# GAHCHO KUÉ PROJECT

# ENVIRONMENTAL IMPACT STATEMENT

## SECTION 11.5

## SUBJECT OF NOTE: MINE ROCK AND PROCESSED KIMBERLITE STORAGE

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# 11.5 SUBJECT OF NOTE: MINE ROCK AND PROCESSED KIMBERLITE STORAGE

## 11.5.1 Introduction

### 11.5.1.1 Context

This section of the environmental impact statement (EIS) for the Gahcho Kué Project (Project) consists solely of the Subject of Note: Mine Rock and Processed Kimberlite Storage. In the Terms of Reference for the Gahcho Kué Environmental Impact Statement (Terms of Reference) issued on October 5, 2007, the Gahcho Kué Panel (2007) identified the need for this subject of note citing the following concerns:

> "*During the environmental assessment various parties expressed considerable concern over the feasibility of storing processed kimberlite and/or waste rock in the mined out pits without creating a long-term contamination source for Kennady Lake. Although parties generally acknowledged that backfilling pits is preferable to large waste rock piles, they considered this technology as unproven*."

For the purposes of the EIS, waste rock is herein referred to as mine rock. Mine rock is the rock around, and interspersed within, the kimberlite ore bodies. It includes the excavated bed rock surrounding the kimberlite deposits and generally consists of granite. The term mine rock is used, because this rock is used within the Project area for construction and reclamation, as well as for storage; consequentially, it is not considered waste. Mine rock will be used during construction to build roads, dykes, and dams. It will also be used for aggregate production, and portions of the Coarse PK Pile and Fine PKC Facility will be covered with mine rock as part of progressive reclamation and closure.

This subject of note includes a discussion of the amount of mine rock and processed kimberlite (PK) that is to be placed in the mined out pits and how this backfill is expected to interact with the refilled Kennady Lake and the surrounding groundwater systems over time. It also includes a discussion of how the on-land mine rock piles, Coarse PK Pile and Fine PKC Facility will be maintained over time and how the height of these structures may affect the behaviour of caribou. The construction, operation and closure of these on-land structures are also addressed in the Project Description (EIS Section 3). The alternatives that were considered and the reasons why the alternatives were rejected or accepted are described in Project Alternatives (EIS Section 2). Development of permafrost conditions in the structures on land and the interactions that may occur between the pit backfill and the surrounding groundwater systems are evaluated in the

Subject of Note: Permafrost, Groundwater, and Hydrogeology (EIS Section 11.6). Therefore, Sections 2, 3, and 11.6 of the EIS overlap this subject of note and provide further context.

### 11.5.1.2 Purpose and Scope

The purpose of the Subject of Note: Mine Rock and Processed Kimberlite Storage is to meet the final Terms of Reference for the EIS issued by the Gahcho Kué Panel. The terms of reference that specifically relate to this subject of note, and the location of where they are addressed, are shown in Table 11.5-1. The entire Terms of Reference document is included in EIS Section 1, Appendix 1.I and the complete table of concordance for the EIS is in EIS Section 1, Appendix 1.II.

The Terms of Reference requires that the EIS provide a detailed description and analysis of how materials in the backfilled mine pits will interact with Kennady Lake over the long-term (i.e., many decades or even centuries after closure and reclamation). More specifically, descriptions of the following are required to be included as part of the EIS:

- interactions between the mine rock and PK in the backfilled pits and all sources of water, including groundwater, surface water and permafrost (including taliks); and
- long-term maintenance of the mine rock and PK under frozen conditions, with due consideration given to climate change.

The Terms of Reference also include the following specific requirements and suggestions for assessing how the height of the mine rock piles may affect caribou behaviour:

- a review of available information on the effects of such structures on caribou behaviour;
- a detailed discussion of alternative designs and their potential impacts; and
- consideration of experiences at any of the existing diamond mines in the Northwest Territories (NWT).

**Table 11.5-1 Terms of Reference Pertaining to Mine Rock and Processed Kimberlite Storage**

| Final Terms of Reference Requirements | | Applicable EIS Sub-section |
|---|---|---|
| **Section** | **Description** | |
| 5.2.6 Biophysical Subjects of Note: Waste Rock and Processed Kimberlite Storage | The EIS must provide a detailed description and analysis of how any water contamination from mine rock and processed kimberlite placed in the backfilled pits will be avoided over the long-term (i.e., many decades or even centuries after mine closure). This will include descriptions of interactions between the mine rock and processed kimberlite (PK) and all sources of water, including groundwater, surface water, and permafrost (including taliks). | 11.5.4.1<br>11.5.4.2 |
| | The EIS must clearly describe the planned long-term maintenance of the mine rock and processed kimberlite under frozen conditions. This description must include different scenarios, including scenarios occurring decades and centuries into the future and a consideration of climate change. | 11.5.4.4 |
| | The EIS must provide a review of available information on the effects of structures (such as the height of the mine rock piles) on caribou behaviour, including experiences at any of the existing mines in the NWT. | 11.5.4.3 |
| | The EIS must provide a detailed discussion of alternative designs for the mine rock pile and their potential impacts. | 2.3.3 |
| 7 (Table 7-4) Other Issues | Remaining issues pertaining to physical stability include:<br>• mine rock and PK co-disposal; and<br>• impacts from changing permafrost. | 11.5.2<br>11.5.4.4 |

Source: Terms of Reference for the Gahcho Kué Environmental Impact Statement (Gahcho Kué Panel 2007).

EIS = Environmental Impact Statement; NWT = Northwest Territories.

### 11.5.1.3 Study Areas

The Project is situated about 280 kilometres (km) northeast of Yellowknife, Northwest Territories (Figure 11.1-1). Two mine rock piles, a fine processed kimberlite containment (PKC) facility, and a coarse PK pile are part of the Project footprint (Figure 11.1-2), and are located within the Kennady Lake watershed. Kennady Lake is a small headwater lake within the Lockhart River system.

The study area for the Subject of Note: Mine Rock and Processed Kimberlite Storage is defined by the location of the associated facilities within the Project development area, which include:

- West (Area 5) and South (Area 6) Mine Rock Piles;
- Fine PKC Facility;
- Course PK Pile;
- backfilled 5034 Pit;
- backfilled Hearne Pit; and
- Tuzo Pit.

### 11.5.1.4 Content

The following briefly describes the content under each heading of this subject of note:

- **Mine Rock and Processed Kimberlite Storage** summarizes the plans for mine rock and PK storage for the Project. The summary includes: reference to storage methods at existing diamond mines, where relevant; proposed storage designs for the Project; environmental design features and mitigation; and alternative designs that were considered (Section 11.5.2).
- **Pathway Analysis** relates to the effects analysis requirements of the Terms of Reference of potential pathways by which mine rock and PK storage could contribute to environmental effects (Section 11.5.3).
- **Effects Analysis** provides a summary assessment of environmental effects pathways related to mine rock and PK storage (Section 11.5.4). A summary assessment is provided, because the primary assessment of environmental effects occurs in other EIS sections.
- **Uncertainty, Monitoring, and Follow-up** presents a discussion of uncertainty, monitoring, and follow-up measures related to the potential for effects to water quality from mine rock and PK (Section 11.5.5).

- **References** lists all documents and other material used in the preparation of this section (Section 11.5.6).
- **Glossary, Acronyms, and Units** explains the meaning of scientific, technical, or other uncommon terms used in this section. In addition, acronyms and abbreviated units are defined (Section 11.5.7).

Effects pathways related to mine rock and PK storage represent potential pathways for effects to valued components (VC) that are assessed in other sections of this EIS. Because effects are only classified for assessment endpoints related to valued components and not for effects pathways (EIS Section 6), residual impacts were not classified and significance was not determined herein.

## 11.5.2 Mine Rock and Processed Kimberlite Storage

### 11.5.2.1 Design Considerations

Mine rock and PK management will be based on the “design for closure principle”, which aims to eliminate environmental effects at the source and to reduce environmental impacts to the minimum practical level consistent with safe and economically viable mining operations. Progressive closure and reclamation will be components of mine rock management, and will start as early as Year 3 of the mine operations.

Containment of the mine rock and PK, and the control and collection of seepage and contact water for treatment will be primary objectives of mine rock and PK management. Contact water refers to groundwater inflow to the active mine pits and process water in the fine PK slurry. Both of these sources of contact water will be reused in the processing plant with the remainder being pumped into the surface PK facilities and the backfilled mine pits.

The mine rock and PK placed in the mine rock piles, Fine PKC Facility and Coarse PK Pile will be located in areas subject to permafrost conditions in the long-term. The mine rock and PK placed into the mined-out pits will be flooded during the refilling of Kennady Lake.

The quantity of mine rock and PK to be placed in surface facilities (i.e., mine rock piles, Fine PKC Facility, and Coarse PK Pile) will be reduced by placement of materials into the mined-out pits. The sequential mining of the multiple kimberlite ore bodies will enable the backfilling of the mined-out 5034 and Hearne pits to the extent required. The following additional benefits will be realized by this process:

- reduction of environmental effects of the Project by allowing for the permanent storage of groundwater inflows to the active mine pits within the backfilled mine pits;
- facilitation of progressive closure and reclamation of the mine rock piles and PK storage areas prior to the end of operations; and
- reduction in closure and reclamation costs.

The facility designs, construction methods, and operating practices described in the EIS are based on preliminary engineering studies. Final designs, construction methods, and operating practices will be developed from detailed engineering undertaken during the final feasibility stage, and will benefit from feedback obtained through the environmental impact review process. However, the designs, construction methods, and operating practices described herein are considered sufficient to assess potential environmental effects, and changes resulting from ongoing consultation and engineering optimization are expected to maintain or enhance environmental performance.

### 11.5.2.2 Mine Rock Considerations

The mine operations at the Project include the sequential development of three open pits in the following order:

- 5034 Pit;
- Hearne Pit; and
- Tuzo Pit.

A total of about 226 million tonnes (Mt) of mine rock is expected to be generated during the development of these three open pits. Of the 226 Mt of mine rock produced to the end of operations, about 143 Mt will be directed to the designed mine rock piles. The remainder will be used for site construction, reclamation or be placed into one of the mined out pits that is to be backfilled.

The mine rock to be generated from the mine operations will be divided into two groups based on geochemical characterization: non-reactive (non-acid generating [non-AG]) and potentially reactive 9potentially acid generating [PAG]). Non-reactive mine rock will be used for construction purposes. To reduce the risk of potential acid rock drainage (ARD), PAG mine rock will be sequestered into the central zones of the mine rock piles in which permafrost conditions are expected to develop. Till from on-going pit stripping will be used to cover PAG rock to keep water from penetrating into that portion of the rock piles. The upper portion of the mine rock pile will be subject to annual freeze and thaw cycles, but the PAG rock sequestered deeper within the rock piles are expected to remain permanently frozen.

### 11.5.2.3 Processed Kimberlite Considerations

The processing operations are expected to generate about 31.3 Mt of PK. The PK will be generated in three streams: fine, coarse, and grits. Fine PK is expected to comprise only 25 weight percent (wt%) of the PK waste streams. The fine PK will be deposited in Areas 1 and 2 as a slurry with a solids content ranging from about 40 to 50 percent (%) by mass. Saddle berms and dykes constructed of overburden till from the 5034 Pit pre-stripping activities will be installed during the construction period to provide platforms for spigot discharge of the fine PK slurry.

Reclamation of the Area 1 and 2 Fine PKC Facility will be completed during mine operations, since fine PK will cease to be deposited in the facility after Year 8 when the Hearne Pit becomes available for fine PK storage. As the Area 1 portion of the facility becomes filled during the initial years of operations, it will be covered with a layer of coarse PK. This approach will allow subsequent vehicle traffic and placement of approximately a 1 to 2 m thick layer of non-AG rock. The facility will be graded to limit ponding of water and direct any surface runoff to Area 3.

The PK grits will be dewatered and combined with the coarse PK for a combined weight fraction of 75%. The coarse and grits PK will be dewatered at the processing plant, hauled by truck, and placed in the Coarse PK Pile adjacent to Area 4 and mined-out pits using conventional earthmoving equipment. Some coarse PK will be used as backfill and as a transition layer in the Fine PKC Facility prior to placement of the mine rock cap. The design storage capacity of the Coarse PK Pile is approximately 5.2 million cubic metres ($Mm^3$). The results of geochemical testing for the Project indicate that seepage from the PK will not generate ARD and is more likely to produce alkaline drainage.

### 11.5.2.4 Sequencing of Mine Rock and Processed Kimberlite Containment Facilities

As shown in Table 11.5-2, about 63% of the mine rock will be deposited in the mine rock piles and about 37% will be deposited in the mined-out open pits. Some of the mine rock will be used for construction of roads, dykes, dams and reclamation of the Fine PKC Facility.

As shown in Table 11.5-3, the fine PK will be deposited into the Area 1 and 2 Fine PKC Facility for the first seven years of mine operations, and then into the

Hearne Pit in Year 8. The coarse and grits PK will be deposited in the Coarse PK Pile. In later years, coarse PK will be used for reclamation of the Fine PKC Facility, and co-disposed with the mine rock in the 5034 Pit. Permafrost conditions are anticipated to develop within the mine rock piles by the end of mine life. Permafrost conditions are expected to develop in the Coarse PK Pile over a similar timeframe, but are expected to take longer to develop in the Fine PKC Facility.

**Table 11.5-2 Distribution of Mine Rock by Year**

| Project Year | 5034 Mine Rock (Mt) | | | Hearne Mine Rock (Mt) | | Tuzo Mine Rock (Mt) | | |
|---|---|---|---|---|---|---|---|---|
| | Total Mined | To: South Mine Rock Pile | To: West Mine Rock Pile | Total Mined | To: West Mine Rock Pile | Total Mined | To: 5034 Pit | To: West Mine Rock Pile |
| -2 | 1.6 | 1.6 | - | - | - | - | - | - |
| -1 | 16.0 | 16.0 | - | - | - | - | - | - |
| 1 | 27.2 | 27.2 | - | - | - | - | - | - |
| 2 | 24.7 | 24.7 | - | - | - | - | - | - |
| 3 | 17.7 | 2.2 | 15.5 | - | - | - | - | - |
| 4 | 10.5 | - | 10.5 | 1.9 | 1.9 | - | - | - |
| 5 | 2.9 | - | 2.9 | 10.0 | 10.0 | 11.6 | 11.6 | - |
| 6 | - | - | - | 11.8 | 11.8 | 13.3 | 13.3 | - |
| 7 | - | - | - | 3.6 | 3.6 | 27.2 | 27.2 | - |
| 8 | - | - | - | - | - | 31.5 | 31.5 | - |
| 9 | - | - | - | - | - | 9.9 | - | 9.9 |
| 10 | - | - | - | - | - | 4.0 | - | 4.0 |
| 11 | - | - | - | - | - | 1.0 | - | 1.0 |
| **Total** | **100.6** | **71.7** | **28.9** | **27.3** | **27.3** | **98.5** | **83.6** | **14.9** |

Mt = million tonnes.

**Table 11.5-3 Processed Kimberlite Deposition**

| Project Year | Fine Processed Kimberlite (Mt) | | | Coarse and Grits (Mt) | | | |
|---|---|---|---|---|---|---|---|
| | Total | Fine PKC Facility | Hearne | Total | Coarse PK Pile | Reclaim/ Dyke | In-Pit |
| 1 | 0.63 | 0.63 | - | 1.89 | 1.89 | - | - |
| 2 | 0.75 | 0.75 | - | 2.25 | 2.25 | - | - |
| 3 | 0.75 | 0.75 | - | 2.25 | 2.25 | - | - |
| 4 | 0.75 | 0.75 | - | 2.25 | 2.15 | 0.10 | - |
| 5 | 0.75 | 0.75 | - | 2.25 | 1.70 | 0.55 | - |
| 6 | 0.75 | 0.75 | - | 2.25 | 0.20 | 0.49 | 1.56 |
| 7 | 0.75 | 0.75 | - | 2.25 | - | 0.49 | 1.76 |
| 8 | 0.75 | - | 0.75 | 2.25 | - | 0.49 | 1.76 |
| 9 | 0.75 | - | 0.75 | 2.25 | - | 0.49 | 1.76 |
| 10 | 0.75 | - | 0.75 | 2.25 | - | 0.49 | 1.76 |
| 11 | 0.45 | - | 0.45 | 1.35 | - | 0.49 | 0.86 |
| **Total** | **7.83** | **5.13** | **2.70** | **23.49** | **10.44** | **3.59** | **9.46** |

Mt = million tonnes; PK = processed kimberlite; PKC = processed kimberlite containment; - = no kimberlite to deposit.

## 11.5.2.5 Backfilled Mine Pits

### 5034 Pit

The 5034 Pit will be primarily backfilled with mine rock from the mining of the Tuzo Pit. Backfilling is expected to begin in Year 5. About 37% of the mine rock generated during mine operations will be backfilled into the 5034 Pit.

The 5034 Pit will be completely backfilled except for the northern quarter where it borders the Tuzo Pit; this shared boundary is lower than the bottom of Kennady Lake. The 5034 Pit will be backfilled to the extent possible with mine rock; the remaining space will be eventually filled with water once mining in the Tuzo Pit is complete.

### Hearne Pit

Mining within the Hearne Pit is scheduled to finish in Year 7 of operations. Once mining in the pit has ceased, backfilling will begin. Hearne Pit will be the repository for the fine PK stream as soon as mining has ceased. The fine PK will be released via a pipeline into the pit. About 34% of the fine PK generated during mine operations will be backfilled into the Hearne Pit. Runoff water, pit water, and decant water from the fine PK will cause a water layer above the settled fine PK in Hearne Pit. The water will be left in place to allow for an accelerated filling schedule of the Hearne Pit. The top of the PK in the pit is anticipated to be 120 m deep; in comparison, the total depth of the Hearne Pit is expected to be 205 m.

**Tuzo Pit**

The Tuzo Pit, which is the last pit to be mined, will not be backfilled and will be about 305 m deep. The pit will be allowed to flood following the completion of the operations phase, as part of the refilling of Kennady Lake. Natural watershed inflows will be supplemented by pumping water from Lake N11. Flooding of the pits and returning Kennady Lake to its original lake level is expected to take approximately eight to nine years to complete after the end of operations.

## 11.5.3 Pathway Analysis

The Terms of Reference for the Subject of Note: Mine Rock and Processed Kimberlite Storage include the following environmental effects analysis requirements:

- evaluation of how the materials placed in the backfilled mine pits may interact with surface water and groundwater, including talik and permafrost areas;
- evaluation of the long-term maintenance and physical stability of the mine rock piles, Coarse PK Pile and the Fine PKC Facility; and
- examination of how the height of the mine rock piles, Coarse PK Pile and the Fine PKC Facility may affect caribou behaviour.

The primary analysis of interactions between the backfilled mine rock and PK and the surrounding permafrost and groundwater is provided in Subject of Note: Permafrost, Groundwater, and Hydrogeology (Section 11.6). The primary analysis of interactions between the backfilled mine rock and PK and the overlying surface water is found in Key Line of Inquiry: Water Quality and Fish in Kennady Lake (Section 8), whereas the long-term maintenance and stability of the mine rock piles, Coarse PK Pile and the Fine PKC Facility is outlined in the Project Description (Section 3) and Key Line of Inquiry: Long Term Biophysical Effects, Closure and Reclamation (Section 10). Similarly, the Key Line of Inquiry: Caribou (Section 7) provides the primary analysis of potential effects of the Project on caribou. A summary of the analyses completed in the above-noted EIS sections is outlined below.

## 11.5.4 Effects Analysis

### 11.5.4.1 Effects of Backfilled Mine Rock and Processed Kimberlite on Groundwater and Permafrost

As noted in Section 11.6, during operations, the open mine pits will act as sinks for groundwater inflow. Groundwater seeping into the open pits will originate from surface waters and from deep bedrock. Groundwater inflow originating from deep bedrock will draw high TDS groundwater to the pits. The TDS content of groundwater flowing into the pits will increase as each pit gets deeper, because of the higher salinity of the groundwater in the deep bedrock encountered as the pits extend to greater depths, and the upwelling of saline water from beneath the pits due to the vertical hydraulic gradient created as a result of Project activities.

Groundwater inflows collected in the pit dewatering systems will be discharged to the water management pond (WMP, Areas 3 and 5) or the process plant. Once the 5034 Pit is mined out in Year 5, discharge of groundwater into the WMP will stop, and the groundwater entering the 5034 Pit will be retained in the pit. Pit water from the Hearne Pit will be sent to the mined-out 5034 Pit. Groundwater inflows to both the 5034 and Hearne pits are predicted to gradually decrease as they are backfilled with mine rock and fine PK, respectively.

Groundwater inflow to the Tuzo pit is similarly predicted to decline after mining is complete and the refilling of Kennady Lake has begun. Once refilling is complete, the hydraulic gradient between the flooded pits and surrounding groundwater will dissipate, and the near hydrostatic fluid pressures that characterize the pre-mining groundwater regime will be re-established.

Flooding of the Tuzo pit basin (Tuzo Pit and unfilled portion of the 5034 Pit) with fresh water will alter hydraulic and density gradients until new pressure and chemical equilibriums are established. The water quality within the talik that will reform directly under the refilled Kennady Lake will initially be more dilute due to fresh water from the pit basin flowing into the talik groundwater system.

Once hydraulic heads return to equilibrium shortly after pit refilling is complete, it is expected any high TDS groundwater that has upwelled beneath the mine site during mining will begin to sink due to its higher relative density. Water in the backfilled Tuzo Pit is expected to be drawn downward from the bottom of the flooded pit into the bedrock, while relatively fresh groundwater discharges into the upper part of the pit. Over time, as the pre-mining fluid density profile is restored, the effects of density-driven flow are expected to be reduced. Inflow velocities should decrease and diffusion should become the dominant transport process, with mass moving from the surrounding deep groundwater system into the Tuzo Pit at a small rate.

Based on the above, the backfilled material placed in the mine out pits is expected to have little effect on the surrounding groundwater systems. Groundwater flow direction will be toward the mine pits during operations and into the post-closure period. Diffusive fluxes will also follow this same direction, with mass moving from the deep groundwater system into the backfilled Tuzo Pit. Materials are not expected to move in the opposite direction, into the groundwater system.

The backfilling of the 5034 and Hearne pits is expected to have a negligible effect on local permafrost conditions. Kennady Lake is currently underlain by a talik, and the placement of mine rock and fine PK into the Hearne and 5034 mine pits is not expected to result in a long-term change to this condition. In other words, while some change to the size and shape of the existing talik is expected to occur during the operation phase of the Project (as a result of lake dewatering), these changes will dissipate over time once the lake is refilled, a process that will not be negatively affected by the use of mine rock and fine PK as pit backfill.

#### 11.5.4.2 Effects of Backfilled Mine Rock and Processed Kimberlite on Surface Water Quality

As outlined in EIS Section 8.8, the flux of material from the backfilled pits, acting in combination with other sources, is predicted to result in changes to water quality in Kennady Lake over the long-term, in comparison to pre-development conditions. Affected parameters that are predicted to be present at higher concentrations than under existing conditions include, but are not limited to, total dissolved solids (TDS), barium, beryllium, boron, molybdenum, phosphorus and strontium. The results of the aquatic health assessment outlined in EIS Section 8.9 indicate that the predicted changes to water quality are not expected to affect aquatic health in Kennady Lake. Therefore, while the material placed in the backfilled pits, particularly the fine PK placed in the Hearne Pit, may be a continuous source of substances to Kennady, flux rates are predicted to be such that aquatic health in Kennady Lake is not expected to be detrimentally affected.

The statements outlined above are put forward with the understanding that the analysis of potential effects related to phosphorus is on-going and not yet complete. They will be updated accordingly in 2011 once the analysis is complete.

### 11.5.4.3 Effects of the Physical Presence of the Mine Rock Piles, Coarse PK Pile and the Processed Kimberlite Containment Facility on Caribou Behaviour

The mine rock piles, Coarse PK Pile and Fine PKC Facility associated with the Project will be permanent features on the landscape, covering approximately 303 hectares (ha). These storage facilities will be between 30 and 90 m high, with the mine rock piles being the highest features after closure. As identified in Section 7, the mine rock and PK storage facilities may attract caribou and present physical hazards that thereby increase the risk of injury or mortality to individual animals, which can affect the caribou population.

The general structure of a mine rock pile is a steep slope of loose rock, relative to the surrounding area. The overall side slopes of the mine rock and coarse PK piles will range from 2.4H:1V (2.4 horizontal:1 vertical) (mine rock piles) to 4H:1V (Coarse PK Pile). The angle of the side slopes will provide stability against sliding, with flatter side slopes being constructed when the final slope is exposed to the shoreline. For comparison, the mine rock piles at the Diavik Diamond Mine were constructed with side slopes ranging from 2H:1V to 5H:1V (DDMI 1998).

During operations, ramps will provide access points for haul vehicles, in a similar manner to the processes used at the Ekati and Diavik diamond mines. The substrate of the ramps will consist primarily of small-diameter crush and fill, creating a smooth gravel road that is easy to traverse. Progressive closure of the storage facilities will include re-grading the surface of the facilities and removing the mine access ramps; however, the ramps may be altered and used to provide access and egress corridors for caribou.

Caribou have been observed using artificial habitats created by mine structures (i.e., roads, PK storage facilities, mine rock piles) during mine operations. These structures may provide a means of avoiding insect harassment, as caribou are often observed bedding or resting on these structures (Gunn et al. 1998; BHPB 2004, 2006, 2007). They may also provide a source of dietary minerals and metals. For example, an analysis of caribou fecal pellets collected in and around the Colomac Gold and Ekati Diamond mines found elevated levels of ash content, indicating uptake of inorganic minerals and metals (MacDonald and Gunn 2004) through foraging on re-vegetation on PKC areas and other artificial mine habitats. To date, no injuries or confirmed mortalities of animals have been as a result of interaction with containment facilities (e.g., PKC facilities) at the Ekati Diamond Mine, the Diavik Diamond Mine or the Jericho Mine (BHPB 2010; DDMI 2010; Tahera 2007). Caribou mortalities have occurred near mine facilities, but these occurrences are presumed to be the result of predation by wolves or bears (BHPB 2006, 2007).

In cases where caribou have entered the mine rock piles at other mines in the NWT, the caribou have been monitored, and in some cases herded off the mine rock pile by environmental technicians. A similar approach will be used to manage and reduce the risk to caribou at the Project. Monitoring programs at the existing diamond mines have included behavioural studies of caribou groups when they are within and immediately adjacent to these mine sites, and caribou in high-risk areas are often monitored by on-site environmental technicians. Additionally, as a result of locally expressed concerns, the mine rock piles and PK storage facilities for the Project will not be vegetated at closure to prevent the facilities from becoming attractive to wildlife.

Although the presence of the on-site storage facilities may attract individual caribou, the implementation of environmental design features and mitigation, including the Wildlife Effects Mitigation and Management Plan outlined in EIS Section 7, Appendix 7.I, are expected to limit the risk of injury or mortality should they access the facilities. At closure, the entire site area will be re-contoured to reduce hazards to wildlife, and access corridors will be graded to facilitate the movement of caribou from these structures. Overall, the physical presence of the mine rock and PK storage facilities is not expected to result in a detectable change to caribou behavior or lead to an increase risk of injury or mortality to individual animals.

#### 11.5.4.4 Long term Stability and Maintenance of Frozen Conditions in Mine Rock Piles, Coarse PK Pile and Fine PKC Facility

The mine rock piles, the Coarse PK Pile and the Fine PKC Facility have been designed to incorporate a 1.5 factor of safety, meaning that the shear strength available to resist slope failure exceeds the shear stresses in place to drive slope failure by at least 50%. This factor of safety applies to both frozen ground and thawed ground conditions, and is consistent with the recommendations of the Canadian Dam Association guidelines (CDA 2007). As a result, the mine rock piles, the Coarse PK Pile and the Fine PKC Facility are all expected to be stable over the long term.

The assessment of potential effects to water quality and fish in Kennady Lake has so far been completed without taking the beneficial effects of permafrost into account. In other words, the assessment has been completed to date assuming no permafrost was present within the mine rock piles, the Coarse PK Pile and the Fine PKC Facility. As a result, an analysis of the presence and persistence of permafrost within the aforementioned structures has not been undertaken.

## 11.5.5 Uncertainty, Monitoring, and Follow-up

Overall, there is a high degree of confidence that the containment structures included in the Project design will function as designed. A detailed monitoring plan for mine rock and processed kimberlite storage will be developed during the detailed design phase that will follow the EIS phase. Key elements of the monitoring plan will include:

- Thermistors will be placed in the mine rock piles, Coarse PK Pile and Fine PKC Facility to monitor the development of permafrost conditions.
- Water quality will be monitored in the Tuzo Pit during and following refilling to confirm water quality predictions in the EIS and the stability of density stratification in the flooded pit.
- Water quality above the 5034 and Hearne pits will be monitored during and following refilling to confirm that saline water in the backfill does not interact with and change the quality of the overlying lake water to a greater extent than predicted.

## 11.5.6 References

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## 11.5.7 Acronyms, Units, and Glossary

### 11.5.7.1 Acronyms and Abbreviations

| | |
|---|---|
| **ARD** | acid rock drainage |
| **De Beers** | De Beers Canada Inc. |
| **EIS** | environmental impact statement |
| **NWT** | Northwest Territories |
| **PAG** | Potentially acid generating |
| **PK** | processed kimberlite |
| **PKC** | processed kimberlite containment |
| **Project** | Gahcho Kué Project |
| **TDS** | Total dissolved solids |
| **WMP** | Water management pond |

### 11.5.7.2 Units

| | |
|---|---|
| **ha** | hectare |
| **Mt** | million tonnes |
| **%** | percent |
| **$Mm^3$** | million cubic metres |
| **m** | metre |
| **km** | kilometre |
| **wt%** | weight percent |

### 11.5.7.3 Glossary

| | |
|---|---|
| **Acid rock drainage** | Acidic pH rock drainage due to the oxidation of sulphide minerals that includes natural acidic drainage from rock not related to mining activity; an acidic pH is defined as a value less than 6.0. |
| **Barren kimberlite** | Non-diamond bearing kimberlite. |
| **Groundwater** | Water that is passing through or standing in the soil and the underlying strata in the zone of saturation. It is free to move by gravity. |
| **Permafrost** | Permanently frozen ground (subsoil). Permafrost areas are divided into more northern areas in which permafrost is continuous, and those more southern areas in which patches of permafrost alternate with unfrozen ground. |
| **Processed Kimberlite** | Kimberlite ore which had been screened and washed as part of the processing procedure. |
| **Processed Kimberlite Containment** | On-site storage facility for storing processed kimberlite. |

| | |
|---|---|
| **Process Water** | Water used for processing kimberlite ore to remove diamonds or to carry fine processed kimberlite as a slurry to surface PKC facilities or backfilled mine pits. |
| **Runoff** | The portion of water from rain and snow that flows over land to streams, ponds or other surface waterbodies. It is the portion of water from precipitation that does not infiltrate into the ground, or evaporate. |
| **Thermistors** | A device whose electrical resistance, or ability to conduct electricity, is controlled by temperature. |
| **Till** | Sediments deposited by glacial ice. |