIS Supplement, material is classified as potentially acid generating (PAG) when reporting both NPR values below 3.0 and sulphide-sulphur concentrations exceeding 0.3%. The criterion of 0.3% sulphide-sulphur when combined with paste pH values greater than 5.5 is used as a typical screening level employed for waste rock classification with respect to acid rock drainage (ARD), and is considered suitable for use at this level given the rock types and mitigation strategies to be used. This is described further in Section 8, Appendix 8.III, Section 8.III.5.1.1 of the 2012 EIS Supplement (De Beers 2012).

The use of an NPR guideline of 3.0 is conservative based on the criteria described in Price (1997), which classifies material reporting an NPR between 1.0 and 3.0 as having uncertain acid generation potential. Though the kimberlite samples report the depletion of CaNP prior to the depletion of sulphide-sulphur, the total sulphide-sulphur concentration of the material is considered insufficient to produce appreciable acidity over the long term. Furthermore, mitigation applied to the deposition of any potentially acid generating (PAG) material will limit oxygen availability to sulphide materials, and hence limit the rate of potential acid generation. These criteria and interpretation of the criteria are consistent with industry standards and consistent with results as observed in humidity cell testing and non-PAG (non-potentially acid generating) testing (De Beers 2012), and are considered appropriate for this site for the reasons as stated above.

(iv) As well as the two ongoing PK columns and humidity cells, an additional 13 tests were initiated for each test method. These tests are all ongoing, and have passed 30 to 60 weeks varying on the start date of each material, and are projected to continue until steady state conditions are reached. The updated results of this kinetic testing, including both saturated column testing and humidity cell testing, have been reported in Appendix 8.III, Section 8 of the 2012 EIS Supplement (De Beers 2012).

Reference

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.

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Price, W. 1997. Draft Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Minesites in British Columbia. B.C. Ministry of Employment and Investment (Ministry of Energy and Mines), Victoria, British Columbia

Glossary

Acid Rock Drainage (ARD): Acidic pH rock drainage due to the oxidation of sulphide minerals that includes natural acidic drainage from rock not related to mining activity.

Carbonate Neutralization Potential (CaNP): A calculated value that represents the bulk amount of acidity that the sample can potentially consume through the dissolution of carbonate minerals.

Neutralization Potential (NP): The bulk amount of acidity that the sample can potentially consume or neutralize. The NP is determined by acidifying the sample with sulphuric acid. Following the acidification of the sample, the amount of acid that is consumed during the test period is determined by a reverse titration.

Neutralization Potential Ratio (NPR): The ratio of neutralization potential to acid potential of a material.

Non-Potentially Acid Generating (non-PAG): Rock with an NPR greater than 3 and less than 0.3% sulphide-sulphur content as determined by static tests.

Potentially Acid Generating (PAG): Rock with an NPR less than 3 and greater than 0.3% sulphide-sulphur content as determined by static tests.

April 2012

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: NRCan 1-6

Source: Natural Resources Canada -MMSL, Reviewer 1

Subject: Long-Term Effects, Reclamation and Closure

EIS Section: Section 10 -Long-term Biophysical Effects, Reclamation and Closure (Documents Reviewed: Section 10, Long-term Biophysical Effects, Reclamation and Closure).

Preamble

During operation and post closure, water quality in Kennady Lake is modelled to have elevated TDS and concentrations of P and metals: Co, Cr, Fe, Hg, Mn, Pb, Se, TI, U and Zn. In addition, concentrations of Ag, Al, As, B, Ba, Be, Cd, Cu, Mo, Ni Sr and V are also projected to increase in Kennady Lake. Some of these are projected further to remain above the post closure water quality guidelines.

Request

(i) Section 10.1.3.1 Site Location The project location longitudinal and latitude coordinates are reversed in the text.

(ii) Section 10.2 Long-term Effects on Water Quality What would be the long-term impacts of these elevated water quality parameters on Kennady Lake habitat and its downstream environment?

Response

i) As indicated above, the longitude and latitude are reversed in the text. This has been corrected in the 2012 EIS Supplement (De Beers 2012), which will be submitted to the Board in April 2012.

ii) The long-term impacts of elevated water quality parameters on Kennady Lake and its downstream environment are addressed in Section 10 of the July 2011 EIS Update (De Beers 2011). Details on the analysis and classification of these long-term impacts are addressed in separate Key Lines of Inquiry for the post-closure period:

- Key Line of Inquiry: Water Quality and Fish in Kennady Lake (Section 8); and
- Key Line of Inquiry: Downstream Water Effects (Section 9).

The potential effects of project activities on the aquatic environment in Kennady Lake and watershed are discussed in Section 8, including effects related to closure and reclamation; assessment tools and modelling used to evaluate these effects are described and the results of the analysis discussed. Similarly, in Section 9, the effects of project activities on the downstream environment are addressed and assessment tools described.

The predictions of water quality for post-closure in Sections 8.8 and 9.8 of the 2011 EIS Update include a comparison to the Canadian Water Quality Guidelines for the Protection of Aquatic Life (CCME 2007) for reference; however, the assessment of effects of changes in water quality to aquatic life is presented in Sections 8.9 and 9.9. In the aquatic health assessments in Section 8.9 and 9.9, changes to concentrations of all substances considered in the assessment were predicted to result in negligible effects to aquatic health in Kennady Lake and in waterbodies downstream of Kennady Lake.

The residual impacts for the Project are classified in Sections 8.14 and, 9.13 of the 2011 EIS Update; the long-term residual impacts are also presented in Section 10.8. The 2011 EIS Update concluded that neither the Kennady Lake watershed, nor its downstream environment, is expected to experience environmentally significant impacts with respect to the suitability of water to support a viable and self-sustaining aquatic ecosystem. As described in Section 10.8.3, the water quality is predicted to change; however, the potential for modelled substances to cause adverse effects to aquatic life was considered to be low or negligible.

However, since the submission of the 2011 EIS Update, the mine plan has been updated to reflect supplemental mitigation associated with the deposition of fine processed kimberlite (PK) to reduce potential loading of phosphorus (see Section 3 of the 2012 EIS Supplement [De Beers 2012]).

This change has resulted in a lower volume of fine PK that will be deposited to the Fine Processed Kimberlite Containment (PKC) Facility. The footprint of the Fine PKC Facility has been reduced to only Area 2 of Kennady Lake (i.e., no longer includes Area 1); this reduces the fine PK surface area by approximately half. This reduction in size alters the projected long-term loading of many of the parameters listed in the preamble to Kennady Lake.

In addition, on-going geochemical testing of site-specific PK material has also identified that the source term loading of many of these parameters, especially phosphorus, from fine PK material is slightly different from the loading reported in the 2011 EIS Update. Updated water quality modelling based on revised source term inputs has been completed for the 2012 EIS Supplement.

Based on the supplemental work completed for the 2012 EIS Supplement, it is still concluded that neither the Kennady Lake watershed, nor its downstream environment, is expected to experience environmentally significant impacts with respect to the suitability of water to support a viable and self-sustaining aquatic ecosystem.

References

CCME. 2007. Summary Table, Canadian Environmental Quality Guidelines for the Protection of Aquatic Life (Updated July 2006). Canadian Council of Ministers of the Environment. Winnipeg, MB.

De Beers (De Beers Canada Inc.). 2011. Environmental Impact Statement for the Gahcho Kué Project. Volumes 3a Revision 2, 3b Revision 2, 4 Revision 2, and 5 Revision 2. Submitted to the Mackenzie Valley Environmental Impact Review Board in Response to the Environmental Impact Statement Conformity Review. July 2011.

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.

Information Request Number: NRCan 1-7

Source: Natural Resources Canada -MMSL, Reviewer 1

Subject: Waste rock geochemical testing

EIS Section: Section 3.7.3.2 Geochemical Characterization of Mine Rock (Documents Reviewed: Section 3, Project description. Geochemical Characterization of Mine Rock).

Preamble

Geochemical testing was conducted on waste rock. It is indicated that granite is the dominate rock type. Testing of mine rock type revealed "neutral to alkaline paste pH values (pH of all samples was 5.5 or greater)".

Request

(i) Please indicate the methodology referring to the pH value and reference of the results.

(ii) Please provide the definition of a neutral pH or reconsider wording in the document.

Response

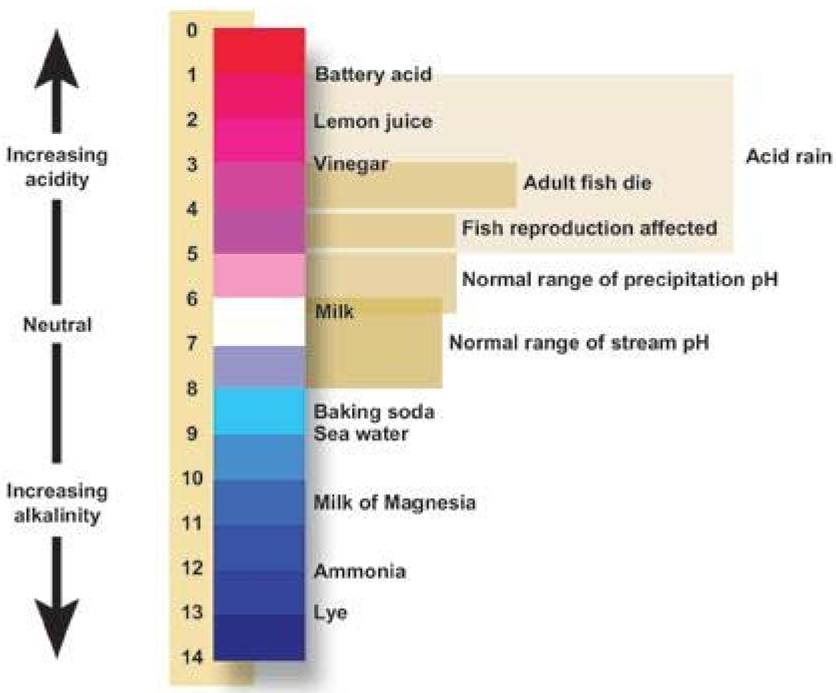
(i) The method used to determine the pH value of the mine rock is based on the method for paste pH described in Price (1997) and Sobek et al. (1978), referenced in the Acid Base Accounting section of Appendix 8.II, Attachment 8.II.2 of the 2010 EIS (De Beers 2010). The method involves the use of 20 grams (g) of dried rock material crushed to less than 0.1 millimetre (mm). The material is mixed with 20 millilitres (mL) of distilled water and allowed to stand for 10 minutes before the pH is measured. The purpose of the method is to determine whether the material is acidic, neutral or alkaline.

(ii) The use of the term “neutral” in the context of the EIS 2010 with respect to pH was used to differentiate waters that were within a naturally occurring range of conditions that would not be considered indicative of anthropogenic derived acidity, or acid rock drainage (ARD) derived acidity.

The pH range of natural waters as shown in Figure NRCan_1-7-1, sourced from Environment Canada (2012). This figure illustrates typical pH values of environmental water sources, including normal precipitation, normal stream water and acid rain. Normal precipitation is classified as precipitation reporting a pH value higher than 5.3 whereas Environment Canada considers rainwater values below pH 5.3 as acid rain.

The definition of the term neutral with respect to pH is further supported in Table 10-2 in Price (1997).

Figure NRCan_1-7-1 Classification of Material pH Values (from Environment Canada [2012])



References

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.

Environment Canada. 2012. Water Pollution - Acid Rain. http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=FDF30C16-1

Price, W. 1997. Draft Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Minesites in British Columbia. B.C. Ministry of Employment and Investment (Ministry of Energy and Mines), Victoria, British Columbia.

Sobek, A.A., W.A. Schuller, J.R. Freeman and R.M. Smith, 1978. *Field and Laboratory Methods Applicable to Overburdens and Minesoils*. Report EPA-600/2-78-054, US National Technical Information Report PB-280 495.

April 2012

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: NRCan 1-8

Source: Natural Resources Canada -MMSL, Reviewer 1

Subject: Overburden: Lake Sediment

EIS Section: Section 3.7.2 Overburden, Section 8.II.1.2, 8.11.1.3, Appendix 8.II Metal leaching and acid/alkaline rock drainage (Documents Reviewed: Appendix 8.II Metal leaching and acid/alkaline rock drainage).

Preamble

Overburden will be used in the construction of dykes within the Kennedy Lake subwatershed areas. Lakebed sediments will be used to cover any areas in the core of the mine rock piles where potentially reactive mine rock is sequestered.

Request

(i) Lake sediments can act as a major sink for pollutant due to anoxic condition prevailing at the bottom of the lake. Please indicate the lake sediment composition and mineralogy.

(ii) Please comment on the potential release of metals from the sediment used as a construction material for reclamation purpose.

(iii) Please comment if sulphide compound are present in the lake sediment. If present, sulphide compound may be oxidized when used as a construction material and further release heavy metals.

Response

i. Lakebed sediments are proposed as a possible construction material at the Project site (see Section 3.5.4, Project Description in the 2010 Environmental Impact Statement [EIS; De Beers 2010]). This material has undergone a preliminary characterization of the solid phase composition, including nutrient and metal concentrations. As described in Sections 8.3.6, 9.3.3 and 10.3.2.5 in the 2011 EIS Update, metal concentrations in the sediments were generally within the applicable aquatic life guidelines, however, arsenic, chromium, cadmium, copper and zinc exceeded the interim sediment quality guidelines (ISQG) in several sediment samples collected from one or more of the site lakes (De Beers 2011). The mineralogical composition and sulphide-sulphur concentrations were not measured as part of this characterization.

ii and iii. The potential for metal release and acid generation in both the long and short term cannot be determined based on the current sediment data set. As noted in the Information Request above, acid base accounting, in particular sulphide-sulphur analysis, as well as a short-term leach testing will be necessary to characterize the material reactivity of the surface overburden material. The testing of sediment proposed for construction purposes will be conducted as part of Mine Rock and Processed Kimberlite Management Plan, which is mentioned in the Project Description (De Beers 2010, Section 3.7). Sediment classified as potentially acid generating (PAG) or metal leaching, based on the classification developed for mine waste, will not be used for construction purposes.

References

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. 2011. Environmental Impact Statement for the Gahcho Kué Project. Volumes 3a Revision 2, 3b Revision 2, 4 Revision 2, and 5 Revision 2. Submitted to the Mackenzie Valley Environmental Impact Review Board in Response to the Environmental Impact Statement Conformity Review. July 2011.

Information Request Number: NRCan 1-9

Source: Natural Resources Canada -ESS

Subject: Overburden: Lake Sediment

EIS Section: Baseline terrain and geotechnical conditions in the mine site area
Relevant to Key Line of Inquiries, Water Quality, Long-term Biophysical Effects; Subject of Note, Permafrost, Groundwater and Hydrogeology

Preamble

Stability of engineered structures including dams, dykes and mine waste management facilities, will be dependent among other factors on the properties of the underlying foundation materials. Some descriptions of subsurface materials are provided as are temperature profiles from boreholes (Annex D). Although the Proponent indicates that geotechnical boreholes were drilled in 2004 to obtain information on materials at mine waste management sites and dam alignments, the detailed logs are not provided. The detailed geotechnical logs in combination with the ground temperature information would provide NRCan with a more complete understanding of variability of sediment properties with depth and the geotechnical properties of the site subsurface materials.

Request

Please provide additional detailed information on characteristics of sub surface materials obtained from geotechnical investigations such as borehole logs and results of laboratory testing (including index and strength tests).

Response

The borehole logs, the gradation analysis carried out on till samples, and testing results of soft lake bottom sediments is attached in Appendix NRCan 1-9-A.

A summary of subsurface condition from 2004 site investigation (Appendix NRCan1-9-A) is presented as follows:

The overburden in the Kennady Lake area appears to have been deposited in the late Wisconsin Glaciation, which is the last glacial event. All deposits are cohesionless in nature and range from silt or fine-grained sand to coarse-grained sand or fine gravel with cobbles and boulders that become higher in concentration with depth approaching the bedrock. In many areas, the glacial till has been reworked and re-deposited as a glaciolacustrine or glaciofluvial deposits. Peat bogs overlie a considerable portion of the lacustrine and glaciofluvial deposits. Eighteen gradation analyses were conducted for the frozen till core samples retrieved using the Geobor S system from eight on-land boreholes drilled within the mine site. The results indicate that the overburden soils are generally silty sand with some gravel and trace clay. The fines (silt and clay) contents ranged from 1.5% to 43% with an average of 23.8%. In general, the shallow lakebed sediments in Kennady Lake range from soft, predominantly silty material containing some sand and traces of clay that grade into dense silty sand with some gravel. The hydrometer testing of the sediments indicated minimal clay sized particles. The lakebed glacial till material in the area is generally described as sand and gravel with traces to some silt with high content of cobbles and boulders, particularly approaching the bedrock interface.

The bedrock encountered in boreholes drilled within the proposed dyke areas was generally described as medium-coarse grained granite to highly foliated granite gneiss. Further, the upper 60 m of bedrock appeared to have higher fracture and jointing densities with lower measured Rock Quality Designation (RQD) values suggesting a stress relieved zone due to glacial retreat and post-glacial rebound events. The results of in situ hydraulic conductivity testing (Packer testing) indicated that bedrock permeability tends to decrease with depth.

Information Request Number: NRCan 1-10

Source: Natural Resources Canada - ESS

Subject: Borrow source requirements
Relevant to Subject of Note, Permafrost, Groundwater and Hydrogeology

EIS Section: EIS section 3

Terms of Reference TOR 3.1.3, 3.2.1, 5.2.5

Preamble

The EIS (section 3) indicates that granular fill will be required for construction of mine infrastructure such as roads, airstrip and foundations. Although the Proponent indicates that crushed mine rock would be used for construction reducing the need for additional quarries, it is not mentioned whether unconsolidated sediments (in addition to till overburden mentioned for processed kimberlite piles) are required for construction. Clarification is therefore required on whether additional sand and gravel resources are required and if required, details on location of potential borrow sites as well as properties of the unconsolidated sediments at these sites. This information is required for NRCan to better understand the footprint of project activities and potential environmental effects that may be associated with granular resource extraction.

Request

Please clarify whether additional borrow sites (unconsolidated sediments) will be required to meet granular resource needs for project construction. If additional borrow sites are required, please provide information on locations and material properties including ground ice conditions.

Response

No additional borrow sites will be required to meet granular resource needs for the Gahcho Kué Project. All granular resource needs will be obtained from construction cut areas (e.g., airstrip, plant site) and material generated from the planned open pit excavations.

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: NRCan 1-11

Source: Natural Resources Canada -ESS

Subject: Dam design and wave height
Relevant to Key Line of Inquiry, Water Quality; Subject of Note, Permafrost, Groundwater and Hydrogeology

EIS Section: EIS section 3, 8

Terms of Reference 3.1,4.1.2

Preamble

A number of dams and dykes will be constructed for water management or diversion. These structures must be sufficiently high to ensure that overtopping does not occur. It is therefore important to understand the variability in water levels that may occur as well as the potential wave height. The proponent also indicates in the EIS (section 3.9.4.2), a dyke is to be constructed at the north eastern edge of the west waste rock pile to decrease wind effects in the settling zone. De Beers indicates that if the wind direction aligns with the long fetch of area 3 and causes increased wave heights the dyke would be constructed to reduce the effect of wind and limit waves. It is not clear whether the proponent has done any analysis to determine the wind and wave climate at the site to ensure that dams and dykes are designed to perform as intended, i.e. to prevent overtopping or to ensure that the effects of wind in the settling zone are minimized. It also not clear what the design freeboard is.

Request

(i) Please provide any additional information how climate and water flow trends, variability and extremes are used to determine dam and dyke design elevations, including design water levels and freeboard.

(ii) Please provide any additional information on analysis conducted related to the wind and wave environment to facilitate dam and dyke design and provide clarification of the design freeboard that will be used.

Response

Responses to Request (i):

Detailed final engineering design for each of the dykes and berms for the Gahcho Kué Project will be carried out before the dyke/berm construction. The minimum freeboard and design crest elevation values adopted for the conceptual design will be reviewed and updated in the detailed final engineering stage. The inflow design flood and associated climatic parameters incorporated into the EIS design are summarized below.

Inflow design flood (IDF) for a given dam classification is suggested in CDA (2007). For a dyke classified as “significant”, which is the dam classification for all the dykes in this study, the suggested annual exceedance probability (AEP) is between 1/100 and 1/1000 for the IDF. CDA (2007) suggested that the selection of the AEP for the IDF should be based on incremental flood analysis, exposure, and consequences of failure. In consideration of the short mine life (11 years of mine production) and relatively low consequences of failure, the AEP adopted for dyke design in this study is 1/100.

Critical floods for a given water-retention structure can result from extreme rainfall events at various durations, melting of extreme snowpack during spring freshet period, or even extreme annual precipitation for a “no discharge” case. Table NRCan 1-11-1 lists values for extreme rainfall, snowpack snow water equivalent, and annual total precipitation estimated for the Gahcho Kué mine site area.

Table NRCan 1-11-1 Selected Precipitation Values Estimated for Gahcho Kué Project

Item	Annual Exceedance Probability (1 over return period in years)	Value (mm)
1 hour extreme rainfall	1/100	28
1 day extreme rainfal	1/100	56
30 day extreme rainfall	1/100	152
Extreme spring snowpack snow water equivalent in wet condition	1/100	162
Mean spring snowpack snow water equivalent	1/2 (mean)	120
Extreme annual total precipitation in wet condition	1/100	553
Mean annual total precipitation	1/2 (mean)	328

mm = millimetre.

Extreme wet year spring freshet from snow-melting or high-intensity short-term rainfall events are most critical to the design of water diversion dykes and water collection ponds. The resulting water level rise in the upstream pond for the short-term events is greater than the water level rise under a longer precipitation event. The long term event allows time for excess water to be drained or pumped to the downstream pond.

In this study, the 1/100 wet year spring snowpack snow water equivalent of 162 millimetres (mm), which is more critical than the 1 day extreme rainfall value of 56 mm, is adopted as the IDF for the water diversion dykes. The maximum water level rise in the upstream pond under the IDF was calculated assuming no water outflow from the upstream pond during the spring freshet event. This represents an extreme scenario that assumes the drainage channel to the downstream pond is completely blocked by ice during the spring freshet.

It is assumed in this study that pumping from water collection ponds (CP1 to CP6) will start simultaneously when the spring freshet starts. The design criteria for the water collection pond berms allow no water overflowing from the water collection ponds under a 1 in 100 wet year spring freshet or a 1-day 1/100 wet, extreme rainfall after the spring freshet.

Longer-term events are more critical to the design of water retention dykes containing a reservoir without discharge or with limited water discharge capability. In this study, water discharge by pumping through a pipeline is allowed during the open water seasons in the first four years of the mine operation (Year -1 to Year 3). The 30-day extreme rainfall value of 152 mm is adopted as the IDF for the water retention dykes during the period. The maximum water level rise in the reservoir under the IDF was calculated assuming that the regular monthly discharge rate will remain uncharged during the one-month extreme rainfall period and extra water discharge will start in the following months. The spring snowpack water equivalent for a 1/100 wet year is only 42 mm more than that for a mean year. This value is smaller than the 30-day rainfall for a 1/100 wet event and therefore does not govern the dyke design.

For the assumed no-discharge period after Year 3 during the mine operation, the IDF adopted for the water retention dykes is the flood generated from a net unit runoff of 202.5 mm over the total catchment area for a given reservoir. This value is equal to 90% of the incremental value of 225 mm between the annual total precipitation value of 553 mm for a 1/100 wet year and that of 328 mm for a mean year.

The dyke/berm design elevations including water levels and freeboards are discussed in the following responses to Request (ii).

Response to Request (ii):

Each of the dykes and berms has been designed to meet or exceed the minimum freeboard requirements that are required by the Canadian Dam Safety Guidelines (CDA 2007). The dyke/berm minimum freeboard and design elevation were determined based on a number of factors including dam classification, maximum normal operating water elevation, inflow design flood, wind setup, wave runup, settlement, etc. Table NRCan 1-11-2 presents the projected maximum reservoir water elevation under inflow design flood, minimum freeboard and design elevation for each of the dykes and berms.

CDA (2007) suggests that the minimum freeboard for a dam crest should be such that no overtopping occurs when 95% of the waves caused by the most critical wind when the reservoir is at its maximum extreme level during the passage of the inflow design flood (IDF). The most critical wind for each case depends on the consequence class of the dam. The minimum value of the wind to be used for calculating the minimum freeboard is the one that corresponds to an annual exceedance probability (AEP) of 1/10 for significant consequence dams. The maximum wind speed measured at the Gahcho Kué weather station was about 17 m/s during the period of from May 2004 to September 2005 (De Beers 2010, Annex B, page B4-5). This wind speed was used to estimate the wind set-up and wave run-up values for the feasibility level dyke design. The design wind speed will be updated for the detailed final engineering design of the dykes.

Table NRCan 1-11-2 Minimum Freeboards and Design Crest Elevations for Water Retention Dykes and Berms

Dyke/Berm	Projected Maximum Reservoir Operating Water Elevation under Normal Operating Conditions (m)	Projected Maximum Reservoir Water Elevation under Inflow Design Flood (m)	Minimum Freeboard from Crest Elevation to Maximum Reservoir Operating Water Elevation Required by CDA (2007) (m)	Adopted Minimum Freeboard from Design Crest Elevation to Projected Maximum Reservoir Operating Water Elevation	Maximum Design Crest Elevation (m)
Dyke A	420.7	421.5	1.6	4.3	425.0
Dyke B	422.1	422.7	1.5	2.4	424.5
Dyke A1	423.0	423.3	0.8	2.5	425.5
Dyke D	423.0	423.6	1.0	2.5	425.5
Dyke E	423.0	423.4	0.6	3.0	426.0
Dyke F	427.0	427.4	1.0	1.5	428.5
Dyke G	426.0	426.4	1.0	3.0	429.0
Dyke H	422.1	422.7	0.7	1.4	423.5
Dyke I	422.1	422.7	0.7	1.4	423.5
Dyke J	420.7	421.9	1.7	1.8	422.5
Dyke K	420.4	421.2	1.5	2.1	422.5
Dyke L	422.1	422.6	1.2	1.9	424.0
Dyke M	422.1	422.7	1.4	1.9	424.0
Dyke N	421.2	422.0	1.5	1.8	423.0
Till Berms around Area 1	423.0	423.3	1.1	2.5	425.5
Collection Pond CP3 Berm	409.5	411.5	2.3	2.5	412.0
Collection Pond CP4 Berm	416.5	417.5	1.1	1.5	418.0
Collection Pond CP5 Berm	413.0	415.5	2.9	3.0	416.0
Collection Pond CP6 Berm	408.0	410.5	2.8	3.0	411.0

M = metre; CDA = Canadian Dam Association.

The minimum freeboard from the crest elevation to the maximum reservoir operating water elevation required by CDA (2007) (Column 4 in the Table NRCan 11-1-2) was calculated to consider the wave runup, wind setup, and potential settlement. As stated earlier, detailed final engineering design for each of the dykes and berms will be carried out prior to dyke/berm construction.

The minimum freeboard and design crest elevation values adopted will be reviewed and updated in the detailed final engineering design.

References

CDA (Canadian Dam Association). 2007. Canadian Dam Safety Guidelines.

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 CANADA

April 2012

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: NRCan 1-12

Source: Natural Resources Canada -ESS

Subject: Foundation stability at dam, dyke and berm alignments
Key Line of Inquiry, Water Quality, Long-term Biophysical Effects; Subject of Note, Permafrost, Groundwater and Hydrogeology

EIS Section: section 3, 8, 10, II (11.6), Annex D; Conformity Response to Item I and 3

Terms of Reference 3.1,4.1.2,4.1.4, 5.2.5, 5.2.6

Preamble

Information collected by the Proponent indicates that permafrost at the mine site is generally warmer than -2.5°C (EIS sec 11.6.2.1, Annex D) and the available information indicates that permafrost may be present beneath some of the dyke and berm alignments. In its Conformity Response (section 4.4), the Proponent has indicated that dykes and berms will not be designed to rely on permafrost conditions over the long-term to ensure integrity and prevent seepage. NRCan would agree with the Proponent that frozen conditions should not solely be relied on given the relatively warm permafrost conditions and the potential for thawing under a changing climate. In section 4.4 of the Conformity Response, the Proponent indicates that the design will include an evaluation of foundation conditions to determine if permafrost thaw is an issue. The Proponent also mentions that additional till fill will be placed on the downstream side of dykes to reduce potential for seepage should the thermal evaluation indicate that permafrost below the key trench will thaw. It is not clear what investigations have been conducted to determine the foundation conditions at the dyke alignments. It is also not clear why the dyke design proposed for the case of permafrost thawing is not utilized for all dykes regardless of whether the thermal evaluation indicates permafrost thaw may occur (especially since dykes will be designed not to rely on frozen conditions over the long-term). If the thermal evaluation does indicate that permafrost thaw below the key trench is unlikely in the long-term, mitigation options and contingency plans will be required should actual conditions deviate from those predicted, in order to ensure maintenance of the integrity of the dykes and minimize potential environmental impacts.

Request

i. Please clarify why a similar design technique will not be utilized for all dykes, given the Proponent's intention not to rely on frozen conditions to control seepage.

ii. Please provide further details on the results of geotechnical investigations conducted for dyke alignments and plans for future investigations ine1uding thermal evaluation to facilitate the detailed dyke design.

iii. Please outline the contingency plans (including secondary containment systems) and mitigation options to be implemented should foundation conditions over the long-term deviate from those predicted in the thermal evaluation. This should also include a discussion of how information obtained through monitoring programs will be utilized in the decision process to determine when mitigation is required and to select from mitigation options.

Response

i. Foundation conditions was one of many criteria for dyke design and thus each dyke/berm required a somewhat unique design. The design technique for each dyke and berm was selected based on the site condition, dyke function, dyke classification and consequence of failure, construction material availability, and construction efficiency. Detailed design criteria and information can be found in the *2012 EBA Technical Memo – 2012 Gahcho Kué EIS Supplement - Summary of Dyke Conceptual Design and Construction Material for Gahcho Kué Diamond Project, NWT, Canada* (Appendix NRCan 1-12-A).

ii. Details of existing geotechnical investigations are summarized in Appendix NRCan 1-12-B, Table 1. The geotechnical and geophysical survey work undertaken to date along the dyke alignments is considered suitable for the development of the conceptual level of dyke design. Once the detailed design activities commence, additional geotechnical investigations are planned to finalize design details on the dykes. This will consist of one to two boreholes for each dyke for which site conditions are not adequately defined from previous site investigations. Additional ground temperature cables will be installed during the investigation to facilitate the design thermal evaluation. The finite element thermal evaluation will consider different climate conditions including climate change scenarios.

iii. The level of risk associated with the water-retaining dykes is considered low as well as the consequences of failure. The dykes are considered to be over-designed relative to their limited heights and the low hydraulic gradients to which they will be subjected. The majority of the dykes keep water from flowing into the mine area; thus minor seepage through the dykes is acceptable and seepage water entering the water collection pond can be easily managed. In the unlikely event that degradation of foundation conditions over the relatively short life of the structure impact a dyke's stability, contingency measures will be applied. Contingency measures may include foundation grouting, downstream or upstream till blankets, ground freezing for temporary situations, cut off walls or dyke reconstruction. The measured ground temperatures and the results from regular site inspection and monitoring activities will be collected, analyzed and reported. The information from monitoring programs will be used to determine if contingency measures are required and will be implemented accordingly.

Information Request Number: NRCan-1.13

Source: EIS section 8, 11.6

Subject: Shoreline erosion associated with rising water levels

EIS Section: 8, 11.6

Terms of Reference Section: 3.1.3, 4.1.2, 5.2.5

Preamble

The water management plan requires diversion of runoff (through construction of diversion dykes) which will result in increased water levels and surface area in a number of diversion lakes (e.g. Lake N11, lakes in watershed A,D,E, EIS Section 8.4, 8.6). Increases in water levels can result in thawing of frozen terrain and shoreline erosion, leading to increased sediment input into lakes. The Proponent has identified this as a potential impact (Table 8.6.1). The Proponent has concluded these effects are likely to be minor and has suggested a number of mitigation options (Table 8.6.1). Surveys will be conducted to determine the sensitivity of shorelines but no detail has been provided on the investigations to be conducted or the criteria that will be utilized to select from the mitigation options

Request

i. Please provide additional information on the surveys to be conducted to characterize shoreline sensitivity.

ii. Provide additional information regarding the decision process/criteria that will be utilized to determine if mitigation will be required to minimize erosion impacts and to also select the mitigation option.

Response

i. Lake shoreline and channel survey data were collected during the 2011 field season and are presented in the 2011 Shoreline and Channel Erosion Assessment report (Golder 2012). This report presents a detailed assessment/analysis of erosion potential at lakes with increase in water levels and lake outlet channels with modified flows.

ii. Mitigation requirements were determined based on erosion potential using an erosion classification system for lake shorelines, and field-derived parameters for outlet channels.

Shoreline erosion potential was estimated based on several parameters using a five-class classification system, ranking from Very Low to Very High. The parameters considered in the lake shoreline analysis included three categories: bank and shoreline features (i.e., bank height, bank vegetation, bank stability, and shoreline geometry), exposure characteristics i.e., (shore orientation and wind direction, fetch length, and water depth at 6 and 30 m from shore) and attenuation characteristics (i.e., aquatic vegetation, bank composition, and bank slope).

For areas with low erosion potential, non-structural measures (i.e., development of simple erosion barriers based on field monitoring during the mine activities) were recommended. For areas with higher erosion potential, structural measures including modification of shoreline slopes and armouring of channel bed and banks, were recommended.

Outlet channel erosion potential was estimated based on several parameters, including bed and bank materials, bank vegetation, active erosion or depositional areas if present, slope measurements, and cross-sectional profiles. Outlet channel mitigation included recommendations for construction of new channels and enhancement of cobble-armoured channels for flow diversions.

Mitigation strategies (or “preparations” as referred to in the EIS) for lakes and lake outlets downstream of Kennady Lake subject to potential erosion from increased flows include construction or enhancement of cobble-armoured channels for new diversions downstream of Kennady Lake. Mitigation options are discussed in Golder (2012, *in preparation*). No mitigation is proposed for shorelines subject to small changes in mean monthly water levels, but these areas will be monitored to identify areas of accelerated erosion during the Construction phase of the Project.

Any gaps in the report, based on updates to the water management plan associated with the mitigated Fine PKC Facility, as described in the 2012 EIS Supplement (De Beers 2012), are anticipated to be addressed during a 2012 field program.

Reference

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.

Golder (Golder Associates Ltd.). 2012 *in preparation*. 2011 Shoreline and Channel Erosion Report. Report No. 11-1365-0001/DCN-048. Submitted to Mackenzie Valley Environmental Impact Review Board. .

April 2012

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: NRCan 1-14

Source: Natural Resources Canada -ESS

Subject: Seepage and stability from processed kimberlite and waste rock piles
Relevant to: Key Line of Inquiry, Water Quality; Subject of Note, Permafrost, Groundwater and Hydrogeology

EIS Section: Section 3, 8,10,11.5,11.6, Conformity Response to Items I and 3

Terms of Reference 4.1.2,4.1.4,5.2.5,5.2.6

Preamble

The Proponent has indicated that processed kimberlite (PK) will be placed at the containment site in winter and summer which may lead to the existence of frozen and unfrozen layers within the pile (e.g. section 4.2., 4.3 of conformity response). It is not clear however, whether consolidation of the unfrozen layers or pore water expulsion during frost penetration will have a significant effect on seepage or pile stability during the operation phase. The Proponent has indicated that freezing or thawing (and associated heave and settlement) of PK is not expected to affect the stability of the pile. However, it is not clear if an assessment of the frost susceptibility and thaw sensitivity of the material has been conducted. The Proponent has outlined measures for controlling infiltration into PK piles and also for ensuring chemical stability of both PK piles and waste rock piles. Submergence of all or part of these piles is part of the design. Infiltration however may occur during operation and prior to completion of refilling of Kennady Lake and return to the original lake level of 420. 7m. It is unclear what measures will be implemented to ensure infiltration is minimized prior to submergence.

Request

i. Please provide additional information related to the stability analysis for the PK piles, in particular provide (a) clarification regarding the effects that consolidation of unfrozen layers or pore water expulsion during freezing will have on seepage and pile stability; (b) information on assessment of frost susceptibility and thaw sensitivity of PK and its incorporation into the stability analysis.

ii. Please provide clarification on measures to be implemented to reduce infiltration into mine waste piles (PK and waste rock) to ensure chemical stability prior to submergence.

Response

i) The fine processed kimberlite (PK) will be deposited as slurry in Area 2. The deposition slope angle is anticipated to be relatively flat (approximately 2%). The thickness of fine PK in Area 2 will be a maximum of approximately 15 m with an average thickness of approximately 6 m. The fine PK will be deposited in Area 2 over a four year period. The majority of consolidation will occur as the fine PK is deposited. Due to frozen layers restricting flow and the continuing deposition of fine PK over previously deposited fine PK some pore pressure may build up in the underlying deposits. This is not anticipated to affect the overall stability of the fine PK surface based on performance of fine processed kimberlite containment (PKC) facilities at other northern diamond mines.

Frost heave testing on fine PK has been carried out for other diamond mines in the Canadian Arctic (EBA 1998). The testing was carried out on the fine and coarse fractions of the fine PK. The samples exhibited classical frost heave behaviour in that there was pore expulsion during the initial portion of the test with high cooling rates, and then frost heave and water intake during the later portion of the test. Over the long term the fine PK is expected to exhibit frost heave behaviour thereby redistributing the water in the fine PK. This is not anticipated to affect the stability of the fine PK area.

Ultimately the fine PK will be covered with a 1 m thick layer of coarse PK and a minimum 1 m thick layer of mine rock. If the fine PK thaws over the long term, ice within fine PK will thaw and may result in settlement in the facility. Thaw consolidation analysis (Nixon and Morgenstern 1971; Johnston 1981) of the fine PK indicates that the long term thaw will be sufficiently slow that the material will thaw and consolidate at a rate that instability in the fine PK will not occur. The cover material is flexible and will conform to the consolidating fine PK surface.

ii) The Fine PKC Facility will be covered with a layer of coarse PK and mine rock once the area has reached its capacity. The fine PK is relatively impermeable thereby restricting the flow of surface water flowing into the fine PK. The amount of seepage into the fine PK has been estimated using finite element seepage analyses. The overall water quality modelling has included the seepage rates from the fine PK (De Beers 2012, Appendix 8.II).

The mine rock will be placed in layers typical to other mine sites. The mine rock is permeable; however placement layers within the mine rock introduce discontinuities with the mine rock. Frozen layers within the mine rock also influences flow within the mine rock. The water quality model of the mine and mine rock piles conservatively assume that there is nothing to restrict the flow within the mine rock piles. The exception to this is potentially acid generating mine rock (PAG); in order to reduce water infiltration into the PAG material and control potential acid generation, it will be encapsulated within the mine rock pile above the restored lake elevation of 420.7 m.

References

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

EBA. 1998. BHP Tailings Characterization Study. Submitted to BHP Diamonds Inc. June 1998, by EBA Engineering Consultants Ltd.

Johnston, G.H. (Editor), 1981. Permafrost: Engineering Design and Construction. John Wiley & Sons, Canada Ltd., Toronto, 540 p.

Morgenstern, N.R. and Nixon, J.F., 1971. "One-dimensional consolidation of thawing soils." Canadian Geotechnical Journal, Vol. 8, No. 4, pp.558-565.