GAHCHO KUÉ PROJECT

ENVIRONMENTAL IMPACT STATEMENT

SECTION 11.2

SUBJECT OF NOTE: IMPACTS ON GREAT SLAVE LAKE

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

11.2 SUBJECT OF NOTE: IMPACTS ON GREAT SLAVE LAKE

11.2.1 Introduction

11.2.1.1 Context, Purpose and Scope

Section 11.2 consists solely of the Subject of Note: Impacts on Great Slave Lake. The Mackenzie Valley Environmental Impact Review Board (MVEIRB 2006) first identified impacts on Great Slave Lake as a subject of note. 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) then carried this topic forward as a separate subject of note to be addressed in the environmental impact statement (EIS).

The purpose of the Subject of Note: Impacts on Great Slave Lake is to meet the final Terms of Reference for the EIS issued by the Gahcho Kué Panel. The table of concordance for the Terms of Reference requirements for this subject of note are shown in Table 11.2-1. The entire Terms of Reference document is included in EIS Appendix 1.I, and the complete table of concordance for the entire EIS and Terms of Reference is in Appendix 1.II of Section 1, Introduction of the EIS.

The specific requirements in the Terms of Reference for the Subject of Note: Impacts on Great Slave Lake are limited to effects to Great Slave Lake. However, Section 7 of the Terms of Reference also requires an analysis of cumulative effects to the Lockhart and Hoarfrost rivers; therefore, the effects to these systems are also addressed herein.

The effects analysis provided herein is broad in nature owing to the direction outlined by the Gahcho Kué Panel, which stated in the Terms of Reference that a summary of the effects analyses completed for the Key Line of Inquiry: Downstream Water Effects (EIS Section 9) was all that was required for this Subject of Note.

11.2.1.2 Study Areas

11.2.1.2.1 General Location

The Gahcho Kué Project (Project) is situated north of the north-eastern arm of Great Slave Lake in the Northwest Territories (NWT) at Longitude 63° 26’ north and Latitude 109° 12’ west. The Project site is about 140 kilometres (km) northeast of the nearest community, Łutselk’e, and 280 km northeast of Yellowknife (Figure 11.1-1).

Table 11.2-1 Terms of Reference Pertaining to Impacts on Great Slave Lake

Final Terms of Reference Requirements		Applicable EIS Sub-section
Section	**Description**	
5.2.1 Biophysical Subjects of Note: Impacts on Great Slave Lake	under the 'downstream water effects' Key Line of Inquiry the EIS must already address the question of how far downstream any effects from water flow fluctuation and contamination are likely to reach.; therefore, a summary of the analysis for Great Slave Lake suffices here	11.2.3
7 (Table 7-3) Water Issues	remaining issues pertaining to surface water and watershed include	
	cumulative effects on Hoarfrost and Lockhart Rivers and Great Slave Lake.	11.2.3

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

The Project site is located in the watershed of Kennady Lake, a small headwater lake within the Lockhart River system. Waters from Kennady Lake eventually discharge to Kirk Lake and then into Aylmer Lake, which is located on the mainstem of the Lockhart River about midway along its length. The Lockhart River system drains into the north-eastern arm of Great Slave Lake.

The Hoarfrost watershed is located to the east of the Project site, with the Hoarfrost River draining into the north-eastern arm of Great Slave Lake, west of the Lockhart River system. The Project is located outside of the Hoarfrost watershed.

11.2.1.2.2 Study Area

A Regional Study Area (RSA) consisting of the upper and lower Lockhart River watershed was initially established for aquatic baselines. Survey intensity varied within each spatial boundary depending on the anticipated magnitude of Project effects. Baseline information was collected for the Local Study Area (LSA) that extended from the Kennady Lake watershed to the outlet of Kirk Lake; existing government data were used to describe baseline conditions in the RSA beyond Kirk Lake.

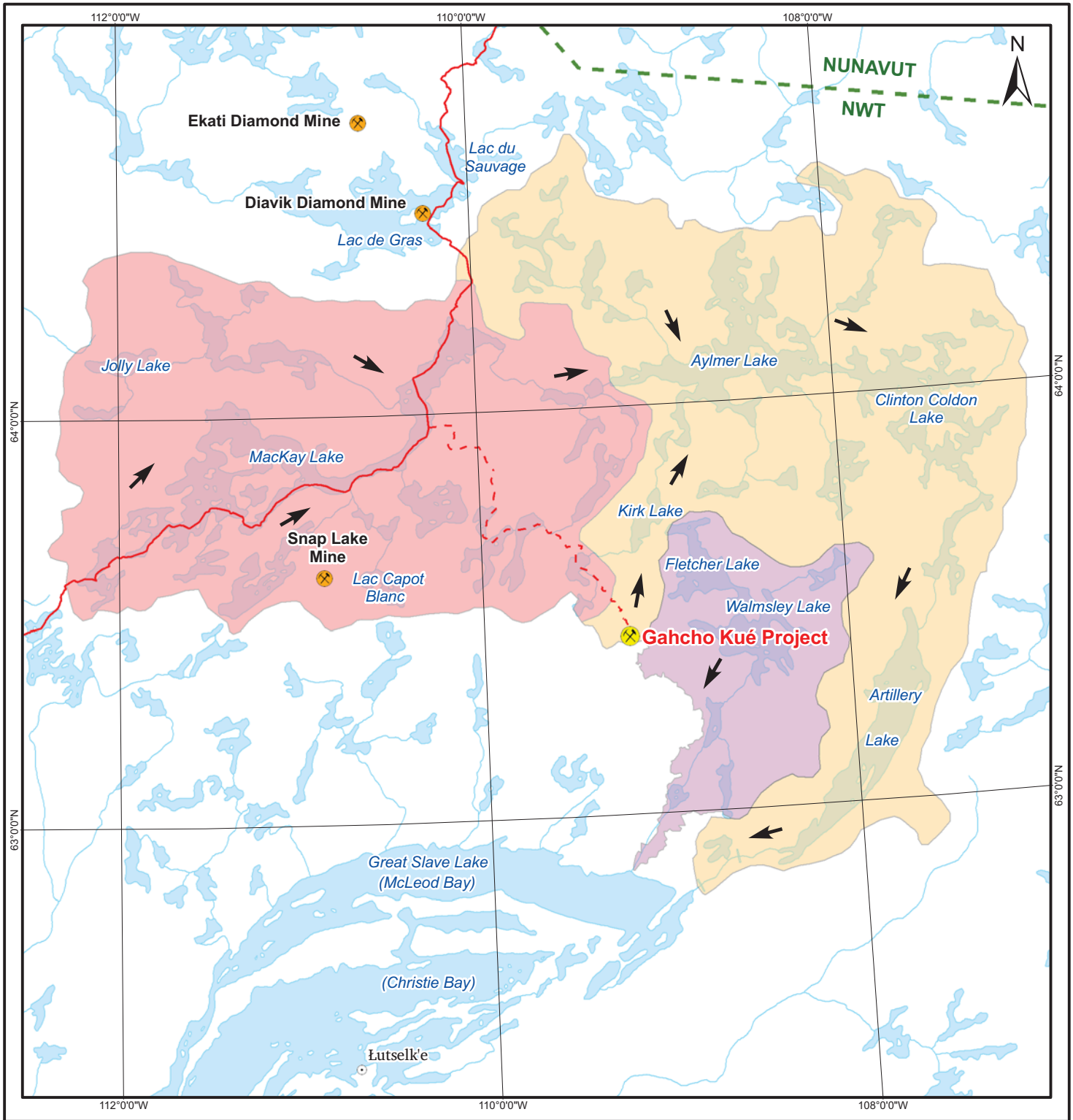
The study area for the Subject of Note: Impacts on Great Slave Lake encompasses the Lockhart River and Hoarfrost River watersheds (Figure 11.2-1), and potential effects of the Project to Great Slave Lake are assessed in the Lockhart River downstream of Artillery Lake, near the mouth before it flows into Great Slave Lake.

11.2.1.3 Content

Section 11.2 provides a summary of the effects analysis that was completed to evaluate potential effects to Great Slave Lake and potential cumulative effects to

the Hoarfrost and Lockhart rivers. The following briefly describes the content under each heading of this subject of note:

- **Existing Environment** provides a summary of baseline environmental information for the Lockhart River watershed at its outflow to Great Slave Lake, with a focus on the size of the watershed and the quality of the water flows into Great Slave Lake through the Lockhart River (Section 11.2.2).
- **Pathway Analysis** identifies all the potential pathways by which the Project activities could affect the Lockhart and Hoarfrost rivers and Great Slave Lake, summarizes the environmental design features and mitigation that will eliminate potential pathways or reduce associated effects, and assesses the validity of each potential pathway (Section 11.2.3).
- **Residual Effects Summary** provides a summary of the results of the pathway analysis and presents a conclusion on the environmental significance of effects (Section 11.2.4).
- **Uncertainty, Monitoring and Follow-up** discusses sources of uncertainty surrounding the predictions of effects outlined in this subject of note (Section 11.2.5), as well as monitoring and follow-up activities that are being considered in relation to these effects predictions.
- **References** lists all documents and other material used in the preparation of this section (Section 11.2.6).
- **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 11.2.7).



LEGEND

- Gahcho Kué Project
- Existing Mine
- Tibbitt-to-Contwoyto Winter Road
- Winter Access Road
- Watercourse
- Waterbody
- Territorial/Provincial Boundary
- Drainage Direction
- Hoarfrost Watershed
- Lower Lockhart River Watershed
- Upper Lockhart River Watershed

NOTES
Base data source: The Atlas of Canada

GAHCHO KUÉ PROJECT

Study Area for Effects to Great Slave Lake

PROJECTION: Canadian Lambert Conf. Conic	DATUM: NAD83	
Scale: 1:1,500,000 (30 15 0 30 Kilometres)		
FILE No: SON-11.2-002-GIS		DATE: November 18, 2010
JOB NO: 09-1365-1004	REVISION NO: 4	
OFFICE: GOLD-CAL	DRAWN: CW / CHECK: JB	

De Beers Canada

Figure 11.2-1

I:\CLIENTS\DE BEERS\09-1365-1004\maps\SON\SON-11.2-002-GIS.mxd

11.2.2 Existing Environment

The estimated watershed areas and mean annual flows for the Kennady Lake and Lockhart River watersheds are summarized in Table 11.2-2. The Kennady Lake watershed is a small part (i.e., approximately 0.1 percent [%]) of the Lockhart River watershed.

Table 11.2-2 Summary of Watershed Characteristics for Kennady Lake and the Lockhart River

Watershed	Watershed Area		Mean Annual Outflow	
	Absolute Value (km^2)	Ratio to Kennady Lake	Absolute Value (m^3/d)	Ratio to Kennady Lake
Kennady Lake	32.5	1:1	11,885	1:1
Lockhart River upstream of Aylmer Lake	~12,000	~400:1	n/a	n/a
Lockhart River downstream of Artillery Lake (near mouth)	26,600	818:1	10,668,493	898:1

Sources: Watershed areas delineated from 1:250,000 NTS maps. Mean annual outflow for Kennady Lake was derived by hydrological modelling reported in Annex H (Hydrology Baseline). Mean annual outflow data for the Lockhart River were derived from Water Survey of Canada Station 07RD001

km^2 = square kilometres; m^3/d = cubic metres per day; n/a = not available

Available water quality information for the upper and lower Lockhart River watershed is presented in Annex I and Addendum II (Water Quality Baseline). In general, water quality throughout the Lockhart River watershed is similar to baseline water quality in the Kennady Lake area and can be characterized as follows:

- low levels of suspended solids, which are often below detection limits;
- low levels of major ions and total dissolved solids;
- low trace metal concentrations; and
- low nutrient concentrations that would classify the trophic status of the watershed in the ultra-oligatrophic (very nutrient poor) to oligotrophic (nutrient poor) range.

11.2.3 Pathway Analysis

11.2.3.1 Methods

Pathway analysis identifies and assesses the issues and linkages between the Project components or activities and the correspondent potential residual effects on Great Slave Lake. It also includes a similar evaluation of how Project

activities could potentially contribute to cumulative effects in the Hoarfrost and Lockhart rivers. The pathway analysis involves a three-step process for initially identifying and then validating linkages between Project activities and potential environmental effects.

The first part of the analysis involves producing a list of all potential effects pathways for the Project. Each pathway is initially considered to have a linkage to potential effects on the systems of interest (e.g., Great Slave Lake). This step is followed by the development and/or identification of environmental design features and mitigation incorporated into the Project to remove the pathway or limit (mitigate) the effects to these systems. The design features are often developed through an iterative process involving the Project's engineering and environmental teams, and include Project designs, environmental best practices, management policies and procedures.

Knowledge of the ecological system and environmental design features and mitigation is then applied to each of the pathways to determine the expected amount of Project-related change that may occur and the associated residual effects (i.e., after mitigation) on the systems of interest, which, in this case, include the Hoarfrost and Lockhart rivers and Great Slave Lake. A source (Project component or activity) and a valid effects pathway are required for an effect to potentially occur.

Pathway analysis is a screening step that is used to determine the existence and magnitude of linkages from the initial list of potential effects pathways for the Project. This screening step is largely a qualitative assessment, and is intended to focus the effects analysis on pathways that require a more comprehensive assessment of effects. Pathways are determined to be primary, secondary (minor), or as having no linkage using scientific and traditional knowledge, logic, and experience with similar developments and environmental design features. Each potential pathway is assessed and described as follows:

- no linkage – pathway is removed by environmental design features and mitigation, so that the Project results in no detectable environmental change and, therefore, no residual effects to the environmental component in question relative to baseline or guideline values;
- secondary - pathway could result in a measurable and minor environmental change, but would have a negligible residual effect on the environmental component in question relative to baseline or guideline values; or
- primary - pathway is likely to result in a measurable environmental change that could contribute to notable residual effects to the

environmental component in question relative to baseline or guideline values.

Primary pathways require further effects analysis to allow for a classification of the potential impacts on the end use or ecological system affected by the change to the component in question (e.g., water flow in the Lockhart River). Pathways with no linkage or that are considered minor (secondary) are not analyzed further, because environmental design features and mitigation will remove the pathway (no linkage) or residual effects can be determined to be negligible through a simple qualitative evaluation of the pathway. Primary pathways are assessed in more detail, using quantitative approaches.

11.2.3.2 Results

Potential pathways by which Project activities could affect conditions in the Lockhart River and Great Slave Lake include the following:

- Changes to surface water flows downstream of Kennady Lake could alter flows in the Lockhart River and water levels in Great Slave Lake.
- Changes to water quality downstream of Kennady Lake could affect water quality in the Lockhart River and Great Slave Lake.
- Deposition of Project air emissions could alter water and sediment quality in the Lockhart River and Great Slave Lake.

A potential pathway by which Project activities could affect conditions in the Hoarfrost River includes the following:

- Deposition of Project air emissions could alter water and sediment quality in the Hoarfrost River.

Changes to surface water flows or water quality from Project water releases is not relevant to the Hoarfrost River watershed, because the Project is located entirely within the Lockhart River watershed.

Each of the four relevant potential pathways outlined above was evaluated as part of the pathway analysis, and was classified as “no linkage” pathway (as shown in Table 11.2-3). They were classified as “no linkage” pathways, because no measureable effects are projected to occur via these pathways at the mouth of the Lockhart River, in the Hoarfrost River or in Great Slave Lake. The rationale for this determination is outlined in more detail below, with reference to potential effects resulting from changes to stream flow and water quality and potential effects resulting from areal deposition.

Table 11.2-3 Potential Pathways for Effects to the Lockhart River, the Hoarfrost River and Great Slave Lake

Project Component/Activity	Effects Pathways	Environmental Design Features and Mitigation	Pathway Assessment
Hoarfrost River			
Mine development and reclamation	Deposition of Project air emissions could alter water and sediment quality in the Hoarfrost River	development and implementation of emission reduction action plans to limit aerial emissions from the Project site routine and regular maintenance of all on-site engines and generators to maintain optimal fuel efficiency compact layout of the surface facilities will limit travel distances and associated areal emissions use of low-sulphur diesel fuel regular watering of mine roads, the airstrip and equipment laydown areas to help control dust levels around the site establishment and enforcement of speed limits at the Project site, which will help limit dust production	no linkage
Lockhart River and Great Slave Lake			
Mine development and reclamation	Changes to surface water flows downstream of Kennady Lake could alter flows in the Lockhart River and water levels in Great Slave Lake	diversion of clear waters around the mine site to minimize effects to downstream flows use of existing on-site water to fill the Water Management Pond, thereby eliminating the need to pump water into the site at the beginning of operations refilling of Kennady Lake at the end of operations and a general return to pre-development drainage conditions	no linkage
	Changes to water quality downstream of Kennady Lake could affect water quality in the Lockhart River and Great Slave Lake	use of backfilled pits as a disposal mechanism for saline groundwater, thereby limiting the release of this water to downstream systems placement of mine rock and processed kimberlite into the completed Hearne and 5034 mine pits, thereby reducing the amounts of these materials that can directly interact with surface waters	no linkage
	Deposition of Project air emissions could alter water and sediment quality in the Lockhart River and Great Slave Lake	Same as those listed above with reference to potential effects to the Hoarfrost River	no linkage

Potential Effects Related to Changes to Surface Water Flows and Water Quality

Potential changes to the surface water flow rates and surface water quality are not expected to be measurable in the Lockhart River for the following reasons:

- Surface water is being managed to minimize effects to flows immediately downstream of Kennady Lake, maintaining those flows within a range that would result in a negligible to low magnitude of impact on fish and fish habitat during construction, operations and closure.
- Projected changes in water quality are not expected to affect the health of aquatic life immediately downstream of Kennady Lake during construction, operations and closure.
- The watershed areas for the Lockhart River upstream of Aylmer Lake (i.e., where outflow from Kennady Lake joins with the Lockhart River) and at the mouth (downstream of Artillery Lake) are approximately 400 and 800 times larger than the Kennady Lake watershed, respectively. Negligible or low magnitude impacts immediately downstream of Kennady Lake would not be measurable in a system that is 400 to 800 times larger.
- The only Project effect that could potentially be measurable in the Lockhart River would be an increase in flows during the initial dewatering of Kennady Lake. However, because the dewatering of Kennady Lake will be executed in a manner to prevent erosion and effects to fish and fish habitat immediately downstream of Kennady Lake, the likelihood that a change in flow beyond the range of natural variability will be measureable in the lower Lockhart River is remote.

Because changes in flows and water quality would not be measurable at the mouth of the Lockhart River, effects to water levels and water quality in Great Slave Lake would similarly not be measurable. Further evidence to support this conclusion is outlined below.

During initial dewatering of Kennady Lake, flows will increase downstream of Kennady Lake as water is pumped from Kennady Lake at a maximum rate of 614,000 cubic metres per day (m^3/d), which represents 6% of the mean annual flow at the mouth of the Lockhart River and approximately 12% of the mean annual inflow flow rate of the Lockhart River to Aylmer Lake. However, the percentage increase would be lower than noted, because dewatering will occur during the open water period when in-stream flows in the Lockhart River are higher than the mean annual flow rate. The magnitude of increase would have a negligible effect on water levels in Aylmer Lake, and would have no effect on fish or fish habitat in Aylmer Lake or in the Lockhart River downstream of Aylmer Lake. The effect on water levels would not be measurable in Great Slave Lake,

which has a watershed area of 971,000 square kilometres (km^2) (BIoO 2010, internet site). The Great Slave Lake watershed is 37 times larger than the Lockhart River watershed and 30,000 times larger than the Kennady Lake watershed.

During operation, flows downstream of Kennady Lake will be lower, as some of the natural inflow to Kennady Lake will remain on-site. Because the outflow from the Kennady Lake watershed represents such a small proportion of flows in the Lockhart River (<1%), projected decreases in flow immediately downstream of Kennady lake would have no effect on flows in the Lockhart River, water levels in Aylmer Lake and water levels in Great Slave Lake.

Effects of changes in water quality in waterbodies immediately downstream of Kennady Lake were assessed in Section 9. The assessment concluded that the magnitude of effects to the health of aquatic life in waterbodies immediately downstream would be negligible for construction, operation, and closure (including beyond closure) phases. Because the Kennady Lake watershed contributes such a small proportion of the total flow to the Lockhart River where it joins at Aylmer Lake, no effects to water quality or aquatic health would be expected in the Lockhart River or in Great Slave Lake.

Potential Effects Related to the Deposition of Project Air Emissions

As previously noted, water and sediment quality in the Hoarfrost and Lockhart rivers and in Great Slave Lake could potentially occur through the deposition of the following substances:

- suspended particulates;
- trace metals; and
- acidifying emissions.

Potential effects related to the deposition of these substances were evaluated in Sections 8 and 9, with respect to Kennady Lake and downstream waterbodies, respectively. The assessment included Project emissions and emissions from the Snap Lake Mine, which is the only other appreciable source of air emissions within the Lockhart River watershed.

Assessment of effects of deposition of total suspended particulates and trace metals in Section 8 concluded that measureable changes to water quality may occur in smaller waterbodies located in the Kennady Lake watershed near the mine site. However, the concentrations of total suspended particulates and trace metals in air are predicted to decline rapidly with distance from the Project, as

outlined in EIS Section 11.4 (Air Quality). Deposition rates of both total suspended particulates and trace metals are expected to follow a similar pattern, declining rapidly with distance from the Project site. As such, the deposition of these materials is expected to have a negligible effect on water and sediment quality in regional waterbodies located more than 2 km away from the Project site, as is the case for the Hoarfrost River watershed, the Lockhart River and Great Slave Lake.

Results of the assessment air emissions on local and regional waterbodies (as presented in EIS Sections 8 and 9, respectively) indicated that the deposition rate of acidifying emissions from the Project and other regional developments will not exceed buffering capacity of lakes within the Lockhart River and Hoarfrost River watersheds. Deposition rates of acidifying emissions are projected to be less than the critical loads of each waterbody. As a result, the effect of Project emissions on the persistence of aquatic biota and aquatic health is expected to be negligible.

11.2.4 Residual Effects Summary

Potential pathways by which effects to the Hoarfrost River, the Lockhart River and Great Slave Lake could occur include alterations to in-stream water flow, water quality and the deposition of air emissions. Each pathway was assessed and found to have no linkage for the following reasons:

- The deposition of air emissions is expected to have a negligible effect on water and sediment quality in regional waterbodies located more than 2 km away from the Project site, as is the case for the Hoarfrost River watershed, the Lockhart River and Great Slave Lake.
- The Project is located entirely within the Lockhart River watershed; therefore, Project water releases and potential changes in surface water flow and/or quality within and downstream of Kennady Lake will have no effect on surface water flows, water levels or water quality in the Hoarfrost River watershed.
- Changes to surface water flows immediately downstream of Kennady Lake would not have a measurable effect on flows in the Lockhart River, because the Project is being designed to minimize the disruption of downstream flows and the watershed area for the Lockhart River upstream of Aylmer Lake (i.e., where outflow from Kennady Lake joins with the Lockhart River) is approximately 400 times larger than the Kennady Lake watershed.

- Potential changes to water quality in waterbodies located immediately downstream of Kennady Lake are expected to have a negligible effect on aquatic health. Because the Kennady Lake watershed contributes such a small proportion of the total flow to the Lockhart River where it joins at Aylmer Lake, no effects to water quality or aquatic health would be expected in the Lockhart River or in Great Slave Lake.

Because Project effects will not be measurable in the Lockhart River watershed, the Hoarfrost River watershed or in Great Slave Lake, the Project would not have a measurable contribution to cumulative effects. Effects that are so small that they cannot be measured will not be environmentally significant.

11.2.5 Uncertainty, Monitoring and Follow-up

There is a high degree of confidence in the predictions that the Project will have no measureable effect on water flow, water quality or aquatic health in the Lockhart River, the Hoarfrost River or Great Slave Lake. The Project's sphere of influence does not extend into the Hoarfrost watershed, eliminating the potential for Project activities to measurably effect water flows or water quality in the Hoarfrost River. Similarly, the Lockhart River and Great Slave Lake are situated too far away from the Project to be directly influenced by the deposition of Project air emission.

Because the magnitude of change in flows are well defined and the magnitude of flow changes resulting from the Project are so much smaller than flows in the Lockhart River, there is a high degree of certainty that the Project will have virtually no effect on surface water flows and water levels in the Lockhart River system and in Great Slave Lake.

In addition, the assessment of downstream effects concluded that potential effects related to changes to water quality would have a negligible effect to the health of aquatic life immediately downstream of Kennady Lake. Because the watershed areas and consequently flows in the Lockhart River are hundreds of times greater than for Kennady Lake, there is a high degree of certainty that there will be no measurable effects to water quality in the Lockhart River or Great Slave Lake.

Water quality, flow and fisheries monitoring will be undertaken in Kennady Lake and downstream waterbodies during construction, operation and closure of the Project (see Sections 8 and 9). Because no measurable effects are expected to occur in the Lockhart or Hoarfrost rivers or Great Slave Lake, no monitoring or follow-up activities are planned for these systems.

11.2.6 References

11.2.6.1 Literature Cited

Gahcho Kué Panel. 2007. Terms of Reference for the Gahcho Kué Environmental Impact Statement. Mackenzie Valley Environmental Impact Review Board. Yellowknife, NWT.

MVEIRB (Mackenzie Valley Environmental Impact Review Board). 2006. Reasons for Decision and Report of Environmental Assessment for the De Beers Gahcho Kué Diamond Mine, Kennady Lake, N.W.T. June 28, 2006.

11.2.6.2 Internet References

BIoO (Biodiversity Institute of Ontario). *Great Slave Lake, Northwest Territories*. In: Encyclopaedia of Earth. Environmental Information Coalition, National Council for Science and the Environment. Washington, D.C. Last assessed at http://www.eoearth.org/article/Great_Slave_Lake,_Northwest_Territories on November 9, 2010.

11.2.7 Acronyms and Glossary

11.2.7.1 Acronyms

EIS	environmental impact statement
LSA	Local Study Area
n/a	not available
NWT	Northwest Territories
Project	Gahcho Kué Project
RSA	Regional Study Area

11.2.7.2 Units of Measure

%	percent
km	kilometre
km^2	square kilometre
m^3/d	cubic metre per day
<	less than

11.2.7.3 Glossary

Buffering capacity	The capability of a system to accept acids without the pH changing noticeably.
Environmental design feature	Environmental design features include Project designs and environmental best practices, management policies and procedures, and social programs. They remove an effects pathway between the Project and the environment or limit the associated effects (e.g., spraying water on roads to reduce dust).
Major ions	Certain ions in water that are positively charged (cations) or negatively charged (anions), including cations of hydrogen, sodium, potassium, calcium, magnesium, ammonium) and anions of fluoride, chloride, sulphate, nitrate, bicarbonate, carbonate, and phosphate.
Metals	A chemical element that is a good conductor of both electricity and heat and forms cations and ionic bonds with non-metals. Examples of metals in water include aluminum and iron.
Nutrients	A chemical an organism (plant or animal) needs to live and grow that must be taken in from the organism's environment. Examples of nutrients in water include nitrogen and phosphorus.
Oligotrophic	Trophic state classification for lakes characterized by low productivity and low nutrient inputs (particularly total phosphorus).
Total suspended particulates	A measure of the total particulate matter suspended in the air. This represents all airborne particles with a mean diameter <30 µm (microns) in diameter.
Suspended solids	The amount of suspended substances in a water sample. Solids, found in wastewater or in a stream, which can be removed by filtration. The origin of suspended matter may be artificial or anthropogenic wastes or natural sources such as silt.
Ultra-oligotrophic	Trophic state classification for lakes characterized by very low productivity and nutrient inputs (particularly total phosphorus).
Watershed	The entire catchment area of runoff containing a single outlet.