April 2012

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: DFO&EC_5

Source: Fisheries and Oceans Canada and Environment Canada (DFO&EC)

Subject: Water Clarity

EIS Section: 9.3.4 Lower Trophic Levels

Terms of Reference Section:

Preamble:

Comprehensive baseline information is essential in order to allow comparisons during construction and operations to detect potential mine effects.

Request

a) Undertake a comprehensive sampling program to better understand water clarity. Using either Secchi discs or light sensors, sample twice per month through the open water season for reference lakes, Kennady Lake and downstream lakes. Sample at the deepest point in the lake to maximize the vertical profile.

b) How will changes to TSS and light attenuation, that may affect primary productivity and benthic invertebrates, be monitored?

Response

a) Secchi depth data have been collected from a variety of lakes within the local study area (LSA) as part of the completed baseline programs associated with the EIS, and as part of on-going monitoring programs; however, they are not reported in the aquatics sections of Sections 8, 9 or 10 of the 2011 EIS Update (De Beers 2011). Secchi depth data are provided in Annex J: Fisheries and Aquatic Resources Baseline, and Annex JJ: Additional Fish and Aquatic Resources Baseline Information provided in the EIS (De Beers 2010). Supplemental secchi depth monitoring data collected from lakes in the LSA are also provided in the 2011 Fish and Aquatic Resources Supplemental Monitoring Report (Golder 2012).

Baseline aquatic data, and on-going monitoring data, linked to water clarity in the LSA and reference lakes during the open-water season, include TSS, turbidity, chlorophyll *a,* Secchi depth, colour, and lower trophic organisms (including phytoplankton and periphyton, zooplankton and benthic invertebrates). The available baseline information describing these physical and biological parameters throughout pre-development, construction, operation, and closure phases will provide a basis to evaluate potential environmental changes due to mine effects in the post-closure Kennady Lake and receiving/downstream lakes.

A comprehensive sampling program that includes these parameters is proposed to be implemented at representative locations in the LSA and at selected times within the Project schedule (e.g., once/twice in each phase of the development), most likely as a component of the aquatic effects monitoring program (AEMP). The approach to aquatic effects monitoring for the Project is still conceptual, and detailed study designs and methods will be evaluated further through consultation with communities and regulatory agencies, and developed during the licensing phase of the Project.

b) The program that has been identified above will include a range of applicable monitoring parameters (from those listed above) at representative lakes in the LSA so that potential changes to light attenuation and TSS concentrations as a result of the Project have a high likelihood of being identified,

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.

Golder Associates Ltd. (Golder). 2012. 2011 Fish and Aquatic Resources Supplemental Monitoring Report. Submitted to the Mackenzie Valley Environmental Impact Review Board, March 2012.

Information Request Number: DFO&EC_6

Source: Fisheries and Oceans Canada and Environment Canada (DFO&EC)

Subject: Groundwater

EIS Section: 8.3.4.3 Groundwater Quality

Terms of Reference Section:

Preamble:

Comprehensive baseline information is essential in order to allow comparisons during construction and operations to detect potential mine effects.

Request

a) Please develop a table summarizing groundwater chemistry. Box and whisker plots, and Piper Plots accompanied by a short description would be useful.

Response

De Beers will provide a response to this Information Request in a separate technical memorandum that will be submitted to the MVEIRB in April 2012.

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: DFO&EC_7

Source: Fisheries and Oceans Canada and Environment Canada (DFO&EC)

Subject: Downstream Effects – Winter Flows

EIS Section: 9

Terms of Reference Section:

Preamble:

It is indicated in Volume 9 that limited field data was collected over the winter because project effects to winter flows are predicted to be small. However, changes to winter flows can have larger impacts on aquatic ecosystems. In addition, it is indicated that there was no flow under ice conditions at the outlets. However it also indicates that measurements were not taken.

Request

a) Please describe how flow conditions were determined if measurements were not taken, and describe measures proposed to confirm this prediction.

Response

Section 9.3.2.2.2 of the 2011 Environmental Impact Statement (EIS) Update (De Beers 2011) indicates that “all lake outlets that were examined, with the exception of Lake N11 and Lake N1, were consistently observed to be completely frozen, with no measureable flow during the winter”. Lake outlet channels were observed to be frozen to the bottom preventing any flow and/or flow measurements.

Freeze up conditions were further estimated on the basis of the observed winter conditions, observed start and end of season lake levels and discharge, the likely influence of watershed area, upstream lakes, and typical regional temperatures. Table DFO&EC_7-1 presents the first and last measurement or observation of each field program since 2004, and shows little to zero flow was observed for lakes with drainage areas smaller than 57 square kilometres (km^2) following or prior to the winter in May, June, or September.

For lakes downstream of Lake 410, the assessment presented in Section 9.7 of the 2011 EIS Update (De Beers 2011) shows that the Project will have very little effect on stages and the Project is, therefore, anticipated to have little to negligible effect on winter flows.

Predictions on winter flows were based on observations and measurements and additional measures to confirm these predictions are not required. Early- and late-season observations could be included in monitoring protocols at hydrometric stations operated during construction and operations.

Table DFO&EC_7-1 First and Last Measured or Observed Discharges, from 2004 to 2011

Lake	Drainage Area [km^2]	Start		End		Source
		Date	Discharge	Date	Discharge	
N7[(a)]	0.301	May-04	0	-	-	2010 EIS, Annex H[(b)]
A3	0.839	26-May-11	0.0098	15-Sep-11	0.0005	2011 Climate and Hydrology Supplemental Monitoring Report[(c)]
N14	0.975	22-Jun-10	0.0048	14-Sep-10	0	2010 EIS, Addendum HH[(b)]
		26-May-11	0.055	15-Sep-11	0.003	2011 Climate and Hydrology Supplemental Monitoring Report
E1	1.39	14-May-04	0	25-Sep-04	0.012	2010 EIS, Annex H
		29-Apr-05	0	20-Sep-05	0.018	2010 EIS, Annex H
D7	1.41	10-May-04	0	24-Sep-04	0.007	2010 EIS, Annex H
		29-Apr-05	0	20-Sep-05	0.13	2010 EIS, Annex H
N18	1.63	26-May-11	0.024	15-Sep-11	0.003	2011 Climate and Hydrology Supplemental Monitoring Report
D1	4.45	12-May-04	0	24-Sep-04	0.017	2010 EIS, Annex H
		29-Apr-05	0	20-Sep-05	0.029	2010 EIS, Annex H
		21-Jun-10	0.038	14-Sep-10	< 0.001	2010 EIS, Addendum HH
		26-May-11	0.097	15-Sep-10	0.01	2011 Climate and Hydrology Supplemental Monitoring Report
N9	5.17	25-May-11	0.01	15-Sep-11	0.009	2011 Climate and Hydrology Supplemental Monitoring Report
N6	9.92	6-Jun-05	0.157	21-Sep-05	0.03	2010 EIS, Annex H
N5[(a)]	13.5	May-04	0	-	-	2010 EIS, Annex H
N4[(a)]	13.6	May-04	0	-	-	2010 EIS, Annex H
N3[(a)]	15.1	May-04	0	-	-	2010 EIS, Annex H
N2	15.8	9-Jun-04	0	25-Sep-04	0.042	2010 EIS, Annex H
		29-Apr-05	0	21-Sep-05	0.102	2010 EIS, Annex H
N17	18.8	22-Jun-10	0.19	14-Sep-10	0.007	2010 EIS, Addendum HH
		26-May-11	0.132	15-Sep-11	0.017	2011 Climate and Hydrology Supplemental Monitoring Report

Table DFO&EC_7-1 First and Last Measured or Observed Discharges, from 2004 to 2011 (continued)

Lake	Drainage Area [km^2]	Start		End		Source
		Date	Discharge	Date	Discharge	
Area 8	32.5	12-May-04	0	26-Sep-04	0.119	2010 EIS, Annex H
		18-Jan-05	0	21-Sep-05	0.154	2010 EIS, Annex H
L1	37.5	3-Jun-04	0.04	26-Sep-04	0.167	2010 EIS, Annex H
		5-Jun-05	1.541	22-Sep-05	0.184	2010 EIS, Annex H
		23-Jun-10	0.416	15-Sep-10	0.009	2010 EIS, Addendum HH
		25-May-11	0.2	14-Sep-11	0.075	2012 Climate and Hydrology Supplemental Monitoring Report
M4[(a)]	45.1	May-04	0	-	-	2010 EIS, Annex H
M3[(a)]	52.6	May-04	0	-	-	2010 EIS, Annex H
N16	52.9	4-Jun-05	0.005	20-Sep-05	0.295	2010 EIS, Annex H
		22-Jun-10	0.314	15-Sep-10	0.083	2010 EIS, Addendum HH
M2[(a)]	54.2	May-04	0	-	-	2010 EIS, Annex H
M1[(a)]	56.7	May-04	0	-	-	2010 EIS, Annex H
N11	115	5-May-10	0.028	15-Sep-10	0.1	2010 EIS, Addendum HH
		25-May-11	0.152	15-Sep-11	0.335	2012 Climate and Hydrology Supplemental Monitoring Report
N1	183	2-Jun-04	0.076	25-Sep-04	1.744	2010 EIS, Annex H
		4-Jun-05	2.435	25-Mar-06	0.2	2010 EIS, Annex H
		5-May-10	0.089	15-Sep-10	0.164	2010 EIS, Addendum HH
Kirk	739	3-Jun-05	1.067	24-Mar-06	1.46	2010 EIS, Annex H
		6-May-10	0.803	15-Sep-10	2.02	2010 EIS, Addendum HH
		25-May-11	1.331	15-Sep-11	2.912	2012 Climate and Hydrology Supplemental Monitoring Report

(a) Visual observation during ground reconnaissance from May 9 to 12, 2004.

(b) De Beers 2010.

(c) Golder 2012.

km^2= square kilometres.

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 (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.

Golder (Golder Associates Ltd.). 2012. 2011 Climate and Hydrology Supplemental Monitoring Report. Report No. 11-1365-0001/DCN-049. Submitted to Mackenzie Valley Environmental Impact Review Board. March 2012.

April 2012

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: DFO_EC_8

Source: Fisheries and Oceans Canada and Environment Canada (DFO&EC)

Subject: Down Stream Effects – Interlake Data – Dissolved Oxygen

EIS Section: 9.3

Terms of Reference Section:

Preamble:

With the removal of overwintering habitat from dewatering Kennady Lake, it is important to know if other lakes in the area can offset the loss. One of the main indicators of overwintering potential is dissolved oxygen levels later in the winter during maximum ice coverage.

Request

a) It is indicated in Volume 9 that limited field data was collected over the winter. Please clarify if the results presented in Figure 9.3-4 average across the years 1998-2010?

b) Please clarify if Table 9.3-19 is providing an average of all the interlake individual measurements together.

c) Given that a number of studies have demonstrated that fish survive in waters with dissolved oxygen below levels of 6.5 mg/L, please justify the potential impacts to overwintering habitat presented in the EIS.

Response

a) The water temperature and dissolved oxygen (DO) profiles presented in Figure 9.3-4 in Section 9 of the 2011 Environmental Impact (EIS). Update (De Beers 2011) represent three sampling events during under-ice conditions in Lakes M3a and M4 between February and March in 2003. The figure title in the EIS Update (De Beers 2011) is incorrect as it suggests the data represents a longer time period.

Water column profile data for other downstream lakes during under-ice conditions are also provided in the July 2011 EIS Update, such as Lake N16 (Figure 9.3-6, provided in Section 9 of the EIS Update [De Beers 2011]), and Lake 410 (Figure 9.3-8, provided in Section 9 of the EIS Update [De Beers 2011]). No under-ice water column profile data were reported for lakes in the L watershed.

Supplemental monitoring water column profile data for downstream lakes were collected in 2011. A larger number of lakes were surveyed in the winter monitoring program, and included Lakes L1b and L2 (L watershed), Lakes M1, M2, M3, and M4 (M watershed), Lake 410 and Kirk Lake, and Lakes N2, N9, N11, N12, N16, and N17 (N watershed). Under-ice DO profiles collected in April are presented in Figure 4.8 of the 2011 Water Quality and Sediment Quality Supplemental Monitoring Report (Golder 2012). Under-ice profiles are similar with those provided in Section 8 of the 2011 EIS Update (De Beers 2011) and Annex I: Water Quality Baseline, provided in the EIS (De Beers 2010).

b) The summary statistics (minimum, median, and maximum) provided in Table 9.3-19 include data collected from the interlakes between 1998 and 2010. The interlakes include the small lakes located immediately downstream of Area 8, and lakes in the L and M watersheds.

Supplemental water column profile data for downstream lakes (including the interlakes and lakes in the N watershed, Lake 410 and Kirk Lake) are provided in Table 4.5 of the 2011 Water Quality and Sediment Quality Supplemental Monitoring Report (Golder 2012).

c) The 6.5 mg/L referred to in the Request is the Canadian Council for Ministers of the Environment (CCME) guideline value for dissolved oxygen for the protection of cold-water aquatic life (CCME 1999). This value was used in the 2011 EIS Update (De Beers 2011) to provide an indication of potential changes to overwintering habitat in Kennady Lake. However, this guideline value is conservative, as it is recognized that fish can survive in water with DO levels lower than 6.5 mg/L. For example, based on published literature for lake trout, the optimal (or preferred) range of dissolved oxygen levels for this sensitive species is greater than 5 to 6 mg/L, with 4 mg/L being the avoidance threshold, and less than 3 mg/L approximating the incipient lethal threshold (Evans 2006). Although little information is available on oxygen tolerances for round whitefish, they have been captured in waters with oxygen concentrations as low as 2.6 mg/L (Hale 1981 reported in Steinhart et al. 2007). Non cold-water species have much lower dissolved oxygen tolerances, with the incipient lethal limit for northern pike being less than 0.75 mg/L (CCME 1999).

In the 2011 EIS Update (De Beers 2011), concentrations of total phosphorus (TP) were projected to increase in the interlakes from 0.005 mg/L to 0.015 mg/L and 0.013 mg/L in the L and M watersheds, respectively. In the 2011 EIS Update (De Beers 2011), the downstream L and M watersheds were projected to be mesotrophic in the long-term. This change in trophic status could result in increased primary productivity and increased oxygen demand during under-ice conditions, and potentially result in small reductions in overwintering habitat availability or suitability at post-closure for fish species remaining throughout the winter.

However, based on the supplemental mitigation associated with the Fine Processed Kimberlite Containment (PKC) Facility and additional geochemical testing presented in the 2012 EIS Supplement (De Beers 2012), the updated water quality modelling results for the long-term steady-state TP concentrations in the L and M watershed lakes are predicted to be 0.009 mg/L and 0.008 mg/L, respectively, which indicates that the long-term trophic status will remain oligotrophic (i.e., less than 0.010 mg/L); these levels are less than that presented in the 2011 EIS Update (De Beers 2011). As a result, any changes to overwintering habitat in these downstream lakes would be very small, or potentially not measurable; no effects on fish would be expected.

References

Canadian Council for Ministers of the Environment. 1999. Canadian Water Quality Guidelines for the Protection of Aquatic Life: Dissolved Oxygen (Freshwater). In: Canadian Environmental Quality Guidelines, 1999, Canadian Council for Ministers of the Environment, Winnipeg.

De Beers Canada Incorporated (De Beers). 2010. Environmental Impact Statement for the Gahcho Kué Project. Submitted to the Mackenzie Valley Environmental Impact Review Board, December 2010.

De Beers. 2011. Environmental Impact Statement Conformity Response. Submitted to the Mackenzie Valley Environmental Impact Review Board in Response to the Environmental Impact Statement Conformity Review, July 2011.

De Beers. 2012. *In Preparation*. Environmental Impact Statement Supplemental Information Submission for the Gahcho Kué Project.

Evans, D.O. 2006. Effects of Hypoxia on Scope-for-Activity of Lake Trout: Defining a New Dissolved Oxygen Criterion for Protection of Lake Trout Habitat. Ontario Ministry of Natural Resources. Technical Report 2005-01.

Golder Associates Ltd. (Golder). 2012. 2011 Water Quality and Sediment Quality Supplemental Monitoring Report. Submitted to the Mackenzie Valley Environmental Impact Review Board, March 2012.

Hale, S.S. 1981. Freshwater Habitat Relationships Round Whitefish (*Prosopium cylindraceum*). Alaska Department of Fish and Game, Contract No. 14-16-0009-79-119, Anchorage, Alaska. Reported in Steinhart, G.B., M. Mineau, and C.E. Kraft. 2007. Status and Recovery of Round Whitefish (*Prosopium cylindraceum*) in New York, USA. Final report to State Wildlife Grant T-3-1, NYSDEC, Bureau of Wildlife, Albany NY. Department of Natural Resources. 12 February 2007.

Information Request Number: DFO&EC_9

Source: Fisheries and Oceans Canada and Environment Canada (DFO&EC)

Subject: Overwintering in Small Lakes

EIS Section: Volume 9-386

Terms of Reference Section:

Preamble:

Overwintering habitat is predicted to be limited in small lakes in various watersheds (e.g., L watershed) if the lakes are less than 3 m deep because the annual predicted ice thickness is 2 m. However, lakes with less than 1 m of free water under the ice are known to support fish.

Request

a) Please provide ice thickness measurements (including time of year that ice thicknesses where taken). Also, dissolved oxygen (DO) should be monitored late in the winter (e.g., April) to establish the overwintering potential of the lakes in question.

b) Please provide information on how reduced flows will affect overwintering potential in these lakes.

Response

a) Ice thickness in Kennady Lake and in other lakes in the Gahcho Kué Project area was measured during various winter sampling surveys as presented in Table DFO&EC_9-1. Additional winter water quality surveys have been conducted in the Project area; however, in some cases, ice thickness was not recorded, or was not entered into the project database.

   It is recognized that late winter (i.e., April or May) is the preferred time to measure under-ice dissolved oxygen, as it represents the extreme conditions that fish would be exposed to in the winter. Where possible, field surveys were scheduled for this period. Note that as part of ongoing winter supplemental monitoring data collection programs, as well as the Aquatics Effects Monitoring Program (AEMP) once implemented, ice thickness will be routinely measured and included in the database.

Table DFO&EC_9-1 Ice Thickness Measurements Recorded in the Gahcho Kué Project Area

Date	Location	Ice Thickness [m]	Date	Location	Ice Thickness [m]	Date	Location	Ice Thickness [m]
18-Jan-04	K5	1.74	6-May-04	North Basin	2	9-May-04	3/6 Pool	2
	N1	-		North basin	1.8		3/6 Pool	2
	M2	-		North basin	1.8		3/6 Pool	2
	M1	-		North basin	1.8		3/6 Pool	2
	P3	-		North basin	1.8		3/6 Pool	2
April 29-30, 2005	D7	1.71		North basin	2		410 lake south basin	2
	D1	1.79		North basin	2		Control Lake	2
	E1	-		North basin	2	May 9-12, 2004	D7	1.75
	K5	1.96		North basin	2		D1	1.64
	L1	(>1.1)		North basin	2		E1	1.68
	N16	-		North basin	2		K5	1.65
	N11	-		North basin	2		L1	-
	N6	(>1.2)		North basin	2		M4,M3,M2	-
	N2	1.86		North basin	1.8		M1	(>1.2)
	N1	1.8		North basin	1.8		N7,N6,N5,	-
4-May-04	South Basin	2	7-May-04	Tuzo	1.2		N4,N3,N2	
	South basin	2		Tuzo	1.2		N1	1.72
	South basin	2		Tuzo	1.2		Lake 410	-
	3/6 Pool	2		Tuzo	1.2		P Lakes	-
	3/6 Pool	2		Tuzo	1.2	5-Apr-11	N17	1.05
	3/6 Pool	2		Tuzo	2		N16	1.08
5-May-04	Outlet	2		Tuzo	2		E1	1.35
	Outlet	1.6		Tuzo	2	6-Apr-11	N11	1.08
	Outlet	1.6		Tuzo	2		N12	1.30
	Outlet	1.6		Tuzo	2		B1	1.25
	Outlet	1.6		Tuzo	2	7-Apr-11	X6	1.20
	Outlet	1.6		South basin	2		D3	1.30
	Outlet	1.6		South basin	2		Area 7	1.25
	Outlet	1.6		South basin	2		Area 6	1.18
	Outlet	1.6		South basin	1.6	8-Apr-11	N9	1.23

Table DFO&EC_9-1 Ice Thickness Measurements Recorded in the Gahcho Kué Project Area (continued)

Date	Location	Ice Thickness [m]	Date	Location	Ice Thickness [m]	Date	Location	Ice Thickness [m]
	Outlet	1.6		South basin	2		A3	1.20
	Tuzo	1.6		South basin	2		Area 3&5	1.08
	Tuzo	1.6		South basin	2		Area 4	1.25
	Tuzo	1.6		3/6 Pool	2	9-Apr-11	F1	1.15
	Tuzo	1.6		3/6 Pool	2		Kirk Lake	1.25
	Tuzo	1.6		3/6 Pool	2		L410	1.25
	Tuzo	1.6		3/6 Pool	2		Ref	1.20
	Tuzo	1.6		3/6 Pool	2		M3	1.30
	South basin	1.6		3/6 Pool	2		N2	1.20
	3/6 Pool	1.6		Outlet	2		M4	1.3
	Outlet	1.6	8-May-04	Outlet	2		Area 8	1.2
	Outlet	1.6		Outlet	2	11-Apr-11	L1B[L16]	1.25
	Outlet	1.6		Outlet	2		L2	1.25
				Outlet	2		M1	1.25
				Outlet	2			
	Outlet	1.6		Outlet	2		M2	-
				Outlet	2			
				Outlet	2			

Sources: JWEL, 2002b. Data Compilation (1995-2001) and Trends Analysis Gahcho Kué (Kennady Lake), Report ABC50310; JWEL, 1998. Water Quality Assessment of Kennady Lake, 1998 Final Report, Report BCV50016; JWEL, 1999. Trip Report #1 and Data Assessment for Kennady Lake Water Quality - 1999 Survey Program. (Data for this depth were represented as an average in "JWEL, 2002. Data Compilation (1995-2001) and Trends Analysis Gahcho Kué (Kennady Lake), Report ABC50310); JWEL, 1999b. Trip Report #1 and Data Assessment for Kennady Lake Water Quality - 1999 Survey Program. (This was omitted in "JWEL, 2002. Data Compilation (1995-2001) and Trends Analysis Gahcho Kué (Kennady Lake), Report ABC50310); EBA, 2002. Gahcho Kué Winter 2001 Water Quality Sampling Program, Gahcho Kué, NWT, Project No. 0701-98-13487.028; AMEC, 2004b. Fisheries Survey. Unpublished data; CANAMERA, 1996. Temperature Profiles (1996) - 5034 Project Kennady Lake, Canamera Geological Limited Environmental Resources; EBA, 2004d. Kennady Lake (Winter 2004) Water Quality Sampling Program, Project # 1740071.001; EBA, 2003. Kennady Lake Winter 2002 Water Quality Sampling Programme Kennady Lake NWT Project # 0701- 98- 13487.035; EBA, 2004a. Kennady Lake Winter 2003 Water Quality Sampling Program, Project No. 0701-98-13487.048; EBA, 2004b. Faraday Lake Winter 2003 Water Quality Sampling Program, Project No. 0701-98-13487.048; EBA, 2004c. Kelvin Lake Winter 2003 Water Quality Sampling Program, Project No. 0701-98-13487-048.

b) The assessment of how reduced flows and lake levels (i.e., during operations) may affect fish habitat in the L and M watersheds is provided in Section 9.10.3.2.2 of the 2010 EIS (De Beers 2010). As described in this section, the lake water levels during winter are reflective of water levels at freeze up (i.e., around the end of October). Although there will be a reduction in water levels under the ice, it is predicted to be less than a 10 cm change from baseline conditions; as a result, the effects on overwintering habitat would be expected to be negligible.

Due to the supplemental mitigation associated with the Fine PKC Facility, presented in the 2012 EIS Supplement (De Beers 2012), the water balance associated with the Project has been updated. Due to diversion of the A watershed to Area 8 instead of the N watershed, the reduction in under-ice water levels in the L and M watershed lakes is predicted to be less than presented in the EIS (i.e., less than 5 cm change from baseline conditions); similarly, this would result in negligible effects to overwintering habitat.

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.

April 2012

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: DFO&EC_10

Source: Fisheries and Oceans Canada and Environment Canada (DFO&EC)

Subject: Downstream Effects – Lake N11 and Lake N1

EIS Section: 9.3.3.2.2 Lakes in N Watershed

Terms of Reference Section:

Preamble:

Lake N11 will receive water from the Water Management Pond during operations and will be used as a source lake for the pump flooding of Kennady Lake at closure. Therefore, it is essential to have comprehensive baseline information in order to detect potential effects. This also applies to other lakes that will be impacted by mine operations.

Request

a) Please provide limnological and fisheries baseline data for Lake N11. These data should include, but not be limited to, dissolved oxygen (DO), and TSS.

b) Please clarify how long is it expected for Lake N11 to return to baseline conditions after pumping from the water management pond has ceased.

c) It is indicated that Lake N11 will experience increases in concentrations of nitrogen and ammonia mainly from blasting residuals. Please describe the proposed handling practices and what other mitigation measures that could be applied to reduce nitrogen and ammonia sources.

d) Given the limited baseline data available for lakes N11 and N1, and their connecting and outlet streams, please describe how DeBeers will develop and implement a comprehensive monitoring program to address this data

Response

a) Baseline water and sediment quality, limnology, lower trophic levels, fish and fish habitat, and fish tissue data were collected for Lake N11 in 2011. These data are summarized in the following baseline reports: 2011 Water Quality and Sediment Quality Supplemental Monitoring Report (Golder 2012a), 2011 Lower Trophic Organisms Supplemental Monitoring Report (Golder 2012b), and 2011 Fish and Aquatic Resources Supplemental Monitoring Report (Golder 2012c).

b) During the first four years of operations, it is expected that water quality within the water management pond will be suitable for discharge to Lake N11. Because the water management pond will contain elevated concentrations of nutrients, discharges to Lake N11 are projected to result in increased nutrient concentrations in the lake. As described in Section 9.10.3.3 of the 2011 EIS Update (De Beers 2011), the concentrations of total phosphorus (TP) are projected to increase in Lake N11 from a background concentration of 0.005 mg/L to a peak of 0.009 mg/L in operations. The trophic status of Lake N11 would remain oligotrophic, as it is under baseline conditions; the effect of the increased nutrient concentrations is expected to be a slight increase in productivity at all trophic levels.

   However, once the pumping from the water management pond stops, it is expected that the nutrient levels in Lake N11 will return to baseline conditions, with the aquatic community within the lake returning to pre-Project conditions. It is expected that this will occur relatively quickly (i.e., within five years) once the pumped discharge ceases. As Lake N11 is oligotrophic and phosphorus-limited, there would be rapid utilization of the increased nutrients, with the natural flushing from the system contributing to dilution.

c) The production and storage of explosives, including mitigation measures, is described in Section 3.10.2.6 of the 2010 EIS (De Beers 2010). As described in this section, explosive use will be managed with the primary environmental goal of limiting loss of ammonia to mine rock and kimberlite, which could subsequently leach into runoff at the Project site or be processed at the processing plant. A summary of mitigation and Project design features to minimize effects from the use of explosives is provided below.

   Runoff from the ammonium nitrate storage areas, mine pits, and mine rock piles will be contained within the controlled area boundary of the Kennady Lake watershed. The ammonium nitrate storage areas, emulsion plant, and explosives storage magazines will be sited north and northeast of the main plant site, with separation distances in accordance with the guidelines set out in the *Quantity-Distance Principles User’s Manual* published by the Explosives Regulatory Division of Natural Resources Canada.

During operations, the Project will use 100% emulsion product for blasting. The use of emulsion will minimize the issues of non-initiated ammonium nitrate product in wet holes typically associated with use of ammonium nitrate fuel oil (ANFO). Ammonium nitrate will be delivered and stored in double-lined bulk bags. This transport and storage method will minimize ammonium nitrate losses typically associated with the handling and storage of ammonium nitrate, such as dust generation caused by unloading and mechanical handling of bulk product.

All emulsion materials will be stored at the emulsion plant; any spills of emulsion materials will be contained within the building. Licensed contractors will supply all explosives and operate the emulsion plant.

The main bulk ammonium nitrate storage will be located north of the Fine PKC Facility (Area 2), with any runoff from the storage area going to the Fine PKC Facility. Runoff from the South Mine Rock Pile can be directed and held in settling ponds in Area 6 and Area 7 if nitrogen and/or ammonia levels are considered too high for pumping to the water management pond, and subsequently Lake N11, if water quality is acceptable for release; water in these areas could be held and later transferred to the mined out pits.

Adaptive management practices can be used to direct pit runoff water from the Hearne and Tuzo pits to the bottom of the mined out 5034 and Hearne pits after Year 5 of operations, rather than directing this water to the water management pond.

Diligent blasting practices will be carried out to ensure that all blast holes are properly charged and initiated. Any zones with excessive misfires will be placed in the South Mine Rock Pile.

Discharge to Lake N11 will be sampled regularly to monitor for compliance with discharge limits to be specified by the Mackenzie Valley Land and Water Board in the water license. Any water not meeting the discharge limits will be stored within the controlled area boundary of the Kennady Lake watershed.

d) As described in Part a) above, baseline sampling was conducted on Lakes N11 and N1 in 2011, and additional sampling will be carried out in subsequent years. The Aquatics Effects Monitoring Program (AEMP) for the Project is currently being developed. The AEMP will have an overall study design that will be developed according to currently accepted statistical design principles and regulatory guidance and will include hydrology, water quality (effluent and receiving water) and sediment quality components, components focused on lower trophic communities (i.e., plankton, periphyton, and benthic invertebrates), and fish and fish habitat. The development of the AEMP will involve regulatory and stakeholder input, as well as consideration of available TK, and allow for adaptive management.

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.

Golder (Golder Associates Ltd.). 2012a. *2011 Water Quality and Sediment Quality Supplemental Monitoring Report.* Report No. 11-1365-0001/DCN-050. Submitted to Mackenzie Valley Environmental Impact Review Board. March 2012.

Golder. 2012b. *2011 Lower Trophic Organisms Supplemental Monitoring Report.* Report No. 11-1365-0001/DCN-052. Submitted to Mackenzie Valley Environmental Impact Review Board. March 2012.

Golder. 2012c. *2011 Fish and Aquatic Resources Supplemental Monitoring Report.* Report No. 11-1365-0001/DCN-054. Submitted to Mackenzie Valley Environmental Impact Review Board. March 2012.

Information Request Number: DFO&EC_11

Source: Fisheries and Oceans Canada and Environment Canada (DFO&EC)

Subject: Downstream Effects - Increased Total Phosphorus and Increased Productivity

EIS Section: 9

Terms of Reference Section:

Preamble:

One of the expected impacts of the development is increased total phosphorus (TP) concentrations, and increased productivity in downstream habitats of Kennady Lake. These increases in TP and productivity are predicted to impact the oxygen dynamics, with the potential to produce anoxia and disrupt fish habitat. In some water quality tables (e.g. 9.3-21) the minimum Method Detection Limit (MDL) for TP was reported as 0.005 mg/L (i.e. 5 ug/L), while in others (e.g. 9.3-19) the MDL for TP is reported as 0.02 mg/L (i.e. 20 ug/L). This latter detection limit is unacceptable. Modern laboratories are more than capable of achieving much more sensitive detection limits. The Gahcho Kué systems are oligotrophic, and by definition, have TP concentrations generally below 10 ug/L. As such, in cases where the MDL was reported as 20 ug/L, TP was reported to be below analytical detection limits, forcing the Proponents to use subjective statistical approaches to analyzing data (e.g., 9-45). This will make detecting changes in TP over the Project, and after closure, extremely difficult.

Request

a) That a MDL for TP at 2 ug/L be utilized for all future analyses.

b) All water bodies be re-sampled during 2012 (monthly) using this new MDL to clarify the pre-impact condition and for model simulations.

c) All baseline data for total phosphorus using methods with detection limits >10 ug/L should be considered of minimal value. The more accurate methods employed in more recent surveys should be utilized in the future.

Response

We acknowledge that limitations exist in the analytical method detection limits (MDL) of the Gahcho Kué baseline water quality laboratory data for total phosphorus (TP) as listed in the Section 9.3 of the 2011 EIS Update (De Beers 2011). The data presented in Table 9.3-19 and Table 9.3-21 in this section include data collected between 1998 and 2010 from various baseline programs, often by different companies. The MDLs in the initial years of study (i.e., up to 2006) were higher, with cases of 0.3 milligrams per litre (mg/L) reported in early programs. Although the MDLs have decreased since that time, data reported with high MDLs relative to actual background concentrations have made it difficult to adequately evaluate existing TP concentrations in Kennady Lake and the downstream watersheds.

Prior to undertaking baseline programs in 2010, the detection limit issue was communicated to the current laboratories with recommendations to improve the detection limits by employing more precise TP analytical techniques (i.e., colorimetry). The improved detection limit is now being used in ongoing monitoring programs.

The answers to the specific questions are as follows:

a) Yes, the suggested 0.002 mg/L MDL for TP will be utilized as a maximum MDL for all future analyses. Samples collected since 2010 have been analysed at low-level concentrations, with MDLs ranging from 0.001 to 0.003 mg/L. For the 2010 monitoring program, MDLs varied between 0.001 and 0.003 mg/L (Addendum II: Additional Water Quality Baseline Information, provided in the 2010 Environmental Impact Statement [EIS; De Beers 2010]), and in the 2011 monitoring program, samples collected from lakes and streams outlets in the local study area (LSA) were analysed with an MDL at 0.001 mg/L (2011 Water Quality and Sediment Quality Monitoring Report [Golder 2012]). In the latter program, TP was detected in greater than 75% of the samples.

b) There are no plans to analyze TP in all waterbodies in 2012. The on-going monitoring program that has been proposed in 2012 includes a reference lake program to be conducted at a minimum of five screened reference lakes in under-ice and open-water conditions, and a targeted monitoring program in the D-E-N lakes during the open-water period. For each of these programs, a comprehensive water chemistry suite of water quality parameters will be analyzed, consistent with the parameters monitored in previous baseline and monitoring programs, which will include low-level TP analysis.

Please note that for the 2011 winter baseline monitoring program, 16 lakes were sampled in Kennady Lake and its sub-watersheds, 14 downstream lakes, and 2 reference lakes. Furthermore, during the 2011 summer program, 22 lakes and streams were sampled in Kennady Lake and its sub-watersheds, 25 downstream lakes and streams, and 2 reference lakes. The MDL for TP analysis in these 2011 seasonal programs was 0.001 mg/L.

c) It is agreed that the 10 micrograms per litre (µg/L; or 0.010 mg/L) MDL for TP is an appropriate minimum value in the historical dataset. In fact, the screening of the TP data for the EIS assessment removed all method detection data that were higher than 0.010 mg/L.

Since the submission of the 2010 EIS, ongoing monitoring with the lower MDL has provided useful TP data to supplement baseline TP information, and for the update to the WQ modelling source term for TP. For example, using the low-level analytical technique with a MDL of 0.001 mg/L in the 2011 monitoring program, the median and maximum TP concentrations measured in samples collected from the downstream lakes during winter conditions were 0.002 mg/L and 0.006 mg/L during under-ice conditions, and 0.002 mg/L and 0.009 mg/L during open-water conditions.

Future monitoring programs will apply the lowest available MDL to collected lake and stream samples.

References

De Beers Canada Incorporated (De Beers). 2010. *Environmental Impact Statement for the Gahcho Kué Project.* Submitted to the Mackenzie Valley Environmental Impact Review Board, December 2010.

De Beers. 2011. *Environmental Impact Statement Conformity Response*. Submitted to the Mackenzie Valley Environmental Impact Review Board in Response to the Environmental Impact Statement Conformity Review, July 2011.

Golder Associates Ltd. (Golder). 2012. 2011 *Water Quality and Sediment Quality Supplemental Monitoring Report.* Submitted to the Mackenzie Valley Environmental Impact Review Board, March 2012.

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: DFO&EC_12

Source: Fisheries and Oceans Canada and Environment Canada (DFO&EC)

Subject: Plankton and Chlorophyll Sampling

EIS Section: 9.3.4 Lower Trophic Levels

Terms of Reference Section:

Preamble:

The developer provides limited baseline data on plankton biomass and chlorophyll for a series of lakes, or lake basins, for a single month (August) for two pre-impact years. Despite little change in chlorophyll between years, algal biomass (by cell counting methods) differed by one order of magnitude between years. Thus, the results for phytoplankton biomass are highly suspect. The large difference in biomass, combined with the low sample size (n= 2 years), will make detecting a statistical change in the phytoplankton biomass extremely difficult. In general, there is considerable among-year variation in the baseline data for lower trophic levels and it is unclear whether this arises from differences in seasonal variation, changes in methods, or true differences among lakes and years. Differences in sampling protocols (e.g. depth integrated versus discreet profiles) greatly confuse the comparison of survey results.

Request

a) Please provide a re-evaluation of phytoplankton biomass (re-counts) for both sampling years to verify values relative to Chlorophyll a (Chla *a*) samples. Please also provide an explanation of approaches taken and how the discrepancy in phytoplankton biomass and Chl*a* may have arisen.

b) In order to ensure adequate pre-impact baseline data with which to assess changes in lower tropic levels, the following items should be included in a sampling program for 2012 as part of baseline data collection, and should be continued as part of an ongoing monitoring program:

   i. Phytoplankton in reference lakes, Kennady Lake and downstream lakes (including N9 and N11) should be sampled for taxonomy and biomass, once every two weeks for at least one entire open water season and then twice through the winter (Water clarity and Chla a could serve as proxies for primary productivity, though in this case information regarding community structure would be lost).

ii. Zooplankton in reference lakes, Kennady Lake and downstream lakes should also be sampled for taxonomy and biomass once every two weeks for at least one entire open water season, and then twice through the winter.

iii. (Chla *a*) sampling should be conducted once every two weeks through the open water season for reference lakes, downstream lakes and Kennady Lake.

iv. Calculate taxon richness for phytoplankton and zooplankton communities.

v. Calculate Trophic State Index (Carlson and Simpson 1996) for reference lakes, Kennady Lake and downstream lakes using Chla, TP, TN, and/or Secchi depth measurements.

vi. Water clarity should be monitored using either Secchi discs or light sensors. Sampling should be undertaken every two weeks through the open water season for reference lakes, Kennady Lake and downstream lakes. Sample at the deepest point in the lake to maximize the vertical profile.

vii. An effective evaluation of within-season variance should also be done for organisms with short generations (e.g. phytoplankton, zooplankton) in order to put the among-year data into context.

Response

a) There are apparent discrepancies between the 2004/2005 and 2007 phytoplankton biomass datasets. It is possible that these discrepancies are related to a change in taxonomist, since the sample collection methods did not vary among years. However, reanalysis of these phytoplankton samples is not possible because they have been disposed.

At this time, a re-evaluation of the data is not recommended because no additional information would be attained to resolve the apparent discrepancy. However, additional phytoplankton and chlorophyll *a* sampling will be completed and the existing baseline data will be augmented. This will provide a more robust dataset to compare future sampling results to evaluate potential Project-related changes.

b) An environmental monitoring framework is being developed for the Project. The objectives of this framework are to define the monitoring objectives and approach for the Aquatic Effects Monitoring Program (AEMP). This framework is still in the conceptual development stage. Detailed study designs and methods will be developed further through consultation with communities and regulatory agencies, and during the licensing phase of the Project. Components outlined in Part b(i) to (vii) will be considered during the development of the detailed study design.

Trophic status of the waterbodies under baseline conditions was defined by TP concentrations, with reference to chl *a* concentrations and Secchi depth. This assessment directly indicates the trophic state of a waterbody (OECD 1982; EC 2004) and is well-accepted by most limnologists. However, there are several ways of defining the trophic state of a waterbody; TSI, or trophic status indicator (Carlson 1977, Carlson and Simpson 1996) is one of these. The TSI scale ranges from 1 to 100 for three index variables (i.e., Secchi depth, total phosphorus [TP] and chlorophyll *a* [chl *a*]), which can be used as a basis for comparing the relative trophic state of a waterbody. The TSI approach has subsequently been supplemented with total nitrogen (TN) (Kratzer and Brezonik (1981), but this index was designed to be used in nitrogen-limiting conditions, which do not apply to the waterbodies in the local study area (LSA). Low TSI values for each variable indicate lower levels of biological productivity, and higher TSI values indicate higher levels.

Total phosphorus, Secchi depth and chl *a* data have been collected during aquatic baseline studies for the project and during on-going supplemental monitoring programs, although not always consistently, as baseline programs completed prior to 2010 were conducted at different times by different companies, and were designed in response to different mine plans. These TP and chl *a* data are reported for waterbodies in the Kennady Lake watershed in Annex I: Water Quality Baseline, Addendum II: Additional Water Quality Baseline Information Report, the 2011 Water Quality and Sediment

Quality Supplemental Monitoring Report (Golder 2012a), and Section 8: Key Line of Inquiry: Water Quality and Fish in Kennady Lake (Sections 8.3.6.2.1 and 8.3.7.2.1), and Secchi depth data are reported in Annex J: Fisheries and Aquatic Resources Baseline, and Addendum JJ: Additional Fish and Aquatic Resources Baseline Information Report, and the 2011 Fish and Aquatic Resources Supplemental Monitoring Report (Golder 2012b).

The average baseline values of TP (0.006 milligrams per litre [mg/L]), Secchi depth (8 metres [m]), chl *a* (0.001 mg/L) indicate that Kennady Lake is an oligotrophic lake (OECD 1982; EC 2004). The same trophic status classification applies if the TSIs are calculated using values obtained in the baseline and monitoring programs (i.e., TP: 30, Secchi depth: 30, chl *a*: 33) also indicate oligotrophy. However, since TSI values range in a wider scale, they give an opportunity to identify small changes in trophic level rather than three main categories of the trophic level (viz., oligotrophic, mesotrophic and eutrophic). They are “unitless” values, and the scale is generally easy to understand for non-technical people. As suggested by the reviewer, ongoing monitoring will include reporting of the TSI index.

References

Carlson, R.E. 1977. A trophic state index for lakes. Limnology and Oceanography. 22:361-369.

Carlson, R.E. and J. Simpson. 1996. A Coordinator’s Guide to Volunteer Lake Monitoring Methods. North American Lake Management Society. 96 pp.

Environment Canada. 2004. Canadian guidance framework for the management of phosphorous in freshwater systems. Ecosystem health: Science-based Solutions Report No. 1-8. National Guidelines and Standards Office, Water Policy and Coordination Directorate, Environment Canada, pp. 114.

Golder (Golder Associates Ltd.). 2012a. 2011 Water Quality and Sediment Quality Supplemental Monitoring Report. Report No. 11-1365-0001/DCN-050. Submitted to Mackenzie Valley Environmental Impact Review Board. March 2012.

Golder (Golder Associates Ltd.). 2012b. 2011 Fish and Aquatic Resources Supplemental Monitoring Report. Report No. 11-1365-0001/DCN-054. Submitted to Mackenzie Valley Environmental Impact Review Board. March 2012.Kratzer, C.R. and P.L. Brezonik. 1981. A Carlson-type trophic state index for nitrogen in Florida lakes. Water. Res. Bull. 17:713-715.

OECD (Organization for Economic Co-operation and Development). 1982. Eutrophication of Waters, Monitoring, Assessment and Control. Organization for Economic Co-operation and Development, Paris. 154 pp.

April 2012

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: DFO&EC_13

Source: Fisheries and Oceans Canada and Environment Canada (DFO&EC)

Subject: Fish Baseline for Small Lakes and Streams in Kennady Lake Watershed

EIS Section: 9.3.5 Fish

Terms of Reference Section:

Preamble

Lakes and their fish communities are intimately connected to their position in the landscape and the radical alterations in hydrology that many will experience are likely to greatly affect them.

Request

a) Please clarify if fish sampling was quantitative for small lakes and streams. Lakes and their fish communities are intimately connected to their position in the landscape and the radical alterations in hydrology that many will experience are likely to greatly affect them.

Response

Yes, fish sampling was quantitative for all lakes and streams sampled. As described in Annex J of the 2010 Environmental Impact Statement (EIS); De Beers 2010), all fish captured were identified to species and enumerated.

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.

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: DFO&EC_14

Source: Fisheries and Oceans Canada and Environment Canada (DFO&EC)

Subject: Non-Fish Bearing vs. Fish Bearing

EIS Section: 8

Terms of Reference Section:

Preamble:

Limited rationale has been provided for designating lakes as non fish bearing.

Request

a) Please provide further rationale for determining whether a lake is non-fish bearing, as a lake with a maximum depth of 3 meters still has overwintering potential.

Response

The rationale for designating lakes as fish bearing, non-fish bearing, or unknown is described in Sections J3.5.9.4 and J4.4.9.3 of Annex J (Fisheries and Aquatic Resources Baseline) of the 2010 Environmental Impact Statement (EIS) (De Beers 2010). Lakes were designated as non-fish bearing if no fish were captured, the maximum depths were too shallow for overwintering fish (i.e., less than 3 metres [m]), and there was no connection to fish-bearing lakes or streams during high flows (i.e., spring).

As ice thickness is typically up to 2 m in depth, isolated lakes less than 3 m deep were considered to be non-fish bearing because they would either freeze to the bottom or would have only small residual pockets of water where anoxic or near anoxic conditions would occur by mid to late winter. Although it may be possible for some forage fish species, such as slimy sculpin and ninespine stickleback, to overwinter during some years in lakes less than 3 m in depth, it is expected that in severe winter conditions, winterkill would occur. However, if the lake was less than 3 m deep, but well connected to other fish-bearing streams or lakes at some time of the year, there would be the possibility that fish (particularly forage fish) would be able to move in and repopulate the lake; in these cases, the lakes were considered to be fish bearing.

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.

April 2012

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: DFO&EC_15

Source: Fisheries and Oceans Canada and Environment Canada (DFO&EC)

Subject: Riverine Habitat

EIS Section: 9

Preamble:

The assessment of riverine habitat quality seems to be based on the spawning potential for Northern Pike and Arctic Grayling. The assessment should be expanded beyond this.

Request

a) Provide an assessment of riverine habitat based on the species likely to be present, and at all life stages.

Response

Other fish species present in the streams downstream of Kennady Lake include slimy sculpin, ninespine stickleback, and burbot. As described in Section 9.3.5 of the 2011 EIS Update (De Beers 2011), these fish species have typically been found in relatively low numbers in comparison to Arctic grayling within the streams between Kennady Lake and Lake 410, with the exception of slimy sculpin, which was the most abundant species found (De Beers 2010, Addendum JJ, Section JJ4.4.3.1.1).

Ninespine stickleback was the least abundant of the species identified in these streams, with only a few individuals being captured in lakes and streams downstream of Kennady Lake (De Beers 2010, Annex J, Addendum JJ). Although ninespine stickleback exhibits a riverine life history type, in northern Canada, it is more common in sloughs and shallow shore waters, and most often found in cool, quiet waters in weedy areas (Evans et al. 2002).

Burbot are likely only present in rivers in the juvenile life stage, as spawning occurs mid-winter when stream habitats downstream of Kennady Lake would be frozen to the substrate; however, all life stages have been presented here for completeness.

Typical habitat preferences for these species at all life stages are presented in Table DFO&EC_15-1, below, compared to Arctic grayling. Habitat preferences that exceed Arctic grayling are italicized in shaded boxes. All habitat preferences are summarized from Evans et al. (2002) and Grant and Lee (2004).

Table DFO&EC_15-1 Habitat Preferences and Timing in a Riverine Environment for Burbot, Ninespine Stickleback and Slimy Sculpin Compared to Arctic Grayling

Species	Life Stage	Preferred Depth [m]	Preferred Velocity [m/s]	Preferred Substrate	Timing in Riverine Environment in the Study Area
Arctic grayling	Adult	0 to 1.3 (prefer 0.61 to 1.08)	1.10 to 1.52 (can be found in 0.23 to 0.91)	R, G	Summer
Burbot		< 0.76	< 0.46	R, Co	Summer
Ninespine stickleback		0.5 to *2.5*	< 0.3	Sa, M	Summer
Slimy sculpin		0.1 to 0.3	0.04 to *1.72*	G, R, Bo, Si, Sa	Summer
Arctic grayling	Juvenile	0 to slow	0.2 to 0.3	Sa, G	Emergence to September
Burbot		< 0.76	< 0.46	V, Co	Summer
Ninespine stickleback		Shallow	< 0.3	Sa	Summer
Slimy sculpin		0.1 to 0.3	0.05 to 0.4	Co, B	Summer
Arctic grayling	Spawning	< 1	< 1.5, prefer 0.3 to 0.8	G, C	Mid-May to early June
Ninespine stickleback		0.9 to *1.35*	< 0.3	Cl, Si, V	May to Late July
Slimy sculpin		0 to 1	Slow	Under cover	Late May to early June
Burbot (Lakes only)		1 to *1.5*	0	G, Sa, R, Co	Late December to mid-January
Arctic grayling	Fry	0.05 to 0.5 (prefer 0.06 to 0.3)	< 0.8 (prefer 0 to 0.25)	B, Co, Si	Emerge late June to early July
Burbot		< 0.76	< 0.46	V, Co	Spring
Ninespine stickleback		Shallow, in nest	0 (in nest) to < 0.3	Sa, Si, Cl	June to August
Slimy sculpin		< 0.2	0.06 to 0.56 (prefer < 0.2)	Co, R, Bo	Late June to July

Substrates: Si = Silt, Cl = Clay, M = Mud, Sa = Sand, G = Gravel, Co = Cobble, R = Rubble, B = Boulder, V = Vegetation.

Note: italics in shaded boxes indicate habitat preferences that exceed Arctic grayling. m= metres; m/s= metres per second; <= less than.

Depth and velocity preferences for each life stage in riverine environments for slimy sculpin are similar to Arctic grayling. Although uncommon in stream systems in the area, the literature shows that ninespine stickleback may have a higher velocity tolerance than Arctic grayling. Very few ninespine stickleback were caught in comparison to slimy sculpin. Additionally, ninespine stickleback would primarily use the small ponds, and stream margins and quiet pools within the streams that would still be present under the operating flow regime. Therefore, additional effects to these species that would not be observed in Arctic grayling are not expected. Burbot within the study area are most likely to spawn in lakes only. The adult, juvenile and fry depth and velocity preferences for burbot are similar to Arctic grayling in the riverine environment. Likewise, changes to total invertebrate biomass effects to Arctic grayling would be similar to effects to these other species.

Overwintering for all species is expected to occur in lakes, with juveniles and adults moving out of the riverine environment prior to ice up.

Velocity comparisons between baseline and the Kennady Lake Dewatering Phase) are included in the 2011 EIS Update in Tables 9.10-4, 9.10-5, 9.10-6, and 9.10-7, with a comparison of average August water velocities between baseline and operations included in Table 9.10-8 (De Beers 2011). Significant effects on habitat suitability for Arctic grayling spawning and rearing have not been identified in the 2010 EIS (De Beers 2011). Therefore, because the range of habitat preferences between all species are generally similar, effects to the other three species that are also present in the riverine environment, but were not directly included as Valued Components (VCs) in the 2011 EIS Update, are also considered to be negligible (De Beers 2011).

A Flow Mitigation Plan is under development to mitigate potential effects to loss of fish habitat during open water periods that may affect spawning and rearing habitat use for all species. A key component of the plan will be to ensure access to riverine habitats is maintained during the spring freshet, and providing suitable depth of passage for adult Arctic grayling and northern pike. This would also result in suitable depth in passage for the smaller-bodied life stages and species discussed above.

In conclusion, additional adverse effects to juvenile burbot, ninespine stickleback, and slimy sculpin compared to Arctic grayling are not predicted for the downstream riverine environment. Any potential effects to habitat suitability during spring migrations and low flow periods in the riverine environment, or in post-closure lake levels, will be addressed in the Flow Mitigation Plan, which is under development.

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.

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Evans, C.L., J.D. Reist and C.K. Minns. 2002. *Life History Characteristics of Freshwater Fishes Occurring in the Northwest Territories and Nunavut, with Major Emphasis on Riverine Habitat Requirements*. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2614.

Grant, C.G.J and E.M Lee. 2004. *Life History Characteristics of Freshwater fishes Occurring in Newfoundland and Labrador, with Major Emphasis on Riverine Habitat Requirements*. Canadian Manuscript Report of Fisheries and Aquatic Sciences 2672.

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: DFO&EC_16

Source: Fisheries and Oceans Canada and Environment Canada (DFO&EC)

Subject: Round Whitefish

EIS Section: 8, page 133

Terms of Reference Section:

Preamble:

Round Whitefish were selected as one of the fish species used in a telemetry study. Unfortunately, too few were tagged to provide conclusive information on the species' movement in Kennady Lake. The results of a telemetry study would be helpful in determining how Round Whitefish are currently using Area 8.

Request

a) Please provide DeBeers' plans with respect to augmenting this information with additional data. Does DeBeers intend to conduct another telemetry study with Round Whitefish to gather the data that was not available due to low numbers of tagged fish in the initial study?

Response

De Beers does not plan on conducting another telemetry study for round whitefish, due to the fact that other surveys conducted as part of baseline studies and subsequent monitoring programs (e.g., gill netting) have provided a good indication of the habitat use of Area 8 by round whitefish, and that the assessment of the effects of isolation of Area 8 on fish and fish habitat was conservative.

Round whitefish in Kennady Lake exhibit a lacustrine life history, conducting all of their life history requirements within the lake. Results from summer and fall gillnetting (Table J.I-36 of Annex J, 2010 Environment Impact Statement [EIS] [De Beers 2010]) show that although round whitefish use Area 8 during the open-water season, they are more abundant in the deeper, colder basins within the main body of the lake (i.e., Areas 2 through 7). Round whitefish likely move in and out of Area 8 relatively quickly because habitat conditions are more suitable in Areas 2 to 7. No round whitefish were ever observed moving out of, or into, Kennady Lake in spring.

Based on shoreline habitat and fall spawning surveys, spawning areas for round whitefish were identified in the main basins of the lake; mature round whitefish were captured in nearshore areas of Areas 3, 4, and 5 (Section J4.4.7 of Annex J, De Beers 2010). Based on these studies, limited round whitefish spawning is expected to occur in Area 8.

As part of the development of dewatering and future lake recovery monitoring, various types of fish tagging techniques may be considered as data collection tools.

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.

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: DFO&EC_17

Source: Fisheries and Oceans Canada and Environment Canada (DFO&EC)

Subject: Baseline Netting

EIS Section: Section 9, page 107-109, Table 9.3-41 (small lakes survey downstream of Kennady Lake and in adjacent N watershed).

Preamble:

Section 9.3.5.2.5 provides a summary of fish species caught in small lakes downstream of Kennady Lake, and in the adjacent N watershed. However, information on methodology is limited and fish data (e.g. length, weight) is absent.

Request

a) Please provide additional information on methods (e.g., mesh size, soak time, number of nets/per lake, time of year, number of years).

b) Please provide fish data (e.g. length, weight, age, abundance).

Response

The information presented below includes results from field surveys completed from 1996 to 2011 (Canamera 1998, Jacques Whitford 2003, Jacques Whitford 2004, EBA and Jacques Whitford 2001, De Beers 2010, Golder 2012). Note that the data presented in Section 9.3.5.2.5, as referred to in the Preamble, included data from 1996 to 2010 (i.e., did not include the 2011 data).

Item A

Fish surveys were conducted in the small lakes downstream of Kennady Lake and in the adjacent N watershed in 1996, 2002, 2003, 2004, 2005, 2010, and 2011. In total, 33 small lakes have been sampled, including 12 in the L watershed, four in the M watershed, and 17 in the N watershed (Table DFO&EC_17-1). Survey methods included gillnetting, shoreline electrofishing, minnow trapping, and angling. Location, soak-times, and dates for all fish survey methods conducted in the small lakes are presented in a Microsoft Excel worksheet (GK Watershed DS Ken and N Fish Effort_March2012.xlsx). Gill net mesh sizes are also included in the worksheet. The life history data (i.e., length and weight measurements, sex, maturity, and age) for recorded fishes are available in a Microsoft Excel worksheet (GK Fish Life History_March2012.xlsx). These files will be provided on CD to DFO&EC.

In 1996, experimental gillnet gangs were set in Lake M4 in July and September (Canamera 1998). In July, net sets were approximately 17 hours in duration, and in September, net sets were approximately two hours in duration.

In 2002 and 2003, sampling was limited to baited minnow traps. In August 2002, traps were set for two to three hours in two lakes in the L watershed (Jacques Whitford 2003). In August 2003, traps were set for 24 to 48 hours in three lakes in the L watershed (Jacques Whitford 2004).

In 2004, backpack electrofishing and gillnetting were completed in Lake N7 (Annex J of the 2010 EIS [De Beers 2010]).

In 2005, a total of 22 small lakes were sampled in the L, M, and N watersheds (Annex J of the 2010 EIS [De Beers 2010]). These included seven lakes in the L watershed, four lakes in the M watershed, and 10 lakes in the N watershed. Gillnetting was conducted in 19 of these lakes. Net sets were approximately two hours in duration. Backpack electrofishing surveys were conducted along representative shoreline sections of 16 lakes.

De Beers Canada

April 2012

Table DFO&EC_17-1: Fish Survey Methods in the Small Lakes Downstream of Kennady Lake and in the Adjacent N Watershed, 1996-2011

Watershed / Site	Year and Method[(a)]												
	1996	2002	2003	2004		2005		2010		2011			
	GN	MT	MT	EF	GN	EF	GN	MT	GN	MT	EF	AN	GN
Downstream of Kennady Lake Watershed													
L1a						✓	✓						
L1b						✓	✓						
L2						✓	✓	✓	✓				
L3							✓	✓	✓				
L4			✓										
L13								✓	✓				
L14			✓										
L15		✓											
L18								✓	✓				
L19						✓	✓						
L20			✓			✓							
L21		✓				✓	✓						
M1						✓	✓						
M2						✓	✓						
M3						✓	✓						
M4	✓						✓						
N Watershed													
N1										✓		✓	✓
N2						✓	✓			✓			✓
N3						✓	✓			✓		✓	✓
N4						✓	✓						
N5						✓	✓			✓			✓
N6						✓				✓			✓
N6a							✓			✓			✓
N7				✓	✓								
N9										✓			✓
N11										✓		✓	✓
N12							✓			✓	✓		✓
N13							✓						
N14						✓	✓	✓	✓	✓			✓
N14a								✓	✓	✓	✓		✓
N14b								✓	✓	✓	✓		
N17								✓	✓				✓
N18							✓						

(a) MT – minnow traps, GN – gill nets, EF – backpack electrofishing, AN – angling.

In 2010 and 2011, a total of 17 small lakes were sampled in the L and N watersheds (De Beers 2010, Addendum JJ; Golder 2012); these included four lakes in the L watershed and 13 lakes in the N watershed. Gillnetting was conducted in 17 of these lakes. Net sets were approximately two hours in duration. Backpack electrofishing surveys were conducted along representative shoreline sections of three lakes. Minnow traps were set for two to three hours in four lakes in the L watershed and 13 lakes in the N watershed. Angling was conducted at three lakes in the N watershed.

Item B

The length and weight measurements for recorded fishes are available in a Microsoft Excel worksheet (GK Fish Life History_March2012.xlsx). If ageing structures were collected, the type of ageing structures and determined fish ages are also included in the worksheet. This file will be provided on CD to DFO&EC.

A summary of length, weight, and age (count, mean and range) for species recorded in the small lakes downstream of Kennady Lake and in the adjacent N watershed are presented in Table DFO&EC_17-2. Number of fish recorded in the small lakes downstream of Kennady Lake and in the adjacent N watershed are presented in Table DFO&EC_17-3.

Table DFO&EC_17-2: Mean Length, Weight and Age of Fish Recorded Downstream of Kennady Lake and in the Adjacent N Watershed, 1996-2011

Watershed /Species[a]	Number of Fish Recorded (n)	Length (mm) [b]			Weight (g) [b]			Age (years) [b]		
		n	Mean	Range	*n*	Mean	Range	*n*	Mean	Range
Downstream of Kennady Lake Watershed										
ARGR	32	32	214	31 – 378	27	232	0.4 – 650	1	2	–
BURB	2	2	126	90 – 162	2	16	5 – 28	0	–	–
CISC	77	71	159	91 – 249	37	112	50 – 250	24	3	1 – 4
LKCH	2	2	106	103 – 108	0	–	–	0	–	–
LKTR	57	54	450	189 – 660	54	1233	75 – 3125	0	–	–
NNST	1	1	48	–	0	–	–	0	–	–
NRPK	12	12	174	50 – 610	10	416	1 – 2090	0	–	–
RNWH	19	18	272	147 – 392	17	321	40 – 800	0	–	–
SLSC	5	5	70	62 – 78	4	4	3 – 6	0	–	–
N Watershed										
ARGR	78	78	304	28 - 402	75	423	13 - 800	0	–	–
BURB	14	14	115	79 - 181	13	13	3.5 - 41.1	0	–	–
LKCH	334	332	73	23 - 129	285	5	0.4 - 24.7	0	–	–
LKTR	112	108	522	272 - 765	108	1689	195 - 4800	0	–	–
LNSC	64	63	184	43 - 480	53	428	0.7 - 1925	0	–	–
NNST	22	22	41	26 - 53	15	1	0.4 - 1.3	0	–	–
NRPK	11	9	638	182 - 832	9	2222	48.4 - 3260	0	–	–
RNWH	60	60	267	148 - 360	59	228	45 - 500	0	–	–
SLSC	21	18	62	38 - 84	14	3	0.4 - 5.9	0	–	–

(a) ARGR = Arctic grayling (*Thymallus arcticus*), BURB = burbot (*Lota lota*), CISC = cisco (*Coregonus artedi*), LKCH = lake chub (*Couesius plumbeus*), LKTR = lake trout (*Salvelinus namaycush*), LKWH = lake whitefish (*Coregonus clupeaformis*), LNSC = longnose sucker (*Catostomus catostomus*), NNST = ninespine stickleback (*Pungitius pungitius*), NRPK = northern pike (*Esox lucius*), RNWH = round whitefish (*Prosopium cylindraceum*), SCKR = unknown sucker, SLSC = slimy sculpin (*Cottus cognatus*), WHSC = white sucker (*Catostomus commersonii*)

(b) Includes all available data for fish that were measured, weighed and/or ageing structures were analysed.

Table DFO&EC_17-3: Number of Fish Recorded Downstream of Kennady Lake and in the Adjacent N Watershed, 1996-2011[(a)]

Watershed / Site ID	ARGR	BURB	CISC	LKCH	LKTR	LNSC	NNST	NRPK	RNWH	SLSC	WHSC	Total
Downstream of Kennady Lake Watershed												
L1a	7									1		8
L1b								3				3
L2	1							3				4
L3								1				1
L4												0
L13												0
L14												0
L15												0
L18	3	1			1							5
L19												0
L20												0
L21	19											19
M1		1						1	6			8
M2			2		1			3		3		9
M3		1			4			1	1			7
M4	2		75	2	48		1		12	1		141
N Watershed												
N1								4				4
N2	4			13	8	2	1		35	1		64
N3	6	1		13	3	6	1		13			43
N4	1			29								30
N5	1	1		22	4	12	4		2	2		48
N6	27	2		27	13	4	2		8			83
N6a				6	1							7
N7												0
N9					1				1			2
N11		7		143	42	20	2	7		2		223

Table DFO&EC_17-3: Number of Fish Recorded Downstream of Kennady Lake and in the Adjacent N Watershed, 1996-2011[(a)] (continued)

Watershed / Site ID	ARGR	BURB	CISC	LKCH	LKTR	LNSC	NNST	NRPK	RNWH	SLSC	WHSC	Total
N12	4	2		45	12	9	1			7		80
N13												0
N14	19			6	2	6	1			1		35
N14a	2			94		7	10			3		116
N14b												0
N17		1		4	23				1	2		31
N18	14		3									17

(a) ARGR = Arctic grayling, BURB = burbot, CISC = cisco, LKCH = lake chub, LKTR = lake trout, LNSC = longnose sucker, NNST = nInespine stickleback, NRPK = northern pike, RNWH = round whitefish, SLSC = slimy sculpin, WHSC = white sucker

References

Canamera Geological Ltd. 1998. 1996 Environmental Baseline Studies: 5034 Diamond Project. Prepared by the Environmental Resources Division of Canamera Geological. Submitted to Monopros Ltd., Yellowknife, NT.

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.

Golder (Golder Associates Ltd.). 2012. 2011 Fish and Aquatic Resources Supplemental Monitoring Report. Supplemental Monitoring Report. Report No. 11-1365-0001/DCN-054. Submitted to Mackenzie Valley Environmental Impact Review Board. March 2010.

Jacques Whitford. 2003. Gahcho Kué (Kennady Lake) Limnological Survey of Potentially Affected Bodies of Water (2002). Project No. NTY71008. Final Report Submitted to De Beers Canada Exploration Inc., Yellowknife, NT.

Jacques Whitford. 2004. Baseline Limnology Program (2003) Gahcho Kué (Kennady Lake). Project No. NTY71037. Prepared for De Beers Canada Exploration Inc., Yellowknife, NT.

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: DFO_EC_18

Source: Fisheries and Oceans Canada and Environment Canada (DFO&EC)

Subject: Baseline Data for Lakes Between Kennady and Kirk Lakes

EIS Section: Appendix J

Terms of Reference Section:

Preamble:

On p. J3-30, Kirk Lake is identified as a “new downstream water body” to be sampled. Changes in these lakes may provide fore-warning of impacts that may affect larger lakes like Kirk Lake and Lake 410 at a later date.

Request

a) Please clarify if there will be continued sampling of Lake 410.

b) To improve the understanding of downstream impacts, more Lakes should be sampled downstream of Kennady Lake including Lakes M3, M4, and possibly L2.

Response

a) Drainage from the adjacent N watershed joins the natural drainage from the outlet of Kennady Lake at Lake 410. Lake 410 will be a focal point for the Aquatic Effects Monitoring Program (AEMP) and sampled on a scheduled basis. The combined drainage then flows out of Lake 410 through the P watershed to Kirk Lake, and then to Aylmer Lake.

b) Baseline information for the downstream lakes in the L and M watersheds has been collected and is presented in the 2010 Environmental Impact Statement (EIS) (De Beers 2010) Section 8 and Section 9 Appendices. Supplemental monitoring information was collected in 2011, and is presented in the 2011 Supplemental Monitoring Reports (Golder 2012a, b, c, d). These lakes will be assessed for inclusion in the AEMP.

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.

Golder (Golder Associates Ltd.). 2012a. 2011 Climate and Hydrology Supplemental Monitoring Report. Report No. 11-1365-0001/DCN-049. Submitted to Mackenzie Valley Environmental Impact Review Board. March 2012.

Golder (Golder Associates Ltd.). 2012b. 2011 Lower Trophic Organisms Supplemental Monitoring Report. Report No. 11-1365-0001/DCN-052. Submitted to Mackenzie Valley Environmental Impact Review Board. March 2012.

Golder (Golder Associates Ltd.). 2012c. 2011 Fish and Aquatic Resources Supplemental Monitoring Report. Report No. 11-1365-0001/DCN-054. Submitted to Mackenzie Valley Environmental Impact Review Board. March 2012.

Golder (Golder Associates Ltd.). 2012d. 2011 Water Quality and Sediment Quality Supplemental Monitoring Report. Report No. 11-1365-0001/DCN-050. Submitted to Mackenzie Valley Environmental Impact Review Board. March 2012.

Information Request Number: DFO_EC_19

Source: Fisheries and Oceans Canada and Environment Canada (DFO&EC)

Subject: Benthic Invertebrates

EIS Section: Section 9-7

Terms of Reference Section:

Preamble:

Benthic invertebrate baseline and subsequent monitoring will result in a substantial increase in understanding and definition of baseline conditions within the study area, and will increase the probability that the objectives of the monitoring program will be met.

Request

a) Please clarify whether there were differences detected between shallow and deep water benthic communities?

b) Please clarify how “deep” is defined in terms of benthic samples.

c) Please confirm the number of samples from Lake 410 that were collected for benthic invertebrate analysis.

d) Please provide a map depicting sampling sites.

e) In order to ensure adequate pre-impact baseline data with which to assess changes in benthic communities, the following items should be included in a sampling program for 2012 as part of baseline data collection, and should be continued as part of an ongoing benthic monitoring program:

   i) Calculate EPT Index (number of Ephemeroptera, Plecoptera, and Trichoptera taxa) for stream sites.

   ii) Calculate Benthic Community Indices for reference sites for both stream and lake samples. For the lake samples, combine five subsamples before calculation.

iii) Ensure a complete data set is collected for all required lake and stream sites. Sampling should occur at the same time using the same methods. For lake sediments, five or six subsamples should be collected for each sample such that there are at least 200 individuals per sample. For stream sites, three subsamples should be collected for each sample.

Once-a-year sampling of benthos is probably sufficient, but differences in mesh sizes and sampling locations among years make determination of natural variance difficult in the existing data set. A determination of among-year natural variability using consistent methods is an essential component of any baseline monitoring program and should be conducted.

Response

a) Differences between benthic invertebrate communities of shallow and deep areas cannot be accurately characterized based on available data, because samples were collected from different depths on different months; hence, seasonal variation interferes with the comparison of data from different depths. Typically observed differences between shallow and deep areas in sub-Arctic lakes include lower density and richness in deep areas than in shallow areas. Additional baseline sampling as part of Aquatic Effects Monitoring Program (AEMP) development will provide a more complete characterization of differences between shallow and deep water communities.

b) During baseline studies, definition of "deep" was qualitative and judged based on the size and habitat characteristics of the individual lakes. Deep water was qualitatively defined as deeper than 6 m; and shallow as less than 6 m (Section J4.3.3 of Annex J of the 2010 Environmental Impact Statement [EIS] [De Beers 2010]).

c) Baseline information for benthic invertebrates in Lake 410 was based on two sites, sampled during August 2004 and September 2004, each with five samples per site.

d) Baseline sampling locations in Lake 410 were shown in Figure J3.4-2 in Section J3.4.1.2 of Annex J of the 2010 EIS.

e) The requirements outlined in this question reflect typical requirements for benthic invertebrate monitoring, and will be addressed to the maximum extent possible during additional benthic invertebrate sampling programs and during AEMP development.

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.

Information Request Number: DFO_EC_20

Source: Fisheries and Oceans Canada and Environment Canada (DFO&EC)

Subject: Changes to Water Quality in Area 8

EIS Section: Appendix 8

Terms of Reference Section:

Preamble:

In Appendix 8.I.3.1 it is argued that modeling of water quality in Area 8 is unnecessary because it will not be in contact with the rest of the lake and hence will not be affected. In reality, the isolation of this part of the lake from the rest of its hydrologic network is likely to alter water chemistry and food web structure considerably.

Request

a) Modeling should be conducted to identify what changes to water quality in Area 8 might occur after its isolation from Kennady Lake. The potential for, and extent of impacts on the current aquatic community structure in this basin should also be discussed.

Response

Water quality in Area 8 was modelled as part of the 2011 Environmental Impact Statement (EIS) Update (De Beers 2011) for all phases of the Project (i.e., construction, operations, closure and post-closure), and updated to support the EIS Supplemental Information Submission (De Beers 2012). Area 8 water quality was modelled separately from other areas of Kennady Lake isolated by Dyke A (i.e., Areas 2 to 7), using the downstream watershed model, which was developed to predict concentrations in Area 8, the Interlakes (i.e., the L and M watersheds), the N watershed, and Lake 410. Effects on aquatic communities in Area 8 during and after its isolation from the other basins of Kennady Lake were evaluated in the 2011 EIS Update (De Beers 2011).

The water quality in Area 8 during all phases of the Project (i.e., construction, operations, closure and post-closure); however, Area 8 is modelled separately from the Kennady Lake Areas isolated by Dyke A (i.e., Areas 2 to 7), in the downstream watershed model. The downstream water quality model was developed to predict water chemistry in Area 8, the Interlakes (i.e., the L and M watersheds), the N watershed, and Lake 410. At each location, average simulated Kennady Lake outflow concentrations were mixed with background concentrations in their relative proportions based on downstream flows provided in the hydrological assessment (Section 9.7.1). Similar to the Kennady Lake water quality model, the water quality in Area 8 was derived using a flow and mass-balance water quality model, developed in GoldSim™, for a range of water chemistry parameters.

During project phases in which Area 8 is hydraulically isolated from Kennady Lake by Dyke A, natural runoff from areas within the Area 8 sub-watershed and redirection of flow from the A watershed (De Beers 2012) will be sufficient to maintain water quality within this lake. As such, no significant adverse effects are expected in Area 8 while it is hydraulically isolated from Kennady Lake. However, as described in Section 8.8.4.1.2, during the operations phase, water quality constituent concentrations are predicted to increase slightly in Area 8 due to evapo-concentration. The construction of Dyke A will result in a reduction in drainage area reporting to Area 8, thereby increasing the residence time and the rate of evaporation relative to recharge. Consequently, all constituents are predicted to increase to slightly above background conditions by the time Dyke A is breached in Year 21.

The assessment of effects due to changes in water levels in Area 8 is included in Section 8.6.2.3 of the 2011 EIS Update (De Beers 2011) under the pathway of *Reduction in upper watershed flow to Area 8 may change surface water levels, and affect surface water quality, fish habitat and fish*. As described in this section, the minor change in depth is not expected to alter water quality in Area 8. Compared to other areas in Kennady Lake, which are slightly deeper in average depth, physico-chemical variability, particularly dissolved oxygen (DO) concentrations, are highly variable (see Annex I and Addendum II of the 2010 EIS [De Beers 2010]). Consistent with other areas in Kennady Lake, under-ice DO concentrations decrease with depth, and during open water conditions, DO concentrations are typically consistent throughout the water column. These characteristics are expected to remain consistent during the operation of the Project.

The changes in water depth and lake area under open-water and ice-covered conditions in Area 8 associated with the short-circuiting of the Kennady Lake watershed (including potable water withdrawals) are described in IR DFO&EC_44f. These changes are based on the updated water balance associated with the supplemental mitigation presented in the 2012 EIS Supplement. The maximum change in lake depth is in operations during July, with decreases in lake depth of 13 centimetres (cm). The small change in littoral area (approximately 2% of the surface area of Area 8) would have a negligible effect on the availability of fish and benthic invertebrate habitat. Changes to water quality, including under-ice dissolved oxygen levels, are expected to be negligible relative to baseline conditions. As a consequence, residual effects to fish habitat and fish (including the availability of overwintering habitat in Area 8) are predicted to be negligible.

The effects to the aquatic community structure relating to isolation of Area 8 are discussed in Section 8.10.3.4 of the 2011 EIS Update. Due to the slight increase in nutrient concentrations due to evaporative concentration of solutes in lake water, total phosphorus was predicted to gradually increase from a mean background concentration of 0.005 mg/L to 0.007 mg/L, along with a proportional increase in concentrations of nitrogen compounds. This change is not expected to alter the trophic status of Area 8 from oligotrophic, but would be expected to result in a slight increase in productivity of plankton and benthic invertebrate communities, without notable changes in community composition or dissolved oxygen concentration. The changes to the fish community are as described in Section 8.10.3.4 of the 2011 EIS Update.

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.

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: DFO&EC_21

Source: Fisheries and Oceans Canada and Environment Canada (DFO&EC)

Subject: Impacts to Biota from Changes in Cations

EIS Section: Appendix 8

Preamble:

Although total dissolved solids (TDS) may not exceed water quality guidelines, changes in cations and anions may affect the species composition of the food webs of Kennady Lake and downstream systems. For example, many invertebrates are limited by calcium in soft-water systems like Kennady Lake.

Request

a) The statement on p. 8-361 that "aquatic life in Kennady Lake or Area 8 will be largely unaffected by the projected increase in salinity" seems unlikely. Please justify this statement.

Response

The potential for elevated TDS and its constituent ions to affect aquatic life in Kennady Lake and Area 8 was discussed in Section 8.9 of the 2011 EIS Update (De Beers 2011a) and was based on predicted changes in water quality presented in Section 8.8 of that document. Based on maximum predicted concentrations, the potential for toxicity due to the predicted increase in TDS and its constituent ions was considered to be low, and residual effects to aquatic communities were expected to be negligible.

The water quality model has been revised based on the supplemental mitigation associated with the Fine PKC Facility. Results of the revised water quality predictions are presented in Section 8 of the 2012 EIS Supplement (De Beers 2012). Predicted maximum concentrations of TDS and its constituent ions have now been revised downward. For example, TDS concentrations in Kennady Lake are now predicted to peak at 145 milligrams per litre (mg/L) after refilling of the lake, and to decrease to 37 mg/L under long-term steady-state conditions, a reduction of 11% and 56% respectively, compared to the predicted concentrations in the 2011 EIS Update (De Beers 2011). Thus, the maximum TDS concentration predicted for Kennady Lake is still below concentrations associated with potential adverse effects to freshwater aquatic life. This also applies for the constituent ions that make up TDS. Further discussion to support this conclusion is presented below.

Toxicity of TDS to Aquatic Life

A number of literature reviews or compilations of toxicity data have been undertaken regarding TDS and/or its constituent ions, including Golder (2011a), USEPA (1988), Environment Canada and Health Canada (2001), Evans and Frick (2001), Weber-Scannell and Jacobs (2001), Weber-Scannell and Duffy (2007), BHP Billiton (2008), and CCME (2011). Information from those reviews indicates that TDS concentrations predicted for Kennady Lake should not adversely affect aquatic life in the lake.

The estimated ionic composition for the maximum predicted TDS concentration in Kennady Lake (145 mg/L) is: chloride (44%); calcium (19%); sulphate (14%); sodium (11%); and, other constituents (0 to 6%). This predicted TDS concentration, and its ionic composition, are both similar to conditions reported for the Snap Lake Mine in 2010, when the maximum TDS concentration was 187 mg/L (Golder 2011b). Preliminary results from aquatic toxicity tests conducted for De Beers in 2011 showed that for the ionic composition associated with Snap Lake, there were no adverse effects in laboratory tests with chironomids, rotifers, diatoms, or green algae at TDS concentrations >1,470 mg/L, but that cladoceran reproduction was affected (20% inhibition) at TDS concentrations >650 mg/L (Golder In preparation; Nautilus Environmental 2011, 2012). Given the similarities in ionic composition, these results show that adverse biological effects should not occur at the maximum TDS concentration predicted for Kennady Lake. The predicted maximum concentration for the major TDS constituent in this scenario (64 mg/L for chloride) is approximately half the recently published CCME (2011) water quality guideline (WQG) for long-term exposure to chloride (120 mg/L). CCME WQGs are conservative, and are intended to protect all forms of aquatic life during all life stages.

The estimated ionic composition for the long-term steady state TDS concentration in Kennady Lake (37 mg/L) predicts a shift in ion composition between the maximum concentration and long-term steady state scenarios. Under long-term conditions, the proportion of chloride ion is predicted to decrease such that the major TDS constituent will become sulphate (albeit at a predicted maximum concentration of 10 mg/L). Chapman et al. (2000) conducted toxicity tests with green algae, chironomids, and rainbow trout embryos and fry, to determine the toxicity of TDS in two synthetic effluents consisting of at least 50% sulphate and 20% calcium. There were no adverse effects on green algae or rainbow trout at >2,000 mg/L TDS, and no effects on chironomid growth at concentrations up to 1,220 mg/L TDS. The sulphate and calcium concentrations used for that study were orders of magnitude higher than the long-term concentrations predicted for Kennady Lake.

Changes in Species Composition

Changes in cations and anions can potentially affect the species composition of lake food webs, but lake biota can also respond and adapt to potential exposure to contaminants and/or nutrients, physical disturbance, changes in habitat variables and ecological interactions (e.g., competition, predation).

Using the example of invertebrates limited by calcium in soft-water systems such as Kennady Lake, the following discussion focuses on bivalves. A comparison is provided between the response of a northern benthic community to mine effluent discharge resulting in elevated TDS concentrations in the receiving environment (from the Snap Lake Diamond Mine), and a northern benthic community exposed to mine effluent discharge resulting in lower TDS concentrations (from the Diavik Diamond Mine). Both benthic invertebrate communities were monitored in fall 2010 as part of long term annual monitoring initiatives by De Beers (2011b) and DDMI (2011). Maximum predicted TDS concentration in Kennady Lake (145 mg/L) is intermediate between those measured in near-field exposure areas of the Diavik Mine (Lac de Gras; ~11 to 20 mg/L) and the Snap Lake Mine (Snap Lake; 187 mg/L) in 2010.

Benthic communities in Lac de Gras and Snap Lake are reasonably similar to those reported for Kennady Lake (i.e., dominated by chironomids and fingernail clams). This type of community is expected in the sub-Arctic region where Snap Lake, Lac de Gras, and Kennady Lake are located (Beaty et al. 2006; Northington et al. 2010).

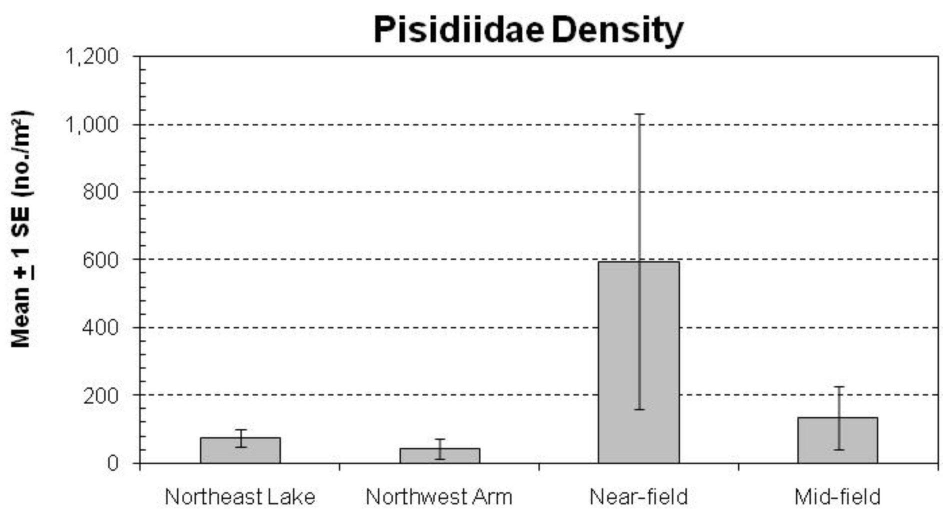
Compared to reference and far-field communities, near-field communities in both lakes have higher proportions of fingernail clams (Figures DFO&EC_21-1 and DFO&EC_21-2) and some chironomid taxa (Figures DFO&EC_21-3 and DFO&EC_21-4). Unlike fingernail clams, chironomids do not have a shell and so are not pre-disposed to being calcium-limited, but are found in lakes with a range of salinities (Cannings and Scudder 1978; Leland and Fend 1998)[1]. Fingernail clams and dominant chironomid taxa in Lac de Gras and Snap Lake near-field areas responded in a similar way to effluent exposure, suggestive of a response to nutrient enrichment in these near-field areas (DDMI 2011; De Beers 2011b).

The available data suggest that near-field benthic communities in Lac de Gras and Snap Lake show similar response patterns, suggesting TDS toxicity is not occurring. Literature concerning the effect of TDS on benthic invertebrate communities is currently limited, but Hynes (1990) reported no statistically significant decreases in abundance or species diversity in benthic communities exposed to 2,700 mg/L TDS in a northern Saskatchewan lake. Species richness declined and there were fewer oligochaetes, Hirudinea, and amphipods, but considerably more *Tanytarsus* (Chironomidae) in exposed communities. At the time of sampling, concentrations of TDS in the lake had increased from 76 to 2,700 mg/L TDS[2] due to inputs of treated uranium mine effluent.

[1] Leland and Fend (1998) reported a range of optimum TDS concentrations for Chironomidae of 160 to 1,300 mg/L.

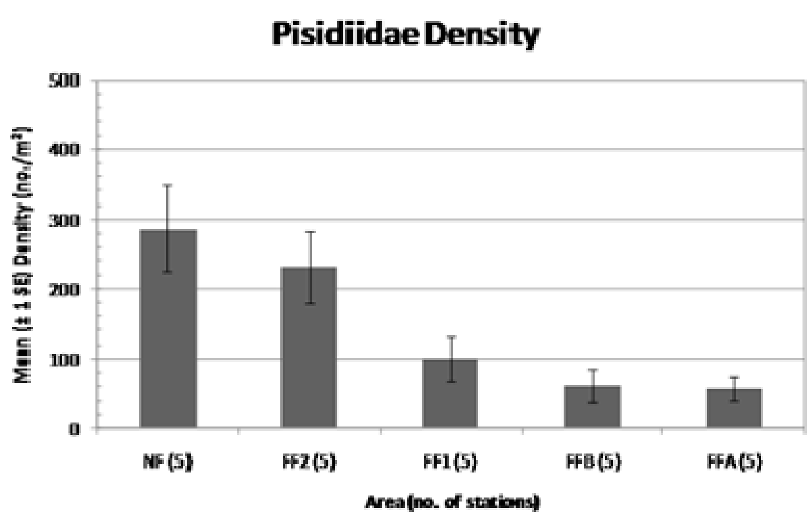
[2] Major constituents were calcium, sodium, chloride, and sulphate.

Figure DFO&EC_21-1. Pisidiidae Densities at Sampling Areas in Snap Lake and Northeast Lake, September 2010. From De Beers (2011b).



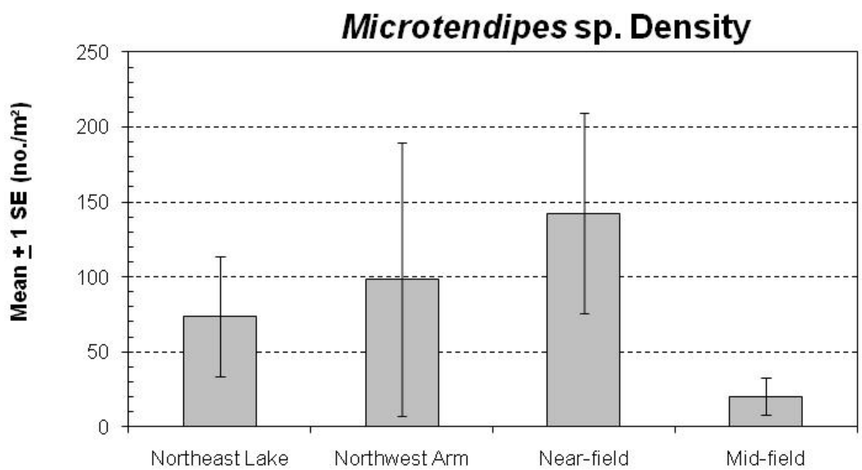
Note: SE = standard error of the mean; no./m² = number per square metre.

Figure DFO&EC_21-2. Pisidiidae Densities at Near-Field (NF) and Far-Field (FF) Areas in Lac de Gras, 2010. From DDMI (2011).



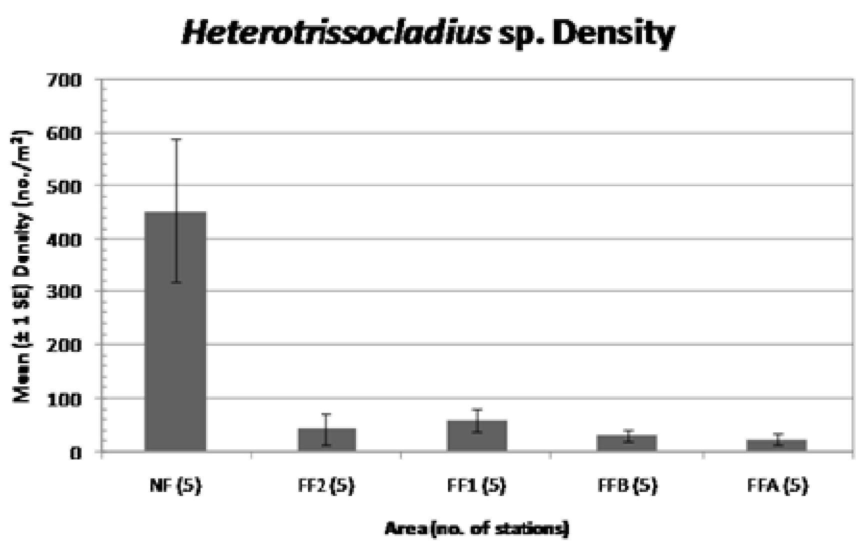
Note: SE= standard error of the mean; no./m² = number per square metre.

Figure DFO&EC_21-3. Densities of *Microtendipes* sp. at Sampling Areas in Snap Lake and Northeast Lake, September 2010. From De Beers (2011b).



Note: SE= standard error of the mean; no./m² = number per square metre.

Figure DFO&EC_21-4. Densities of *Heterotrissocladius* sp. at Near-Field (NF) and Far-Field (FF) Areas in Lac de Gras, 2010. From DDMI (2011).



Note: SE= standard error of the mean; no./m² = number per square metre.

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GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: DFO_EC_22

Source: Fisheries and Oceans Canada and Environment Canada (DFO&EC)

Subject: Use of Control (reference) Lake

EIS Section: Appendix 8

Terms of Reference Section:

Preamble

Lake N16 has been identified as a control or reference lake. To be effective, this approach needs multiple years of pre-impact data to capture natural variability, (these data currently do not exist). In addition, a larger suite of reference lakes would be preferred to provide an envelope of natural variability (see Underwood 1992 Exp. Mar. Biol. Ecol. 161: 145-178; Underwood 1994. Ecol. Appl. 4: 3-15). Consideration should be given to methods that employ multiple control sites such as the reference condition approach (Reynoldson et al. 1997. J. N. Am. Benthol. Soc. 16: 833-852).

Request

a) Please describe the methods (e.g. BACI, reference condition) that will be used to assess project effects. Also describe the approach to be undertaken to gather more detailed pre-impact data from more reference lakes.

Response

a) The methods that will be used to evaluate aquatic effects of the project will be developed during the detailed design phase of the Aquatic Effects Monitoring Program (AEMP). It is anticipated that the AEMP will incorporate both control/impact and gradient elements, depending on the type of effects predicted and their spatial distribution. For example, evaluation of effects on Area 8 will likely require control/impact comparisons using one or more reference lakes, whereas evaluating the type end extent of downstream effects may require a gradient approach.

In 2012, De Beers is undertaking a field program to select reference lakes for inclusion in the AEMP. The approach to select reference lakes involves initial lake selection based on location, lake area, drainage area and shoreline complexity, followed by field evaluation of bathymetry, water and sediment quality and biological characteristics of the candidate lakes.

Lake N16 is no longer a valid reference lake, because the current mine plan results in the diversion of the D and E watershed to Lake N14, which flows to Lake N16. Additional reference lakes, Lake X6 and Reference Lake in the adjacent Hoarfrost watershed have been included in recent monitoring programs (Golder 2012); however, supplemental monitoring work is underway to select reference lakes for inclusion in the AEMP.

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GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: DFO_EC_23

Source: Fisheries and Oceans Canada and Environment Canada (DFO&EC)

Subject: Determinations of Sediment Quality and Benthic Invertebrates

EIS Section: 9.3 Existing environment

Terms of Reference Section:

Preamble:

Changes in sediment quality and benthos are especially difficult to quantify in lakes undergoing changes in water level because conditions at any individual site after manipulation reflect both recent conditions and historical conditions when the site was at a different depth.

Request

a) Determinations of sediment quality and benthic invertebrates should be done in transects, so as to better quantify the distribution in the lake with respect to depth.

Response

The recommended methodology with respect to the collection of sediment quality and benthic invertebrates data will be considered during the development of the Aquatic Effects Monitoring Program (AEMP).

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: DFO&EC_24

Source: Fisheries and Oceans Canada and Environment Canada (DFO&EC)

Subject: Fish Data

EIS Section: 9.3 Existing environment

Terms of Reference Section:

Preamble:

With so much information on fish in the project area, separated into various sections of the EIS, it would be useful for reviewers if DeBeers could collate information together into a database.

Request

a) Compile all length/weight measurements for fish into a database (including all years, not just 2004). Also, please compile all log length/log weight formulas into one table.

b) Develop a fish-species list for each lake and stream that has been studied, and include: comprehensive life-history information for each species, such as spawning time/temperature, food preferences, years to sexual maturity, feeding/rearing/ spawning location.

c) Develop Standard Weight equations (Murphy et al. 1990) for as many species as possible, but particularly for Lake Trout, Arctic Grayling and Slimy Sculpin. Use the Standard Weight equations to develop an understanding of Relative Weight for as many species as possible, for as many lakes as possible, and for as many times as possible.

d) Please provide the dates that habitat surveys were conducted.

Response

Data for this response was collated from the following sources: Canamera (1998), Jacques Whitford (2003, 2004), EBA and Jacques Whitford (2001), De Beers (2010), and Golder (2012).

Item a

The length and weight measurements for recorded fishes are available in a Microsoft Excel worksheet (GK Fish Life History 1996-2011March2012.xlsx). Data on the number of fish caught by season, year, and capture method are also available in a Microsoft Excel worksheet (GK Fish Catch 1996-2011March2012.xlsx). These files are provided on CD to DFO&EC.

Standard $\log_{10}$length (g) - $\log_{10}$weight (mm) regressions were calculated for all species in Microsoft Excel. The coefficients for the regression formulas are located in Table DFO&EC_24-1. Regressions were completed for all species by watershed, basin, and site, when sample size was equal to or greater than 10 ($n \geq 10$). For basins B, E, I, P, Lake 410, and Kirk Lake there were data from only one site in the basin (i.e., the regression was calculated using data from one site). For all other basins, measurement data from fish captured at all sites were used to calculate the regression.

Table DFO&EC_24-1: Coefficients and Model Fit for the Log_{10}length (mm)-$\log_{10}$weight (g) Regression Formulas for all Species Recorded in the Project Study Area,1996-2011

Species Common Name (Scientific Name)	Watershed	Basin	Site	log length - log weight coefficients and r^2			*n*	Comments
				Intercept	Slope	r^2		
Arctic grayling (*Thymallus arcticus*)	All	All	All	-5.09	3.06	1.00	511	
	Kennady Lake	All	All	-5.16	3.09	0.98	161	
		A	All	-5.61	3.29	0.98	20	
			A1[a]	-5.66	3.30	0.99	12	
		B	B1[a]	-4.88	2.99	0.90	12	
		I	I1	-5.17	3.10	0.67	7	
		K[b]	All	-4.95	3.01	0.98	120	
			K1[a]	-5.30	3.14	0.99	22	
			K3[a]	-4.40	2.78	0.99	15	
			K4	-5.16	3.11	0.99	10	one small fish
			K5[a]	-5.17	3.09	0.97	67	
	Downstream of Kennady Lake	All	All	-5.20	3.11	0.99	133	
		L	All	-5.16	3.10	0.99	118	
			L1a[a]	-5.11	3.07	1.00	49	
			L2[a]	-5.06	3.04	0.99	39	
			L21	-3.83	2.57	0.92	18	no small fish
		M	All	-5.28	3.14	0.99	11	

Table DFO&EC_24-1: Coefficients and Model Fit for the Log_{10}length (mm)-log_{10}weight (g) Regression Formulas for all Species Recorded in the Project Study Area,1996-2011 (continued)

Species Common Name (Scientific Name)	Watershed	Basin	Site	log length - log weight coefficients and r^2			*n*	Comments
				Intercept	Slope	r^2		
Arctic grayling (Thymallus arcticus) (continued)	N	N	All	-5.06	3.05	1.00	217	
			N2[(a)]	-5.43	3.20	1.00	14	
			N3[(a)]	-5.06	3.04	0.99	58	
			N4[(a)]	-4.91	2.97	0.97	62	
			N6[(a)]	-4.68	2.87	1.00	25	
			N12	-5.10	3.08	1.00	12	one small fish
			N14	-5.51	3.25	0.99	18	one small fish
			N18[(a)]	-5.13	3.10	0.99	18	
Burbot (*Lota lota*)	All	All	All	-5.02	2.92	0.99	123	
	Kennady Lake	All	All	-4.85	2.83	0.98	14	
		K	All	-4.91	2.86	0.99	10	
	Downstream of Kennady Lake	All	All	-4.94	2.88	0.98	23	
		L	All	-5.96	3.36	0.99	11	
		M	All	-4.11	2.46	0.95	8	
	N	N	All	-5.10	2.96	0.99	84	
			N4	-5.38	3.09	0.98	15	one large fish
			N11	-4.90	2.85	0.95	11	one small fish
Cisco (*Coregonus artedi*)	All	All	All	-5.52	3.25	0.97	95	
	Downstream of Kennady Lake	All	All	-5.03	3.04	0.89	60	
		410	410	-4.45	2.80	0.91	23	
		M	All	-5.73	3.34	0.89	37	
			M4	-4.95	3.00	0.90	35	no small fish
	N	N	N16	-5.68	3.30	0.99	35	
Lake chub (*Couesius plumbeus*)	All	All	All	-5.24	3.14	0.97	584	
	Kennady Lake	All	All	-4.35	2.69	0.96	22	
		K	All	-4.27	2.65	0.96	20	
	Downstream of Kennady Lake	All	All	-4.48	2.78	0.89	12	
	N	N	All	-5.28	3.16	0.97	550	
			N2	-5.30	3.16	0.97	45	
			N3	-5.09	3.09	0.92	27	
			N4	-4.93	2.99	0.99	55	
			N5	-4.87	2.96	0.98	35	
			N6	-5.42	3.23	0.94	108	
			N11	-5.31	3.17	0.98	111	
			N12	-5.45	3.23	0.97	57	
			N14a	-4.66	2.84	0.96	73	
			N17	-5.08	3.06	0.97	27	

Table DFO&EC_24-1: Coefficients and Model Fit for the Log_{10}length (mm)-log_{10}weight (g) Regression Formulas for all Species Recorded in the Project Study Area,1996-2011 (continued)

Species Common Name (Scientific Name)	Watershed	Basin	Site	log length - log weight coefficients and r^2			*n*	Comments
				Intercept	Slope	r^2		
Lake trout (*Salvelinus namaycush*)	All	All	All	-5.09	3.04	0.98	782	
	Kennady Lake	All	All	-5.16	3.08	0.98	363	
		I	I1[(a)]	-5.24	3.11	0.99	16	
		K[(b)]	All	-5.18	3.08	0.98	338	
			K1[(a)]	-5.33	3.14	0.98	112	
			K2[(a)]	-5.05	3.04	0.98	62	
			K3[(a)]	-5.07	3.04	0.98	70	
			K4[(a)]	-4.91	2.99	0.99	24	
			K5[(a)]	-5.30	3.12	0.98	66	
	Downstream of Kennady Lake	All	All	-4.67	2.89	0.97	168	
		410	410[(a)]	-4.05	2.67	0.91	76	
		Kirk	Kirk[(a)]	-2.54	2.11	0.67	35	
		M	All	-4.85	2.96	0.99	56	
			M4[(a)]	-4.85	2.96	0.99	49	
	N	N	All	-5.15	3.06	0.98	247	
			N11[(a)]	-4.94	2.98	0.96	42	
			N12[(a)]	-2.76	2.17	0.69	12	
			N16[(a)]	-5.15	3.06	0.99	133	
			N17[(a)]	-5.46	3.18	0.99	23	
Lake whitefish (*Coregonus clupeaformis*)	All	All	All	-3.89	2.65	0.97	47	
	Downstream of Kennady Lake	All	All	-3.89	2.65	0.97	47	
		Kirk	Kirk	-3.89	2.65	0.97	47	
Longnose sucker (*Catostomus catostomus*)	All	All	All	-5.13	3.12	1.00	91	
	N	N	All	-5.14	3.12	1.00	89	
			N3	-4.25	2.79	0.88	73	
			N11	-5.26	3.20	0.98	111	
			N16	-5.12	3.11	1.00	57	
Ninespine stickleback (*Pungitius pungitius*)	All	All	All	-3.20	1.86	0.62	21	
	N	N	All	-3.25	1.90	0.65	20	
Northern pike (*Esox lucius*)	All	All	All	-5.23	3.04	1.00	143	
	Kennady Lake	All	All	-5.20	3.04	0.99	99	
		A	All	-5.48	3.13	1.00	6	
		D	All	-5.06	2.99	0.99	34	
			D2	-5.01	2.98	0.99	111	
		K[(b)]	All	-4.61	2.83	0.94	55	
			K4	-5.05	2.99	0.94	57	
			K5	-5.10	3.00	0.96	73	
	Downstream of Kennady Lake	All	All	-5.29	3.07	1.00	35	
		L	All	-5.42	3.13	1.00	11	
		M	All	-5.22	3.05	1.00	18	
	N	N	All	-4.84	2.87	0.99	9	

Table DFO&EC_24-1: Coefficients and Model Fit for the Log_{10}length (mm)-log_{10}weight (g) Regression Formulas for all Species Recorded in the Project Study Area,1996-2011 (continued)

Species Common Name (Scientific Name)	Watershed	Basin	Site	log length - log weight coefficients and r^2			*n*	Comments
				Intercept	Slope	r^2		
Round whitefish (*Prosopium cylindraceum*)	All	All	All	-5.34	3.15	0.97	823	
	Kennady Lake	A	All	-4.54	2.85	0.97	12	
			A1[a]	-4.54	2.85	0.97	12	
		All	All	-5.68	3.29	0.97	604	
		K[b]	All	-5.68	3.29	0.97	592	
			K1[a]	-5.56	3.23	0.97	161	
			K2[a]	-5.74	3.32	0.98	111	
			K3[a]	-5.48	3.21	0.93	100	
			K4[a]	-5.69	3.30	0.95	88	
			K5[a]	-5.48	3.19	0.97	132	
	Downstream of Kennady Lake	All	All	-4.98	3.01	0.99	72	
		410	410[a]	-4.50	2.81	0.93	47	
		L	All	-3.51	2.10	0.62	6	
		M	All	-5.45	3.21	0.96	18	
			M4[a]	-5.74	3.31	0.97	11	
	N	N	All	-5.10	3.04	0.93	146	
			N2[a]	-4.51	2.81	0.88	35	
			N3[a]	-4.53	2.82	0.86	13	
			N16[a]	-5.38	3.14	0.97	87	
Slimy sculpin (*Cottus cognatus*)	All	All	All	-5.22	3.13	0.94	535	
	Kennady Lake	All	All	-6.38	3.76	0.94	11	
	Downstream of Kennady Lake	All	All	-5.23	3.14	0.94	299	
		410	410[b]	-4.58	2.78	0.95	25	
		Kirk	Kirk[a]	-4.68	2.81	0.93	34	
		L	All	-5.33	3.20	0.93	191	
			L1a[a]	-5.61	3.35	0.94	24	
			L1b[a]	-5.42	3.25	0.84	12	
			L2[a]	-5.25	3.15	0.92	153	
		M	All	-5.26	3.15	0.97	49	
			M1[a]	-5.36	3.20	0.98	23	
	N	N	All	-5.06	3.03	0.91	223	
			N1[a]	-4.62	2.76	0.82	17	
			N2[a]	-4.91	2.95	0.92	10	
			N3[a]	-4.78	2.86	0.91	54	
			N4[a]	-5.12	3.08	0.95	33	
			N5[a]	-5.88	3.48	0.97	12	
			N11[a]	-4.63	2.77	0.86	20	
			N12[a]	-4.28	2.61	0.83	13	
			N16[a]	-5.06	3.03	0.93	41	

(a) Used in W_s calculation – see item c.

(b) Basin K = Kennady Lake; sub-basins in Kennady Lake include K1 (Areas 2, 3, and 5), K2 (Area 4), K3 (Area 6), K4 (Area 7), and K5 (Area 8).

Item b

A fish species list for each lake and stream that has been studied are provided in Tables DFO&EC_24-2 and DFO&EC_24-3. Data on the number of fish caught at each site by season, year, and capture method are available in a Microsoft Excel worksheet (GK Fish Catch 1996-2011March2012.xlsx). The life history data (i.e., length and weight measurements, sex, maturity, and age) for recorded fishes are available in a Microsoft Excel worksheet (GK Fish Life History1996-2011March2012.xlsx). These files are provided on CD to DFO&EC.

Lake sites where fish sampling was conducted, but fish were not captured include: L4, L13, L14, L19, L20, A2, A4, A5, A6, A7, A8, A9, B2, D5, D10, E2, E3, F1, H1b, I2, J1a, J2, K1-2, Ka1, Kb1, Kb2, Kb3, Kb4, Kd1, N7, N13, and N14b. Similarly, fish were not captured at stream sites L11 and G1. These lake and stream sites are not included in Tables DFO&EC_24-2 and DFO&EC_24-3.

Life-history information for each species, including spawning time/temperature; food preferences, years to sexual maturity; feeding, spawning, and rearing location; and preferred spawning substrate are provided in Table DFO&EC_24-4. The life-history information was obtained from site-specific data, where available; otherwise, a literature review was completed.

Table DFO&EC_24-2: Fish Species List for each Lake in the Project Study Area, 1996-2011

Watershed	Site ID	Species[a]
Downstream of Kennady Lake	410	BURB, CISC, LKCH, LKTR, NRPK, RNWH, SLSC
	Kirk	CISC, LKTR, LKWH, NRPK, RNWH
	L1a	ARGR, SLSC
	L1b	NRPK
	L2	ARGR, NRPK
	L3	NRPK
	L18	ARGR, BURB, LKTR
	L21	ARGR
	M1	BURB, NRPK, RNWH
	M2	CISC, LKTR, NRPK, SLSC
	M3	BURB, LKTR, NRPK, RNWH
	M4	ARGR, CISC, LKCH, LKTR, NNST, RNWH, SLSC

Table DFO&EC_24-2: Fish Species List for each Lake in the Project Study Area, 1996-2011 (continued)

Watershed	Site ID	Species[a]
Kennady Lake[b]	A1	ARGR, BURB, RNWH
	A3	ARGR, BURB, LKTR, NRPK, Unknown
	B1	ARGR, LKTR, NNST, SLSC
	D1	BURB, NRPK
	D2	NRPK
	D3	BURB, LKTR, NRPK
	D7	ARGR, BURB, NRPK
	E1	NRPK, SLSC
	G2	NNST
	H1a	NNST, SLSC
	I1	ARGR, LKTR, NNST, SLSC
	J1b	BURB
	K1	ARGR, BURB, LKCH, LKTR, NNST, NRPK, RNWH, SLSC
	K1/K3	BURB, SLSC
	K1-5	ARGR, BURB, LKCH, LKTR, NNST, NRPK
	K2	ARGR, LKCH, LKTR, NRPK, RNWH
	K3	ARGR, BURB, LKCH, LKTR, NNST, NRPK, RNWH
	K3-4	ARGR, LKTR, NRPK
	K4	ARGR, BURB, LKCH, LKTR, NNST, NRPK, RNWH, SLSC
	K5	ARGR, BURB, LKCH, LKTR, NNST, NRPK, RNWH, SLSC
N	N1	NRPK
	N2	ARGR, LKCH, LKTR, LNSC, NNST, RNWH, SLSC
	N3	ARGR, BURB, LKCH, LKTR, LNSC, NNST, RNWH
	N4	ARGR, LKCH
	N5	ARGR, BURB, LKCH, LKTR, LNSC, NNST, RNWH, SLSC
	N6	ARGR, BURB, LKCH, LKTR, LNSC, NNST, RNWH
	N6a	LKCH, LKTR
	N9	LKTR, RNWH
	N11	BURB, LKCH, LKTR, LNSC, NNST, NRPK, SLSC
	N12	ARGR, BURB, LKCH, LKTR, LNSC, NNST, SLSC
	N14	ARGR, LKCH, LKTR, LNSC, NNST, SLSC
	N14a	ARGR, LKCH, LNSC, NNST, SLSC
	N16	BURB, CISC, LKCH, LKTR, LNSC, NNST, RNWH, SLSC, WHSC
	N17	BURB, LKCH, LKTR, RNWH, SLSC
	N18	ARGR, CISC, LKCH
Reference	East	BURB, LKTR, RNWH, SLSC

[a] ARGR = Arctic grayling, BURB = burbot, LKCH = lake chub, LKTR = lake trout, LNSC = longnose sucker, NNST = ninespine stickleback, NRPK = northern pike, RNWH = round whitefish, SLSC = slimy sculpin, WHSC = white sucker (*Catostomus commersonii*).

[b] Basin K = Kennady Lake; sub-basins in Kennady Lake include sites K1 (includes Areas 2, 3, and 5), K2 (Area 4), K3 (Area 6), K4 (Area 7), and K5 (Area 8).

Table DFO&EC_24-3: Fish Species List for each Stream in the Project Study Area, 1996-2011

Watershed	Site ID	Species[a]
Downstream of Kennady Lake	410	BURB, LKCH, SLSC
	K5	ARGR, BURB, LKCH, LKTR, LNSC, NRPK, RNWH, SLSC
	Kirk	ARGR, NNST, SLSC
	L1a	ARGR, BURB, LKCH, NRPK, SLSC
	L1b	ARGR, BURB, SLSC
	L1c	SLSC
	L2	ARGR, BURB, LKTR, NNST, NRPK, SLSC
	L3	ARGR, BURB, NRPK
	L13	BURB
	L14	RNWH
	L15	RNWH
	L18	RNWH, SLSC
	M1	ARGR, BURB, LKCH, LKTR, NRPK, RNWH, SLSC
	M2	BURB, LKCH, NNST, NRPK, SLSC
	M3	ARGR, BURB, NRPK, SLSC
	M4	ARGR, BURB, LKTR, NRPK, SLSC
	P4	ARGR, BURB
Kennady Lake	A1	ARGR, BURB, LKCH, NNST, NRPK, SLSC
	A2	ARGR, BURB, NRPK
	A3	ARGR, BURB, LKTR, NNST, NRPK
	B1	ARGR
	D1	ARGR, BURB, NNST
	D2	ARGR, BURB, NRPK , SLSC
	D4	SLSC
	D7	SLSC
	E1	ARGR, BURB, NNST, NRPK
	H1a	NNST, NRPK
	H1b	NNST
	J1a	ARGR
	Kd1	NNST
	Ke3	NNST
N	N1	BURB, LKCH, SLSC
	N2	ARGR, BURB, LKCH, LNSC, NNST, SLSC
	N3	ARGR, BURB, LKCH, LKTR, LNSC, SLSC
	N4	ARGR, BURB, LKCH, NNST, SLSC
	N5	ARGR, BURB, LKCH, LNSC, NNST, SLSC
	N6	ARGR, BURB, LKCH, NNST, SLSC
	N6b	BURB, LKCH, LNSC
	N9	BURB, LKCH, SLSC
	N11	BURB, LKCH, NNST, SLSC
	N12	ARGR, BURB, LKCH, NNST, SLSC
	N14	ARGR
	N14a	SLSC
	N15	LKCH , SLSC
	N16	ARGR, BURB, LKCH, LKTR, LNSC, SLSC
	N17	ARGR, BURB, LKCH, LKTR, LNSC, NNST, SLSC
	N18	ARGR, BURB, LKCH, LKTR, SLSC

(a) ARGR = Arctic grayling, BURB = burbot, LKCH = lake chub, LKTR = lake trout, LNSC = longnose sucker, NNST = ninespine stickleback, NRPK = northern pike, RNWH = round whitefish, SLSC = slimy sculpin

Table DFO&EC-24-4: Life-History Information for each Species Recorded in the Project Study Area (1996-2011)

Species[a]	Spawning Time	Spawning Temperature (°C)	Spawning Location: Lake	Spawning Location: Stream	Suitable Spawning Substrate	Food Preference	Years to sexual maturity	Feeding Location	Rearing Location
ARGR	Spring (early June)[b]	0-5 [b]		✓ Large spawning run in outlet of Kennady Lake (K5); smaller spawning run - N3, N12, A1, A2, B1, D1, E1, L3 [b]	large rock, cobble, gravel, fines	zooplankton and corixidae (data from Kennady Lake, M4 & N16) [b]	6-9 (406-508mm)	Kennady Lake - K1, K2, K3 and K4 (appear to avoid K5) [b]	K5, L2, L1a, L1b, N, and L3 provide summer rearing habitat [b]
BURB	November to May	0.6-1.7	✓	✓	gravel	invertebrates and fish	3-4 (280-480 mm, males mature at smaller sizes)	streams and lakes	rocky shores of stream
CISC	Late October	4-5	✓		cobble, gravel	zooplankton, invertebrates	3-6	lakes	lakes
LKTR	Late August and October[b]	5.5-14	✓ In Kennady Lake, boulder dominated shoreline in Basin K1 is likely an important spawning location; shoreline along the northeastern corner of the island separating Basins K1 and K2 may also provide spawning habitat; data indicates that they may spawn in other basins as well [b]		large rock, cobble	fish (Kennady Lake - RNWH, N16 - CISC) [b]	8/9 (450 mm) [b]	Kennady Lake: Summer - K1, K2, K3 and K4 (avoided K5), prefer K1; Spring: move into the outlet (near K5) likely to feed on spawning ARGR and/or their newly laid eggs. N16: move into tributaries in spring likely to feed on spawning ARGR and/or their newly laid eggs [b]	unknown
LKWH	September and October	<7.8	✓		large rock, cobble	invertebrates and small fishes	6-7	lakes	lakes
NRPK	Early June	4.4-11.1	Basin D is likely the primary spawning location, particularly lakes D2 & D3; may also spawn in K5[b]		gravel, fines, vegetation	zooplankton, invertebrates, fish	6 females; 5 males	prefer K4 and stream D1	vegetated rivers of bays
RNWH	Late October [b]	2-5.5 [b]	✓		gravel	Kennady Lake: zooplankton and bivalves; N16: chironomids [b]	5-8 (males >237 mm, females >268 mm) [b]	Kennady Lake: likely move extensively between all basins [b]	streams or lakes
WHSC	Early June	10	✓	✓	gravel	invertebrates	5-8	streams or lakes	streams or lakes
LNSC	Early June	5	✓	✓ Kennedy Lake: move into outlets and inlets to spawn [b]	gravel	invertebrates	5-7	streams or lakes	streams or lakes
LKCH	June-July	unknown	✓	✓	large rock, cobble	invertebrates	unknown	prefer lakes	prefer lakes
NNST	Summer	unknown	✓		vegetation	invertebrates	unknown	streams or lakes	streams or lakes
SLSC	June - July	~5	✓	✓	large rock, cobble	invertebrates	unknown	rocky bottoms of lakes or streams	rocky bottom of lakes or streams

Note: sub-basins in Kennady Lake include sites K1 (includes Areas 2, 3, and 5), K2 (Area 4), K3 (Area 6), K4 (Area 7), and K5 (Area 8).

(a) ARGR = Arctic grayling, BURB = burbot, CISC = cisco, LKCH = lake chub, LKTR = Lake trout, LKWH = lake whitefish, LNSC = longnose sucker, NNST = ninespine stickleback, NRPK = northern pike, RNWH = round whitefish, SCKR = unknown sucker, SLSC = slimy sculpin, WHSC = white sucker.

(b) Site-specific information is from Annex J and Addendum JJ of the EIS (De Beers 2010), Golder (2012), and references cited within. Remainder of information collated from a literature review (Scott and Crossman 1973, Nelson and Paetz 1992).

Item c

Methods

Relative weights are commonly used as measures of fish well-being (i.e., condition). Higher relative weights (i.e., W_r ≥100) may indicate more favourable environmental conditions (e.g., abundant prey, habitat cover) for fishes, while a lower relative weight (i.e., W_r ≤ 100) may indicate less favourable environmental conditions (Blackwell et al. 2000). Optimal W_r for fish in good habitat is typically near 100; however, this value may fluctuate depending on the population and season (Blackwell et al. 2000). Detailed information for the species discussed here is not available to determine optimum W_r, therefore for the discussion below, it is assumed that optimum W_r is 95 to 105.

Relative weights were calculated using standard weight (W_s) relationships for Arctic grayling, lake trout, slimy sculpin, and round whitefish using the 75th regression-line-percentile (RLP) technique as presented in Murphy et al. (1990). The RLP technique is the currently accepted approach for development of W_s equations (Pope and Kruse 2007). To calculate W_s equations, length-weight relationships from various populations are required. We used sites to define populations. For each species, the standard $\log_{10}$length-$\log_{10}$weight relationship was calculated for each site (i.e., population) where n ≥ 10 (Table DFO&EC_24-5; Murphy et al. 1990). Sites where the r^2 value was greater than or equal to 0.9 for the $\log_{10}$length-$\log_{10}$weight relationship were included in the development of the W_s formula. Sites that were obviously missing a length category (e.g., no small fish were recorded) were excluded. The number of sites that met the criteria for analyses ranged from 9 to 12, depending on the species (Table DFO&EC_24-5).

Table DFO&EC_24-5: Standard Weight Coefficients and Summary for Arctic Grayling (ARGR), Lake Trout (LKTR), Slimy Sculpin (SLSC) and Round Whitefish (RNWH) in the Project Study Area, 1996-2011

Species	W_s					All Fish Recorded (1996-2011)
	Intercept	Slope	Number of Populations (N)	Total Sample Size (n)	Sample Size Range per Population (n)	Length Range [mm]
ARGR	-5.02	3.04	12	393	12-67	30-410
LKTR	-4.60	2.88	11	673	12-133	93-860
SLSC	-5.15	3.10	10	409	10-153	29-113
RNWH	-5.51	3.23	9	749	11-161	33-392

It should be noted that the W_s relationships were calculated using a small number of populations, some of which had few individuals (i.e., *n* = 10, Table DFO&EC_24-1). Murphy et al. (1990) calculated W_s relationships using data from 16 populations where the sample size was greater than or equal to 10. However, Brown and Murphy (1996) recommended data from 50 populations to calculate standard weights. This quantity of data is not available for this Project. Therefore, the W_s relationships and predictions of standard and relative weights should be used and interpreted with caution. The W_s equations should be updated when new information is available for fish in the region.

Using $\log_{10}$length-$\log_{10}$weight relationships, the $\log_{10}$weight in 1-cm length intervals for each population was predicted over the minimum and maximum lengths for each species recorded in the study area. The $\log_{10}$weight values were then transformed (i.e., inverse log) to weight (termed 'expected weight') and the 75th percentile of the expected weights in each length interval was calculated. A regression was then performed on re-transformed $\log_{10}75^{th}$ percentile expected weights, versus the $\log_{10}$lengths, to determine parameter coefficients for the W_s equation.

The W_s equations calculated for Arctic grayling, lake trout, slimy sculpin, and round whitefish (Table DFO&EC_24-5) were then used to calculate the W_s for each Arctic grayling, lake trout, slimy sculpin, and round whitefish recorded, respectively, from 1996-2011. The relative weights (W_r) for each Arctic grayling, lake trout, slimy sculpin, and round whitefish recorded were calculated using the following formula: $W_r = 100*(W/W_s)$. The mean W_r and standard deviation were calculated for fish per watershed, basin, season, and year.

Results

The mean W_r for pooled Arctic grayling indicates that the captured fish were in normal condition (Table DFO&EC_24-6). Note that the majority of fish included in the calculation of mean W_r were from basin K (Kennady Lake watershed), basin N (N watershed), and basin L (downstream of Kennady Lake watershed), and therefore, the pooled W_r reflects this bias. The mean W_r for each watershed indicates that Arctic grayling were in slightly better condition in watershed N, followed by Kennady Lake and downstream of Kennady Lake (Arctic grayling were not recorded in the Reference watershed). For basins, Arctic grayling appeared to be in the best condition in basin B and in the worst condition in basin P. This difference may be attributed to biases associated with small sample sizes (basin B: n = 12, basin P: n = 3), rather than a true difference in condition. Arctic grayling were in the best condition during the summer sampling season (Table DFO&EC_24-7) and in 2005 (Table DFO&EC_24-8).

The mean W_r for pooled lake trout were below normal condition. The majority of fish used in the calculation of mean W_r were from basin K (Kennady Lake watershed) and basin N (watershed N). The mean W_r for each watershed indicates that lake trout were in the best condition in the Kennady Lake watershed, followed by the reference, downstream of Kennady Lake, and N. Similar to Arctic grayling, lake trout appeared to be in the best condition in basin B. Lake trout appeared to be in the worst condition in the Kirk Lake basin. Overall, lake trout were in the best condition during the winter sampling season and in 2005. Note that winter sampling was conducted only in the Kennady Lake watershed.

The mean W_r for pooled round whitefish indicated that captured fish were in normal condition; however, the majority of fish in this calculation were from basin K (Kennady Lake watershed). The mean W_r for each watershed indicates that round whitefish were in the best condition downstream of Kennady Lake, followed by the Kennady Lake, Reference and N watersheds. Round whitefish appeared to be in the best condition in basin L. All basin populations were in relatively good condition (i.e., $W_r > 90$), but were in the lowest condition in basin N. Generally, round whitefish were in the best condition during the summer sampling season and in 2010.

The mean W_r for all slimy sculpin indicated that the fish recorded in the study area were in normal condition. This mean value is biased towards values in basin L (downstream of Kennady Lake) and basin N (watershed N) where the majority of fish were captured. The mean W_r for each watershed indicates that slimy sculpin were in the best condition downstream of Kennady Lake, followed by N, Kennady Lake, and Reference watersheds. Slimy sculpin appeared to be in the best condition in the L basin and were in the worst condition in the B basin. Slimy sculpin were only recorded during the summer and fall surveys, and were in slightly better condition in the summer and in 2004.

Table DFO&EC_24-6 Mean Relative Weights (W_r) of Arctic Grayling, Lake Trout, Slimy Sculpin and Round Whitefish in each Watershed and Basin of the Project Study Area, 1996-2011

Species	Watershed	Basin	Mean W_r	Standard Deviation	*n*
Arctic grayling	All	All	98.0	18.1	511
	Kennady Lake	All	97.3	13.8	161
		A	93.7	18.4	20
		B	105.0	16.4	12
		D	90.7	-	2
		I	98.3	8.8	7
		K	97.1	12.7	120
	Downstream of Kennady Lake	All	97.1	17.1	133
		L	98.3	16.5	118
		M	95.3	16.6	11
		P	71.3	-	3
		Kirk	55.0	-	1
	N	N	99.2	21.2	217
Lake trout	All	All	89.2	13.6	782
	Kennady Lake	All	91.3	14.7	363
		A	102.1	3.9	5
		B	111.5	-	3
		D	73.8	-	1
		I	90.9	5.0	16
		K	91.0	14.7	338
	Downstream of Kennady Lake	All	89.5	11.3	168
		L	104.2	-	1
		M	90.4	11.5	56
		410	91.4	10.6	76
		Kirk	83.4	10.4	35
	N	N	85.9	12.7	247
	Reference	East	91.2	-	4

Table DFO&EC_24-6 Mean Relative Weights (W_r) of Arctic Grayling, Lake Trout, Slimy Sculpin and Round Whitefish in each Watershed and Basin of the Project Study Area, 1996-2011 (continued)

Species	Watershed	Basin	Mean W_r	Standard Deviation	*n*
Round whitefish	All	All	95.7	15.8	823
	Kennady Lake	All	95.8	13.6	604
		A	110.4	10.6	12
		K	95.5	13.5	592
	Downstream of Kennady Lake	All	105.3	26.1	72
		L	152.7	42.5	6
		M	103.7	22.0	18
		410	98.9	17.2	47
		Kirk	149.4	-	1
	N	N	90.6	15.6	146
	Reference	East	93.2	-	1
Slimy sculpin	All	All	98.0	18.3	535
	Kennady Lake	All	93.7	19.2	11
		A	87.7	-	4
		B	94.9	-	2
		K	98.1	23.3	5
	Downstream of Kennady Lake	All	99.8	17.6	299
		L	101.2	18.3	191
		M	98.5	14.6	49
		410	98.5	15.6	25
		Kirk	95.1	18.5	34
	N	N	96.0	19.0	223
	Reference	East	76.9	-	2

Table DFO&EC_24-7: Mean Relative Weights (W_r) of Arctic Grayling, Lake Trout, Slimy Sculpin and Round Whitefish for each Sampling Season in the Project Study Area, 1996-2011

Species	Watershed	Fall			Spring			Summer			Winter		
		Mean W_r	*n*	SD	Mean W_r	*n*	SD	Mean W_r	*n*	SD	Mean W_r	*n*	SD
Arctic grayling	All	90.7	45	17	95.5	129	14	100.0	337	19			
	Kennady Lake	99.1	19	12	94.0	69	16	99.9	73	11			
	DS of Kennady Lake	85.6	16	19	98.3	40	12	98.9	77	18			
	N	82.9	10	14	95.1	20	11	100.5	187	22			
Lake trout	All	89.6	211	12	87.1	35	19	88.7	523	13	107.9	13	25
	Kennady Lake	90.8	149	12	83.9	7	13	90.7	194	15	107.9	13	25
	DS of Kennady Lake	86.1	22	8	85.4	11	17	90.3	135	11			
	N	86.7	40	15	89.6	17	21	85.4	190	11			
	Reference							91.2	4	6			
Round whitefish	All	95.4	191	17	83.7	7	9	96.0	625	16			
	Kennady Lake	97.5	172	16	75.5	1	-	95.2	431	13			
	DS of Kennady Lake	77.3	3	14	85.0	6	9	108.5	63	26			
	N	75.9	16	12				92.4	130	15			
	Reference							93.2	1	-			
Slimy sculpin	All	96.1	192	15				99.1	343	20			
	Kennady Lake	104.1	3	14				89.9	8	20			
	DS of Kennady Lake	96.7	150	14				102.9	149	21			
	N	93.1	39	18				96.6	184	19			
	Reference							76.9	2	12			

Table DFO&EC_24-8: Mean Relative Weights (W_r) of Arctic Grayling, Lake Trout, Slimy Sculpin and Round Whitefish for each Sampling Season in the Project Study Area, 1996-2011.

Species	Watershed	1996			1999			2004			2005			2007			2010			2011		
		Mean W_r	n	SD	Mean W_r	n	SD	Mean W_r	n	SD	Mean W_r	n	SD	Mean W_r	n	SD	Mean W_r	n	SD	Mean W_r	n	SD
Arctic grayling	All	97.5	25	12.3	93.4	44	9.3	97.5	121	14.7	101.9	132	17.3	98.1	155	23.7	99.8	7	8.1	89.0	27	9.9
	Kennady Lake	97.9	19	12.2	95.1	39	8.0	96.7	92	15.6	112.5	7	11.6	102.0	4	14.0						
	DS of Kennady Lake	96.2	6	13.8	80.1	5	8.0	100.0	29	11.5	99.3	51	18.9	93.8	39	18.6	104.6	3	7.8			
	N										102.7	74	16.2	99.5	112	25.4	96.2	4	7.0	89.0	27	9.9
Lake trout	All	87.0	233	11.6	87.1	59	10.3	92.4	249	15.1	90.5	133	15.7	93.7	6	14.0	77.0	7	23.1	85.9	95	8.4
	Kennady Lake	86.6	122	11.7	86.6	35	12.4	94.8	196	14.8	111.5	3	35.3	101.6	4	4.3	67.8	3	31.6			
	DS of Kennady Lake	88.6	42	8.4				89.4	24	13.3	89.7	101	11.9				104.2	1				
	N	86.9	69	13.1	87.9	24	6.5	78.8	29	10.8	91.0	29	22.7	77.9	2	13.1	77.2	3	10.5	85.7	91	8.5
	Reference																			91.2	4	5.5
Round whitefish	All	89.6	299	11.9	88.9	95	8.1	100.2	298	14.0	106.4	72	18.1	110.4	12	10.6	125.0	12	40.9	91.6	35	18.7
	Kennady Lake	90.9	216	12.2	89.3	82	8.0	100.7	288	13.8				110.4	12	10.6	97.3	6	5.0			
	DS of Kennady Lake	93.4	10	14.1				88.5	9	13.7	105.0	47	20.1				152.7	6	42.5			
	N	84.9	73	9.3	86.5	13	8.7	64.3	1	-	109.0	25	13.8							91.5	34	19.0
	Reference																			93.2	1	-
Slimy sculpin	All							116.4	1	-	101.8	108	20.2	96.9	408	17.9	101.8	9	11.7	97.2	9	17.8
	Kennady Lake							116.4	1	-	83.8	3	20.3	94.8	7	18.5						
	DS of Kennady Lake										104.2	59	19.8	98.8	239	16.9	90.8	1	-			
	N										99.8	46	20.3	94.3	162	18.9	103.2	8	11.7	103.0	7	14.8
	Reference																			76.9	2	12.5

Item d

Habitat surveys were conducted in lakes and streams on the dates outlined in Table DFO&EC_24-9 and Table DFO&EC_24-10, respectively.

Table DFO&EC_24-9: Habitat Survey Dates for Lakes in the Project Study Area, 1996-2011

Lake ID	Dates Surveyed
Kennady Lake	22-26 July 1996, 11-14 September 1996, 27 June 1996, 4-9 May 2004, 10-24 June 2004, 27-31 July 2004, 1-15 August 2004, 10-20 September 2004, 9 & 20 June 2005
A1	August 2002, 6 & 24 June 2004, 6 August 2004, 15 & 18 September 2004
A2	August 2002
A3	6 & 24 June 2004, 6 August 2004, 15 & 18 September 2004
A4	19-27 July 2010
A5	1 August 2005, 14 September 2005
A6	1 August 2005, 14 September 2005
A7	30 July 2005, 1 August 2005, 14 September 2005
A8	1 August 2005, 14 September 2005
A9	11-15 August 2003, 1 August 2005, 14 September 2005
B1	4 & 24 June 2004, 4 August 2005, 14 September 2005
B2	7 & 8 August 2004, 18 September 2004
B3	14 September 2005
B4	16 August 2004
C1	14 September 2005
D1	11-15 August 2003
D2	5 & 24 June 2004, 7 August 2004, 19 September 2004, 14 September 2005
D3	7 August 2004, 19 September 2004, 14 September 2005
D5	6-19 July 2011, 6-22 August 2011
D7	7 & 8 August 2004, 18 September 2004, 14 September 2005
D10	11-15 August 2003
E1	5 & 24 June 2004, 8 August 2004, 19 September 2004, 14 September 2005
E2	11-15 August 2003, 8 August 2004, 4 August 2005, 14 September 2005
E3	11-15 August 2003, 14 September 2005
F1	4 August 2005, 15 September 2005
G1	4 & 24 June 2004, 15 September 2005
G2	6 August 2004, 18 September 2004, 15 September 2005
H1a	5 & 24 June 2004, 6 & 11 August 2004, 18 September 2004
H1b	4 & 6 August 2005, 15 September 2005
I1	26 July 1996, August 2002, 4 & 11 August 2004, 18 September 2004
I2	August 2002, 11 August 2004, 1 August 2005, 14 September 2005
J1a	August 2002, 11 & 24 June 2004, 4 & 11 August 2004, 18 September 2004
J1b	August 2002, 3 & 11 August 2004, 18 September 2004
J2	August 2002
Ka1	11-15 August 2003, 4 August 2005, 15 September 2005
Kb1	1 August 2005, 14 September 2005
Kb2	August 2002, 6 & 7 August 2004, 18 September 2004
Kb3	August 2002, 6 & 7 August 2004, 18 September 2004
Kb4	11-15 August 2003, 1 August 2005, 14 September 2005
Kd1	5 June 1996, 6 August 2005

Table DFO&EC_24-9: Habitat Survey Dates for Lakes in the Project Study Area, 1996-2011 (continued)

Lake ID	Dates Surveyed
L1a	8 & 24 June 2004; 28 & 29 July 2005
L1b	28-30 July 2005
L1c	28 & 30 July 2005
L2	28 & 30 July 2005
L3	28, 30 & 31 July 2005; 3 & 5 August 2005
L4	11-15 August 2003
L13	19-27 July 2010
L14	11-15 August 2003
L15	August 2002
L18	19-27 July 2010
L19	11 August 2004, 30 July 2005, 1 August 2005, 14 September 2005
L20	11-15 August 2003
L21	August 2002, 11 August 2004, 30 July 2005, 1 August 2005, 15 September 2005
M1	9 & 22 June 2005, 26 July 2005
M2	27 July 2005
M3	27 July 2005
M4	13-15 September 1996, 9 & 22 June 2005, 27 July 2005
410	9 May 2004, 16 & 18 June 2004, 9 & 13 August 2004, 16 September 2004, 31 July 2005, 4 August 2005
Kirk Lake	2 August 2005
N2	28 & 29 July 2005
N3	10 & 22 June 2005, 28 & 29 July 2005
N4	28 July 2005
N5	28 July 2005
N6a	28 July 2005
N6b	28 July 2005
N7	11 August 2004
N11	10 July 2011
N12	5, 6, & 8 June 1996; 7 & 22 June 2005; 6 August 2005
N13	28 July 2005
N14	27 & 28 July 2005
N14a	19-27 July 2010, 6-19 July 2011, 6-22 August 2011
N14b	19-27 July 2010, 6-19 July 2011, 6-22 August 2011
N16	9 May 2004, 15 June 2004, 9 & 12 August 2004, 13 September 2004
N17	19-27 July 2010
N18	28 July 2005

Table DFO&EC_24-10: Habitat Survey Dates for Streams in the Project `Study Area, 1996-2011

Stream ID	Dates Surveyed
A1	16-27 July 1999, 4-9 June 2000
A2	8 June 1996, 4-9 June 2000
A3	7-8 June 1996, 4-9 June 2000, 6 August 2004
A5	4-9 June 1996
A6	4-9 June 1996
A7	4-9 June 1996
A9	4-9 June 1996
B1	4-9 June 1996, 16-27 July 1999, 4-9 June 2000, 6 August 2004
B2	6 August 2004
B3	6 August 2004
B4	6 August 2004
C1	4-9 June 1996, 4-9 June 2000
D1	6 June 1996, 4-9 June 2000
D2	6 June 1996, 4-9 June 2000
D3	4-9 June 2000
D4	6 August 2004
D6	6 August 2004
D7	6 August 2004
D8	6 August 2004
D9	6 August 2004
E1	7 June 1996, 16-27 July 1999, 4-9 June 2000
E2	6 August 2004
F1	4-9 June 2000
G1	7 June 1996, 5 August 2004
G3	7 June 1996
H1a	5 June 1996, 5 August 2004
H1b	5 June 1996
H2	5 June 1996, 5 August 2004
I1	5 June 1996, 4 August 2004
I2	5 June 1996, 4 August 2004
J1a	4 August 2004
J2	4 August 2004
K5	4-9 June 1996, 16-27 July 1999, 14 July 2001, 23 May 2004, 23 June 2004, 9 August 2004, 18 September 2004
Ka1	4-9 June 1996, 4-9 June 2000
Kb1	4-9 June 1996, 4-9 June 2000
Kb2	4-9 June 1996, 4 August 2004
Kb3	4-9 June 1996
Kb4	4-9 June 1996, 4-9 June 2000
Kd1	5 June 1996
Ke3	4-9 June 1996
Ke4	4-9 June 1996
L1a	4-9 June 1996, 22 June 2004, 3 August 2004, 20 September 2004
L1b	4-9 June 1996, 16-27 July 1999, 22 June 2004, 3 August 2004, 20 September 2004
L1c	24 June 2004, 3 August 2004, 20 September 2004

Table DFO&EC_24-10: Habitat Survey Dates for Streams in the Project `Study Area, 1996-2011 (continued)

Stream ID	Dates Surveyed
L2	4-9 June 1996, 16-27 July 1999, 4-9 June 2000, 24 June 2004, 3 August 2004, 20 September 2004
L3	4-9 June 1996, 16-27 July 1999, 24 June 2004, 3 August 2004, 20 September 2004
L11	19-27 July 2010
L13	4-9 June 1996, 6-23 June 2005, 19-27 July 2010
L14	19-27 July 2010
L15	19-27 July 2010
L18	19-27 July 2010
M1	20 June 2004, 3 August 2004, 19 September 2004
M2	20 June 2004, 3 August 2004, 19 September 2004
M3a	21 June 2004, 3 August 2004, 19 September 2004
M3b	21 June 2004, 3 August 2004, 19 September 2004
M4	4-9 June 1996, 22 June 2004, 1 August 2004, 20 September 2004
N1	23 May 2004, 22 June 2004, 9 August 2004, 18 September 2004
N2	23 May 2004, 22 June 2004, 9 August 2004, 18 September 2004
N3	23 May 2004, 22 June 2004, 9 August 2004, 18 September 2004
N4	23 May 2004, 22 June 2004, 9 August 2004, 18 September 2004
N5	23 May 2004, 22 June 2004, 9 August 2004, 18 September 2004
N6a	23 May 2004, 22 June 2004, 9 August 2004, 18 September 2004
N6b	23 May 2004, 22 June 2004, 9 August 2004, 18 September 2004
N7	4-9 June 2000, 23 May 2004, 23 June 2004, 8, 9 & 11 August 2004, 6-23 June 2005
N8	4-9 June 2000, 6-23 June 2005
N9	6-23 June 2005
N10	6-23 June 2005
N11	6-23 June 2005
N12	6-23 June 2005
N13	6-23 June 2005
N14	6-23 June 2005
N14a	19-27 July 2010
N14b	19-27 July 2010
N15	6-23 June 2005
N16	6-23 June 2005
N17	16-27 July 1999
P1	6-23 June 2005
P2	6-23 June 2005
P3E	6-23 June 2005
P4	6-23 June 2005
P5	6-23 June 2005
P6	6-23 June 2005
P7	6-23 June 2005

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GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: DFO_EC_25

Source: Fisheries and Oceans Canada and Environment Canada (DFO&EC)

Subject: Bathymetry

EIS Section: J3-3

Terms of Reference Section:

Preamble

To adequately understand, predict, and mitigate potential impacts to fish and other aquatic biota, it is essential to have an understanding of the environment in which the biota reside. Lake bathymetry provides the physical boundaries of that environment.

Request

a) Please provide area and volume data for all bathymetry maps (for those not already calculated). For example, N16 and the L watershed lakes are missing.

Response

All bathymetry data collected during the 2010 and 2011 field seasons were presented in the 2010 EIS and 2011 baseline documents.

Bathymetry data collected during the 2010 open water season are presented in Section HH3.6 (Addendum HH) of the 2010 Environmental Impact Statement (EIS); De Beers 2010. Calculated volumes and the water level surveys are presented in Table HH3-14. Bathymetry maps for each lake are presented in Appendix HH.III.

Bathymetry data collected during the 2011 open water season are presented in Section 3.6 of the 2011 Climate and Hydrology Baseline draft report (submitted to De Beers December 2011). Calculated volumes for each lake are presented in Table 16 of the report. Bathymetry maps for each lake are shown in Appendix E of the report.

Volume data were extracted from the above documents and supplemented by corresponding areas, and presented below in Table DFO&EC_25-1. Bathymetry data were not collected for Lake N16.

Table DFO&EC_25-1 Lake Areas and Volumes Calculated from Measured Bathymetry

Lake Name	Date	Area [km^2]	Volume [m^3][a]
Lake A3	20 Jul 2010	0.238	1,110,000
Lake B1	22 Jul 2011	0.084	145,000
Lake B2	22 Jul 2011	0.066	59,700
Lake D10	21 Jul 2010	0.047	41,100
Lake D2	21 Jul 2010	0.125	65,400
Lake D3	25 Jul 2010	0.384	566,000
Lake D5	22 Jul 2010	0.014	6,180
Lake D7	23 Jul 2011	0.376	578,000
Lake E1	19 Jul 2010	0.210	290,000
Lake E2	22 Jul 2011	0.029	15,700
Lake E3	22 Jul 2011	0.011	4,390
Lake F1	19 Jul 2011	0.043	59,500
Lake G1	19 Jul 2011	0.027	20,300
Lake G2	19 Jul 2011	0.054	87,100
Lake H1a	18 Jul 2011	0.030	27,200
Lake H1b	18 Jul 2011	0.028	39,800
Lake I1	18 Jul 2011	0.130	498,000
Lake I2	18 Jul 2011	0.020	9,740
Lake J1	17 Jul 2011	0.491	679,000
Lake L2	17 Jul 2010	0.110	136,000
Lake L3	17 Jul 2010	0.036	21,400
Lake L13	17 Jul 2010	0.031	17,900
Lake M2	19 Aug 2010	0.308	631,000
Lake M3	19 Aug 2010	0.882	2,300,000
Lake M4	14 Aug 2010	0.807	3,880,000
Lake N1	18 Aug 2010	3.88	12,200,000
Lake N7	19 Jul 2010	0.051	48,200
Lake N11	16 Jul 2010	5.40	18,000,000
Lake N14	19 Jul 2010	0.219	278,000
Lake N14a	22 Jul 2010	0.034	41,800
Lake N14b	21 Jul 2010	0.020	8,990
Lake N17 (northeast embayment)	24 Jul 2010	0.891	2,990,000
Lake 410	20 Aug 2010	5.71	13,000,000
Kirk Lake (south embayment)	16 Aug 2010	9.68	19,300,000

[a] Volumes on the day of survey, as presented on bathymetry figures.

Note: m^3 = cubic metres; km^2 = square kilometres.

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.

Golder (Golder Associates Ltd.). 2012a. 2011 Climate and Hydrology Supplemental Monitoring Report. Report No. 11-1365-0001/DCN-049. Submitted to Mackenzie Valley Environmental Impact Review Board. March 2012.

GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT
INFORMATION REQUEST RESPONSES

Information Request Number: DFO&EC_26

Source: Fisheries and Oceans Canada and Environment Canada (DFO&EC)

Subject: Dyke Construction

EIS Section: 8-127

Terms of Reference Section:

Preamble:

As noted in Section 8-217, silt curtains are proposed as the primary mitigation for sediment release during dyke construction for Area 8. The Meadowbank project in Nunavut was cited as an example of where silt curtains were used as mitigation. However, silt curtains were not initially successful as mitigation, and DeBeers should outline additional mitigation measures which may be implemented. The Meadowbank project may provide an example of where mitigation did not work, and subsequent improvements.

Request

a) Please provide a dyke construction plan with mitigation alternatives (e.g., site isolation, water management and construction practices) and contingencies.

Response

The dyke construction plan is provided in Section 3 of the 2012 EIS Supplement with further details 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 DFO&EC_26-A). Dyke A is the only dyke where water may enter the surrounding environment during operations. Dyke A will be constructed partially in the wet, in water up to about 2 m in depth. Based on the current dyke construction plan, Dyke A will be constructed in early months of Year -2 before the spring freshet. During the Dyke A construction period, the Kennady Lake surface including the channel where Dyke A will be constructed will be covered with thick ice. It is expected that there would be no to minimal flow passing through the channel during the Dyke A construction period.

General dyke construction plan includes the following:

- Install turbidity barriers (e.g., silt curtains), prior to dyke construction, on either side of the dyke alignment to protect Kennady Lake water quality during construction. Given the shallow water at the proposed Dyke A location, installation and maintenance of the turbidity barrier is expected to be straightforward.

- Remove snow and ice or other deleterious materials over the area within the dyke footprint.

- Construct a temporary crossing structure using relatively clean rock fill in the narrow downstream of the Dyke A centreline. The structure will provide temporary access to the airstrip and later form a part of the dyke shell of Dyke A. The structure will also help control the suspended solids in the water from reaching Area 8 during the Dyke A construction. Similarly, a temporary rock fill berm can be constructed on the other side of Dyke A to help control the suspended solids in the water from reaching Area 7 during the dyke construction. The berm will later become a part of the dyke shell of Dyke A.

- Construct the remaining portions of the dyke including till core that is located between the temporary crossing structure and berm.

- Maintain the turbidity barriers until construction of the dyke is completed and total suspended solids (TSS) concentrations between the dyke and the barriers have been reduced below required levels.

Some general considerations in the use of turbidity barriers in dyke construction are presented on Page 8-217 of the 2011 EIS Update (De Beers 2011). In the event that TSS concentrations approach monitoring thresholds, construction activities will be temporarily curtailed and additional measures would be implemented to meet the water quality requirements in Area 8. These contingency measures would include: 1) installing additional rows of the turbidity barriers, 2) constructing a temporary filter berm to retain the excess suspended solids and allow the clean water to pass through, or 3) pumping the water with excess TSS to a temporary polishing pond.

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.

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TECHNICAL MEMO

ISSUED FOR USE

TO:	Andrew Williams, De Beers Veronica Chisholm, De Beers	**DATE:**	March 27, 2012
C:	Wayne Corso, JDS, Dan Johnson, JDS		
FROM:	Bill Horne, EBA Gordon Zhang, EBA, Hongwei Xia, EBA	**EBA FILE:**	E14101143
SUBJECT:	2012 Gahcho Kué EIS Supplement - Summary of Dyke Conceptual Design and Construction Material for Gahcho Kué Diamond Project, NWT, Canada		

1.0 INTRODUCTION

EBA Engineering Consultants Ltd. operating as EBA, A Tetra Tech Company (EBA) was retained by JDS Energy and Mining Inc. (JDS) to develop a waste and water management plan as a part of the project feasibility study for the Gahcho Kué Diamond Project. EBA completed the original waste and water management plan and submitted the report to JDS in September 2010 which included conceptual designs for dykes required for the Gahcho water and waste management.

Modifications to the waste and management plan were made as described in the 2012 EIS Supplement (De Beers 2012) Project Description. The mine waste and water management plan has been updated accordingly as well as the dyke conceptual designs. This memo is an update of EBA's previous dyke conceptual design and construction material summary memo (EBA 2011) to reflect the recent update on the mine waste and water management plan.

2.0 DYKE/BERM DESIGN AND CONSTRUCTION

2.1 Key Considerations

The key considerations for the dyke/berm design were as follows:

- Comply with the Canadian Dam Safety Guidelines;
- Minimize seepage through dykes while optimizing the construction efficiency;
- Maximize the use of mine waste materials produced during pit development;
- Minimize overall environmental footprints and effects;
- Facilitate an effective mine closure plan;
- Optimize the dyke construction sequences to reduce initial construction requirements during pre-operation stage and construction intensity during mine operation;

- Establish adequate setback from the open pit limits for mining safety and minimizing seepage into the open pits; and
- Incorporate mine site roads (including haul roads) into dykes, wherever practical.

2.2 Design Criteria

The following design criteria were adopted for the dyke design:

- All dykes were designated as Significant Dyke Class based on the recommendation of the Canadian Dam Safety Guidelines (CDA 2007)
- The Area 1 perimeter berms and water collection pond berms were designated as Low to Significant Dyke class
- Peak ground acceleration (PGA) of 0.06 g was adopted for the dyke design
- A minimum freeboard of 1.0 m was adopted for the dyke design
- The minimum factors of safety for dyke slopes meet or exceed the requirements in the Canadian Dam Association guidelines (CDA 2007).

2.3 Conceptual Level Dyke Design

A total of 14 dykes are required for the water and waste management during the mine operation. The locations of the dykes are shown in Figure 1, the overall layout of the mine site. The typical cross section for each dyke is presented in Figures 2 through 15.

2.3.1 Dyke A

The construction of Dyke A is required during early mine development before the initial lake dewatering and pit development. The dyke would be constructed in winter to satisfy the current mine construction plan. An existing water depth of about 2 m is anticipated along the main portion of Dyke A. Up to 6 m thick overburden till over bedrock was identified over the Dyke A area during the 2004 site investigation. Several boulders (up to 0.3 m) were recovered in the overburden zone from a borehole drilled in the main channel at the Dyke A location. A talik (unfrozen year-round) was identified within the main channel area during the site investigation. In consideration of the above information, a soil-bentonite slurry cutoff wall through a till fill zone placed over the overburden and the overburden to the bedrock surface has been adopted as the main seepage control measure for Dyke A. The cut-off wall will be protected by a downstream filter zone and a mine rock shell zone. The proposed dyke cross section is shown in Figure 2.

Dyke A will be breached to restore the original channel between Area 7 and Area 8 at the end of final mine closure after the water quality in the restored Kennady Lake in Areas 2 to 7 meets discharge criteria.

2.3.2 Dyke B

Dyke B is an 850 m long, internal water retention dyke between Areas 3 and 4 that will be constructed for draining Area 4 before mining the Tuzo Pit within the Area 4 basin. Dyke B will be constructed in Year 4 and early Year 5 when up to 11 m of water will be present above the lakebed along the Dyke B centreline. The overburden thickness along the dyke centreline is expected to be in a range from 1 m to 5 m.

Overburden materials from pit development will be available for Dyke B construction; therefore, a wide till core has been selected as the main seepage control measure for Dyke B. Several other options of seepage control measures, including sheet-pile wall, slurry cut-off wall, or jet grouting through dyke till fill and overburden foundation to bedrock surface, were also considered. Preliminary seepage analyses indicated that the magnitude of the seepage rates through the dyke and its foundation for those options would be similar to that for the dyke with a wide till core. The reason for the relatively low overall effectiveness of these advanced seepage control measures is that substantial seepage though fractured bedrock is predicted for all the cases. Without applying curtain grouting through the fractured bedrock zone beneath the dyke, the benefit gained from incorporating more advanced seepage control measures into Dyke B may not justify the anticipated high incremental cost.

Based on the above, Dyke B will be designed as a wide till core dam that excludes advanced seepage control measures and bedrock curtain grouting. The proposed dyke cross section is shown in Figure 3. This dyke design will maintain the seepage rate through the dyke in a manageable range. Seepage through the dyke will be collected in the water collection pond CP6 and the sumps in Tuzo Pit. The water will be either pumped back to Area 3 or directed to the process plant as a portion of reclaim water.

Dyke B will be constructed in two stages. The Stage 1 construction will include placing the upstream mine rock berm and downstream coarse PK berm in Year 4 when the projected water elevation in Areas 3 to 5 is below 419.5 m. The two berms will provide confinement to the wide till core materials to be placed in the water between the two berms. The upstream mine rock berm will also provide protection to the till core against wave action and potential slope instability through the core. The downstream coarse PK zone will provide downstream slope stability of the till core and partially serve as a filter zone to the till and overburden.

The till core will mainly serve as a low-permeable material to control the seepage through Dyke B. The overall permeability or hydraulic conductivity will depend on the source material properties, placement method, and in-place densities. Densification of a selected critical zone of the till core may be required to achieve the design intents. Depending on the till material gradation and placement method, particle segregation may occur during till placement. Special measures, such as using long-arm conveyer instead of truck end-dumping, may be required to reduce the potential particle segregation.

The till core dumped in the water will be relatively soft until any excess porewater pressure generated in the soil mass is dissipated and the consolidated is initiated; this is estimated to take several months. Trafficability of large construction equipment over the soft till will be an issue. This can be resolved before or during the early stage of the construction by conducting some field trafficability tests using selected construction equipment. Furthermore, the two Stage 1 construction berms may be used as solid bases for till placement from both the upstream and downstream sides inwards.

Dyke B will be lowered to a maximum crest elevation of 418.0 m at early mine closure and completely submerged under water when the Kennady Lake is restored to its original lake elevation of 420.7 m during the late stage of mine closure.

2.3.3 Dykes A1, D, E, F, and G

Dykes A1, D, E, F, and G are located away from major water bodies, so permafrost is expected to exist beneath the dyke footprints. Dyke A1 is a water diversion dyke to divert runoff water from the catchment area of Area 1 and to isolate the A watershed from Area 2. Dyke D is a water retention dyke to prevent water in Area 2 from flowing north into Lake N7 during the late stage of mine operation. Dyke E serves as a water diversion dyke initially and then a water retention dyke during the late stage of mine operation. Dyke F is a water diversion dyke to prevent water from the D watershed from flowing into Area 5 during mine operation. Dyke G is a water diversion dyke to prevent water from the E watershed from flowing into Area 6 during mine operation. The design concepts for these dykes are similar. The seepage control measures adopted for these structures include a liner keyed into competent frozen ground (saturated inorganic permafrost) or bedrock. The design intent was to protect the original permafrost foundation from thawing when possible and limit the seepage through these structures and their foundations. The till fill zone upstream of the liner provides thermal protection to the key trench and limits the seepage through the dyke that could result from a damaged liner. The mine rock shell provides the necessary overall stability and also serves as thermal cover to the dyke foundation around the key trench area. Proposed conceptual design cross sections for these dykes are shown in Figures 4 through 8.

Dykes A1 and D will remain in place after mine closure. Dykes E, F, and G will be breached to restore the original natural flow regimes during mine closure.

2.3.4 Dykes H, I and J

Dykes H, I, and J are internal water retention dykes between Area 5 and Area 6 (for Dykes H and I) and between Area 4 and Area 6 (for Dyke J). Two stages of construction will be adopted to limit the construction requirements during the early Stage 1 construction in Year -2 before pit development. The cofferdams for Dykes I and J will be placed under water during the early stage of the initial lake dewatering. The fills for the remaining Stage 1 construction for the dykes will be placed in dry conditions when the water level in Area 6 is further lowered to expose the lakebeds under the dyke footprints. A wide till core has been selected as a main water control measure to limit seepage through the dykes. The Stage 2 construction of the dykes will be completed before Year 3 when sufficient till is available from pit development and the projected maximum water level in Areas 3 to 5 remains below 419.5 m. Dyke cross sections are shown in Figures 9 through 11. Seepage through the dykes will be collected and pumped back to the source reservoir as required.

Dykes H and I will remain in place after mine closure. Dyke J will be lowered to a top crest elevation of 418.0 m to limit net fish habitat losses.

2.3.5 Dykes K, M and N

Dykes K, M, and N are internal water retention dykes and will be constructed in dry conditions. A wide till core has been selected as the main seepage control measure for these dykes. Dykes K and N will be constructed in two stages to meet the design intent and lower the overall construction cost. Dyke cross sections are shown in Figures 12, 14, and 15. The Stage 1 construction of Dyke N will serve as a portion of the haul road from the 5034 Pit to the south mine rock pile and will be constructed using overburden materials from the 5034 Pit. Similarly, the Stage 1 construction of Dyke K will serve as a portion of the haul road from the Hearne Pit to the west mine rock pile and will be constructed using overburden materials from the Hearne Pit. The Stage 2 construction will be completed in early Year 6 for Dyke K and in Year 9 for Dyke N. Dyke M will be completed before the Year 3 spring freshet. Seepage through the dykes will be collected and pumped back to the source cells as required.

Dykes K and N will be lowered to a maximum crest elevation of 418.0 m at early mine closure and completely submerged under water when the Kennady Lake is restored to its original lake elevation of 420.7 m during the late stage of mine closure. Dyke M can remain in place after mine closure.

2.3.6 Dyke L

Dyke L is a 1070 m long, curved filter dyke to retain the particles in the fine PK placed in Area 2 while allowing sufficient clean water passing through the dyke from Area 2 to Area 3. The dyke is designed based on past experience gained for similar filter dykes designed and construction managed by EBA at both the EKATI Diamond Mine and Jericho Diamond Mine. The dyke cross section is shown in Figure 13. The lower portion (below an elevation of about 419.5 m) of the dyke will be placed underwater with a maximum water depth of approximately 6.5 m. The mine rock benches within both the side slopes are required for slope stability. The dyke can be constructed in two stages to reduce early construction requirements. The Stage 1 construction to a crest elevation of 421.0 m will be in Year -1 before any fine PK is placed in Area 2. The remaining construction can be completed in Year 2.

A section (100 m width) of Dyke L crest close to the northwest abutment will be lowered down to an elevation of 421.0 m to create a contingency drainage path across the dyke after mine closure. The remaining portion of Dyke L will remain in place but will not retain water.

2.3.7 Area 1 Perimeter Berms

Three low berms are required at the low saddles along the west to south perimeter of Area 1 to retain water and provide some freeboard in Lake A1. The freeboard will prevent the water in the Lake A1 from flowing into Area 3 or Area 4 under an extreme precipitation event. The berms will be 2 to 3 m in height and constructed using available till materials and mine rock. A typical cross section of the berms is shown in Figure 16.

One of the berms will be breached to allow the excess water flowing from Area 1 into Area 3 after the water quality in the restored Kennady Lake in Areas 2 to 7 meets discharge criteria.

2.3.8 Water Collection Pond Berms

Four berms for water collection ponds CP3 to CP6 are required to limit surface runoff to flow into the active pits. A typical cross section of the berms is shown in Figure 16. The berms are designed to have a liner keyed into the key trench that is backfilled with selected till fill. The liner can be placed directly over the upstream surface of the berm slope and anchored into the fill immediately below the berm crest.

The berms for water collection ponds will not be requried after the end of mine life and will be completely submerged below water after the water elevation in Areas 4 and 6 is raised to above 418.0 m during mine closure.

2.4 Dyke Stability

Limited dyke slope stability analyses were conducted for Dyke L in this study. The design side-slopes for the remaining dykes and berms in this study were determined based on the findings from the stability analyses for Dyke L along with engineering judgement from previous engineering designs in the region and the mine rock pile stability analyses summarized in Appendix C of EBA's Water and Waste Management Report (EBA 2010). The design slopes are considered to be conservative and are expected to meet the design criteria

Detailed slope stability analyses with known soil properties of both the construction materials and foundation soils will be required to finalize and optimize the dyke/berm geometries in the final stage of designs for these dykes and berms.

2.5 Thermal Considerations

Permafrost is expected to exist beneath the majority of the footprint for each of Dykes A1, D, E, F, G, and M. These dykes, except for Dyke M, have been designed as zoned earth fill dykes with a liner keyed into the expected permafrost foundation to limit the seepage through the dyke and its foundation. No thermal analyses were conducted at this stage of study. Similar dykes have been successfully designed by EBA and constructed in other northern mines including EKATI and Jericho. The thermal behaviour of the dykes for this study was assessed based on the general site conditions at the Gahcho Kué project site and the experience gained from the dyke design for other northern mines. A minimum of 4 m thermal cover over the key trench area was adopted for Dykes A1, D, E, F, and G to maintain or delay thawing of the existing permafrost beneath the key trench.

A thermal cover of 3 m over the top of slurry cut-off wall in Dyke A was adopted to limit the freeze-thaw thermal effects on the wall.

Dykes A, E, F, and G are water diversion structures to limit water flowing into the internal water management ponds in the mine site area during mine operation. Any minor seepage through these dykes would be collected in the ponds and impose no or negligible negative effects on the surrounding environment. Dyke M is an internal dyke between Area 5 and Area 4. Any minor seepage through the dyke will be pumped back to its upstream side pond. Therefore, it is preferred, but not necessary, to maintain the existing permafrost beneath these dykes as long as the seepage rates through these dykes are manageable. A greater overall water storage capacity for the water management during mine operation is required when more water seeps through the diversion dykes. These dykes will be breached during mine closure or at the end of final mine closure.

Dykes A1 and D will remain in place after mine closure. It is expected that the permafrost could be maintained in the area beneath the key trench in these dykes over the relatively short period during the mine operation and early mine closure before the water quality in Area 2 to 7 meets the discharge criteria. The liner system together with permafrost foundation beneath the key trench will effectively cut off the seepage through the dykes. After the final mine closure when the water quality in Area 2 to 7 meets the discharge criteria, minor seepage through the dyke foundations would be acceptable; therefore, the presence of permafrost in the key trench area would be preferred but no longer a requirement.

The thermal designs in this study are experience-based and considered to be reasonable for the level of the current study and are expected to meet the general design criteria. Detailed thermal analyses with known site conditions and soil properties will be required to evaluate the thermal performance of the dykes and finalize the thermal designs during the next stage of study. The thermal analyses for these dykes must consider climate change (global warming) scenarios.

3.0 CONSTRUCTION MATERIALS AND QUANTITIES

3.1 Construction Materials

Eleven types of dyke/berm construction materials are proposed in this study, including mine rock fill, transition fill, liner bedding, till fill, till filter, road surface fill, rip-rap, fine PK filter, coarse PK, slurry cut-off wall material, and geomembrane liner. The general requirements for the materials are specified below for cost estimates only for the feasibility study. The requirements for each of the materials can vary slightly for a specific dyke or berm to meet specific design intents. The material specifications for construction will be developed in the final designs of the dykes and berms during the next stage of study.

Mine rock fill, used mainly for constructing the dyke/berm shell, can be sourced from selected run-of-mine mine rock from pit development or from rockfill quarry sites when required. The fill can have a wide variation in gradation, with a maximum particle size of 800 mm. The fill particles shall be angular and shall be derived from hard, durable, non-acid generating rock. The depth and spacing of drill holes and weight and delay of charge shall be selected to produce mine rock of specified size and quality.

Transition fill will mainly serve as a separator between mine rock fill and other finer materials such as liner bedding or till fill. It may need to meet filter design criteria under some applications. It can also be used as erosion protection and rip-rap bedding. The material shall be free of roots, organics, and other deleterious material and have a particle size distribution falling within the limits presented in Table 1. Processing will be required to achieve the specified gradation. The material can be processed from hard, durable, non-acid generating mine rock.

Table 1: Transition Fill Particle Size Distribution Limits

Particle Size (mm)	% Passing
150	100
100	75 – 100
50	40 – 70
20	20 – 50
10	0 – 30
5	0 – 10

Liner bedding fill will mainly serve as beddings placed above and below a geomembrane liner to protect the liner from damage during construction and under normal loading conditions. It may also be used to key the liner into the underlying permafrost foundation and to backfill the key trench. The required gradation will depend on the type of the liner to be protected and other specific applications. For construction planning purposes, gradation limits, as presented in Table 2, have been developed for the material. The maximum size of the particles could be larger if a more puncher-resistant liner, such as a bituminous geomembrane liner, is selected. The material can be processed from hard, durable, non-acid generating mine rock. Under certain applications, selected natural till or even coarse PK may be selected as potential alternatives to the specified liner bedding fill. This cost-saving opportunity can be investigated in the final designs of the dykes and berms.

Table 2: Liner Bedding Fill Particle Size Distribution Limits

Particle Size (mm)	% Passing
20	100
12.5	65 – 100
5	45 – 70
.63	15 – 35
.08	4 – 10

Till fill represents a wide range of natural overburden materials including inorganic till and even some lakebed sediments. An effective mixture of these two soil types may also be chosen. The major application of the till fill in this study is to serve as a low-permeable general fill to reduce seepage through dykes/berms and their foundations. The material shall be free of roots, organics, and other deleterious material. The material can have a wide variation in gradation with a maximum particle size of 300 mm and a fines (less than 0.08 mm) content of 10% to 40%. Selected till fill should be used to backfill the key trench over the liner for the water collection pond berms to form a low-permeable mass without damaging the liner. The overburden soils removed from the footprints of the three pits can be used as till fill material during the dyke and berm construction

Till filter is defined as a material that mainly protects the till fill from potential erosion/instability under seepage forces and hydraulic conditions. The material shall be free of roots, organics, and other deleterious material and have a particle size distribution falling within the limits presented in Table 3. Processing will be required to achieve the specified gradation. The material can be processed from hard, durable, non-acid generating mine rock.

Table 3: Till Filter Particle Size Distribution Limits

Particle Size (mm)	% Passing
38	100
20	75 – 100
12.5	50 – 100
5	35 – 60
.63	5 – 20
.08	0 – 5

Road surface fill will be used over either till fill or crushed rock to provide a stable foundation for the site roads. The fill should meet the requirements of site road designs, which are beyond the scope of this study.

The fill may have a tentative maximum particle size of 50 mm and a fines (less than 0.08 mm) content of less than 8%. The material can be processed from hard, durable, non-acid generating mine rock.

Rip-rap shall be used as erosion protection for Dyke L. The material shall be free of roots, organics and other deleterious material and have a particle size distribution falling within the limits presented in Table 4. Processing will be required to achieve the specified gradation. The material can be processed from hard, durable, non-acid generating rock that may otherwise go to the waste material storage sites.

Table 4: Rip-Rap Particle Size Distribution Limits

Particle Size (mm)	% Passing
300	100
150	75 – 100
50	25 – 65
25	10 – 40
5	0 – 15

Fine PK filter is defined as a filter material used in Dyke L to retain the majority of the fine PK particles but to have sufficient permeability for water to pass through. The material shall be free of roots, organics, and other deleterious material and have a particle size distribution falling within the limits presented in Table 5. Processing from hard, durable, non-acid generating rock will be required to achieve the specified gradation.

Table 5: Fine PK Filter Particle Size Distribution Limits

Particle Size (mm)	% Passing
20	100
12.5	85 – 100
5	65 – 80
1.25	43 – 55
0.63	32 – 45
0.315	23 – 33
0.16	16 – 26
0.08	10 – 18

Coarse PK from the process plant is planned to be used as a construction material for the construction of Dyke B. Its gradation has not been specified at this stage. It is expected to consist of predominantly sand-sized particles. The gradation, hydraulic conductivity, and durability of coarse PK should be investigated before coarse PK is selected as dyke construction material during the final design of the dykes and berms.

Slurry cut-off wall material for Dyke A will comprise either 50 mm minus crush rockfill with 6% bentonite (by weight) or sand and gravel with 6% bentonite.

Geomembrane Liner serves as a seepage barrier for each of Dykes A1, D, E, F, G, N14, E1, N18, and four water collection pond berms in this study. Generally, three types of the geomembrane liners are commercially available for this application. They are HDPE, polypropylene or bituminous geomembrane liners; each has its advantages and disadvantages. The bituminous geomembrane liner, Coletanche ES3 for Dykes A1, D, F, and G, and Coletanche ES2 for the remaining dykes and berms with liner, are selected for cost estimating purposes at this stage of design. If HDPE or polypropylene geomembrane liner is adopted, nonwoven geotextile cushion should be applied both above and below the geomembrane liner to protect the liner from damage during construction and normal operation. The final selection of the liner type will be made during the final design stage based on final design/construction requirements, construction season, and other considerations.

3.2 Construction Quantities

Tables 6 to 10 summarize the estimated material quantities for construction of dykes and berms for water and waste management. The material quantities are "in-place" and do not include material waste, bulking factors, liner seaming allowance, and contingencies. Seaming allowance and contingencies must be added to liner quantities to account for overlap, damaged sections, and/or waste during construction. Bulking factors and contingencies must be added to fill quantities. The volume of key trench excavation has been calculated assuming a trench depth of 2 m. The depth and volume of key trench excavation depend on the actual site conditions encountered.

Table 6: Construction Material Quantities for Dykes A, B, and L

Item	Unit	Dyke A	Dyke B		Dyke L	
			Stage 1 Construction	Stage 2 Construction	Stage 1 Construction	Stage 2 Construction
Mine Rock Fill	m^3	22,600	157,700	23,200	151,500	36,600
Transition Fill	m^3	N/A	N/A	18,400	19,800	9,900
Till Fill	m^3	2,500	N/A	835,400	N/A	N/A
Till Filter	m^3	1,300	N/A	18,400	N/A	N/A
Road Surface Fill	m^3	4,100	N/A	N/A	N/A	N/A
Rip Rap	m^3	N/A	N/A	7,200	12,200	8,800
Fine PK Filter	m^3	N/A	N/A	N/A	19,800	9,900
Coarse PK	m^3	N/A	133,500	50,200	N/A	N/A
Slurry Cut-off Wall Excavation	m^3	700	N/A	N/A	N/A	N/A
Slurry Cut-off Wall Backfill	m^3	700	N/A	N/A	N/A	N/A
Total Fill Volume	m^3	31,200	291,200	952,800	203,300	65,200

Table 7 Construction Material Quantities for Dykes A1, D, E, F, and G

Item	Unit	Dyke A1	Dyke D	Dyke E	Dyke F	Dyke G
Mine Rock Fill	m^3	19,000	7,200	18,800	11,300	17,100
Transition Fill	m^3	N/A	N/A	N/A	4,100	3,200
Liner Bedding	m^3	12,400	4,800	4,500	4,600	3,800
Till Fill	m^3	37,700	11,900	12,300	6,000	2,700
Till Filter	m^3	3,400	1,200	700	1,000	1,000
Road Surface Fill	m^3	4,200	2,300	2,700	1,300	3,000
Trench Excavation	m^3	14,000	5,900	4,200	4,600	5,900
Geomembrane Liner	m^2	16,400	5,300	4,100	4,400	4,100
Total Fill Volume	m^3	76,700	27,400	39,000	28,300	30,800

Table 8: Construction Material Quantities for Dykes H, I, J, K, M and N

Dyke	Construction Stage	Dyke Construction Material Volume (m^3)					
		Mine Rock Fill	Transition Fill	Till Fill	Till Filter	Road Surface Fill	Total Fill Volume
Dyke H	Stage 1	400	N/A	900	N/A	N/A	1,300
	Stage 2	4,400	N/A	13,900	900	2,600	21,800
Dyke I	Stage 1	1,700	1,500	19,200	500	N/A	22,900
	Stage 2	8,600	1,100	47,500	3,500	12,100	72,800
Dyke J	Stage 1	500	300	2,400	N/A	N/A	3,200
	Stage 2	1,300	N/A	5,000	400	1,200	7,900
Dyke K	Stage 1	N/A	N/A	75,900	N/A	10,100	86,000
	Stage 2	15,600	800	35,700	4,700	N/A	56,800
Dyke M	One stage	3,400	N/A	6,500	100	3,100	13,100
Dyke N	Stage 1	N/A	N/A	112,500	N/A	6,800	119,300
	Stage 2	23,400	900	57,700	6,400	N/A	88,400

Table 9: Construction Material Quantities for Water Collection Pond Berms for CP3 to CP 6

Item	Unit	Water Collection Pond Berm			
		CP3	CP4	CP5	CP6
Mine Rock Fill	m^3	5,400	500	3,000	8,500
Transition Fill	m^3	700	N/A	500	1,300
Liner Bedding Fill	m^3	1,800	300	800	2,000
Till Fill	m^3	3,800	700	1,300	3,500
Till Filter	m^3	500	100	200	600
Key Trench Excavation	m^3	4,600	900	1,400	3,800
Geomembrane Liner	m^2	4,100	600	1,400	3,600
Total Fill Volume	m^3	12,200	1,600	5,800	15,900

Table 10: Construction Material Quantities for Area 1 Perimeter Berms

Fine PK Management Berm	Berm Construction Material Volume (m^3)		
	Berm 1	Berm 2	Berm 3
Mine Rock Fill	2,300	1,100	1,900
Till Fill	7,500	4,000	6,500
Key Trench Excavation	2,500	1,500	2,400
Total Fill Volume	9,800	5,100	8,400

3.3 Construction Schedule

Table 11 presents the overall construction schedules for the dykes and berms required for the water and waste management.

Table 11 Summary of Dyke/Berm for Gahcho Kue Project, NWT

Name	Dyke/Berm Type	Approximate Construction Year	Maximum Design Operating Water Head at Dyke/Berm Centreline (m)	Total Length of Dyke/Berm (m)
Dyke A	Water retention /diversion dyke	Early Year -2 (before start of initial lake dewatering)	2.0	480
Dyke B	Internal water retention dyke	Year 4 to early Year 5	11.5	930
Dyke A1	Diversion/water retention dyke	Before Year -1 spring freshet	4.0	670
Dyke D	Water retention dyke	Before Year 2 spring freshet	2.0	240
Dyke E	Diversion dyke/water retention	Before Year 1 spring freshet	1.3	370
Dyke F	Diversion dyke	Before Year -1 spring freshet	3.0	290
Dyke G	Diversion dyke	Before Year -1 spring freshet	1.0	390
Dyke H	Internal water retention dyke	Stage 1 Construction in Year -2 ; full dyke (Stage 2) before Year 3	2.5	280
Dyke I	Internal water retention dyke	Stage 1 Construction in Year -2; full dyke (Stage 2) before Year 3	4.5	410
Dyke J	Internal water retention dyke	Stage 1 Construction in Year -2; full dyke (Stage 2) before Year 3	2.7	135
Dyke K	Internal water retention dyke	Stage 1 (haul road) construction in Year -1; full dyke (Stage 2) in Year 5 to early Year 6 (before Year 6 spring freshet)	7.7	340

Table 11 Summary of Dyke/Berm for Gahcho Kue Project, NWT

Name	Dyke/Berm Type	Approximate Construction Year	Maximum Design Operating Water Head at Dyke/Berm Centreline (m)	Total Length of Dyke/Berm (m)
Dyke L	Internal filter dyke	Stage 1 in Year -1 (before placing fine PK in Area 2) and full dyke (Stage 2) in Year 2	1.0	1065
Dyke M	Internal water retention dyke	Before Year 3 spring freshet	1.5	215
Dyke N	Internal water retention dyke	Stage 1 (haul road) construction in Year 4; full dyke (Stage 2) in Year 9	8.3	410
Area 1 Perimeter Berms	Internal water diversion berms	Year -1 or Early Year 1	1.0	680
Berms for Water Collection Ponds	Internal water retention berm	Road berm for CP2 in Year -1); berms for CP3 to CP5 in Year -1 and berm for CP6 in Year 5	3.0	1120

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