DE BEERS
CANADA
GAHCHO KUÉ PROJECT

December 15, 2011

File: S110

Chuck Hubert
Environmental Assessment Officer
Mackenzie Valley Environmental Impact Review Board
Suite 200 – 5102 – 50th Avenue
PO Box 938
Yellowknife, NT X1A 2N7

Dear Mr. Hubert,

RE: <u>De Beers Canada Inc. – Gahcho Kué Project EIS Analysis Session (November 28-December 2, 2011) Updates</u>

De Beers Canada Inc. (De Beers) is pleased to provide the Environmental Impact Review Panel with the following updates:

- Undertaking #2 – from De Beers Gahcho Kué Project Environmental Impact Statement (EIS) Analysis Session (Golder Technical Memo December 15, 2011);
- Additional Information regarding ENERGETICs, Population Viability Analysis and Effects of access from the winter road (Golder Technical Memo Dec 15, 2011); and
- Follow-up response to questions by Stephen Ellis (Treaty 8 Tribal Corp) (Golder Technical Memo December 15, 2011).

Should you have any questions please contact me at veronica.chisholm@debeerscanada.com or 1-877-446-8701 or Stephen Lines at stephen.lines@debeerscanada.com or 867-766-7352.

Sincerely,

Veronica Chisholm

Veronica Chisholm
Permitting Manager

Attachments: 3

TECHNICAL MEMORANDUM

DATE December 15, 2011 **DOCUMENT No.** 11-1365-0001/3010/DCN-045

TO Veronica Chisholm and Stephen Lines
De Beers Canada Inc.

CC Amy Langhorne and John Faithful (Golder Associates Ltd.)

FROM John Virgl and Cameron Stevens **EMAIL** cameron_stevens @golder.com

RE: UNDERTAKING #2 FROM DE BEERS GAHCHO KUÉ PROJECT ENVIRONMENTAL IMPACT STATEMENT (EIS) ANALYSIS SESSION

Paraphrased from EIS Analysis Sessions Transcript Volume 4, pages 22-24:

"In Section 11.13.5, the residual effects summary states that all of the pathways for climate change were determined to have no linkage or minor (secondary) changes to the classification of effects from the Project on the biophysical environment. Given the 10 year period of construction and operation and predictions of further climate change, it seems questionable that the proponent is confident that a warming climate will not cause measurable changes with residual effects relative to baseline. There is no discussion of the current rate of warming relative to non-linear and unpredictable effects and increases in annual and season variability. For example; in the KLOI for caribou, for example, population modeling indicates a large effect on caribou abundance from changes in the levels of insect harassment (to which any effects of the mine would be additive). Insect harassment is temperature dependent and is predicted to be more severe under a warmer climate. In that case, effects of the mine additive to the effects of a warmer climate would have residual effects."

Response:

The assessment of climate change in the EIS is consistent with the directions provided in the Terms of Reference. Within Section 5.2.7 of the Terms of Reference it states that "the EIS must address climate change impacts in combination with development related impacts on any of the valued components". Climate change is assessed in the EIS as a Subject of Note (Section 11.13), and is also considered for valued components in the respective sections of the EIS (e.g., Section 7 KLOI Caribou). The impact assessment considered the potential interactions (i.e., combinations of effects) between climate and the Project for the duration of the Project.

For the aquatic assessment a conservative approach was applied based on Project designs that do not rely on existing or future temperature regimes. For example, the assessment of potential effects to water quality and fish in Kennady Lake, and downstream waters, was completed without the establishment of permafrost in the Mine Rock and Coarse Processed Kimberlite Piles, and the Fine Processed Kimberlite Containment Facility. Water quality in Kennady Lake and downstream waters following closure was simulated assuming unimpeded seepage flows through these facilities, with loading assigned to these flows based on geochemistry testing of those materials. Under current climate conditions, permafrost will develop in the reclaimed structures, which will lower rates of seepage through the facilities and limit geochemical loading to Kennady Lake. With the onset of climate change conditions that reduce or eliminate permafrost conditions at the Project site, the conservative approach means that the long-term water quality parameter concentrations will not be higher than simulated in the assessment. Therefore, potential effects from climate change are not anticipated to alter the classification of effects on the aquatic environment.

The terrestrial assessment, which includes wildlife, soils, and vegetation, demonstrated that the absolute and relative magnitude of effects from the Project is small. For example, the physical change to the terrestrial landscape from the Project footprint is 392.5 hectares, which is less than 1% of the effects study areas for wildlife valued components. Project-related effects on the physical environment and demography of wildlife species are negligible relative to the temporal and spatial scales that are associated with climate change processes.

Climate does have the potential to affect populations of wildlife directly (e.g., extreme heat, cold events), and the distributions of individual components of ecosystems may shift in different ways under different climate scenarios, generating potentially new combinations of species and new ecosystem types (reviewed in Mawdsley et al. 2009). A key point is that changes resulting in indirect effects are difficult to predict (e.g., bottom-up vs. top-down responses) (Krebs and Berteaux 2006). There is also uncertainty in the ability to forecast the course of climate change in coming decades and the ability to predict the ecological and biogeographic responses to climate change (Jackson et al. 2009). Climate change is also a function of physical and biological processes and outcomes that provide feedback for further influences on climate. Correlative models (e.g., temperature-insect relationship) can be useful in gauging the potential biotic consequences of particular climate change scenarios. However, they should be considered cautionary and illustrative, and not predictive and prescriptive (Jackson et al. 2009). For example, the effects of warming temperatures on insect activity may be offset by increases in the occurrence of wind, which is also a variable determining the level of insect harassment. This supports Krebs and Berteaux (2006) who state that causal mechanistic chains must be understood to provide predictability in climate change outcomes.

As proposed by Dr. Gunn, we also recognize that the natural environment can have large influences on the ecological processes and functions on the landscape. The large effect of insect activity levels on the modeled caribou population, for example, was demonstrated in the population viability analysis (PVA) in the EIS (Volume 2, Section 7.5.4). Follow-up work based on feedback from ENR has also demonstrated that the relative effect of insect activity levels on caribou are likely stronger than predicted when compared to predicted Project-related impacts. For example, if considering a less conservative relationship of weight loss and parturition rates, the incremental and cumulative effects of the Project are noticeably reduced, and therefore, the relative effects of insect activity levels are more pronounced. The models were also refined to capture the effect of temporal variation in summer to autumn range conditions on parturition and calf survival that may be partially related to climate change events (i.e., by using increasing, decreasing, and average range condition scenarios). This work is captured in a memo entitled Additional Information Regarding Energetics, Population Viability Analysis, and Effects of Access from the Winter Road (dated December 16, 2011 that is publicly available through the Mackenzie Valley Review Board's website).

As noted above, the key point is that the absolute magnitude of direct and indirect effects from the Project is small and the long-term trajectory of the abundance and distribution of valued components will not be significantly affected by the Project. The relative contribution to changes may increase when population size is low and environmental conditions are poor, but such events will likely be infrequent within the next 30 years and the absolute effect size from the Project would remain negligible. Recently completed modelling tests supports this conclusion and addresses the issue of uncertainty and the possibility of climate change, and related effects on the caribou population (see Additional Information Regarding Energetics, Population Viability Analysis, and Effects of Access from the Winter Road, December 16, 2011). For example, the magnitude of effects to the persistence of the modeled population remained similar even with a substantial reduction in the carrying capacity of the landscape over a 30 year period. In other words, caribou are predicted to remain resilient to the effects from the Project and the previous and current extent of human development even under a hypothetical scenario of a decrease in range conditions due to climate change.

The effects from climate change operate over multiple spatial and temporal scales. In the EIS, a conservative assessment approach was applied by simulating population viability models for 30-year periods where it was assumed that Project-related effects were constant across this entire period. However, the actual length of time when the Project may affect key measurement endpoints such as parturition rate in caribou and mortality in carnivores is closer to 15 years. Sensory disturbance effects will likely be much weaker during the closure and post-closure phases of the Project. The key point is that the magnitude, duration, and geographic extent of effects from the Project on the physical environment and demography of wildlife species are negligible relative to the temporal and spatial scales that are associated with climate change processes.

Reclamation progress could also be affected by changes in climate given the potential temporal overlap in succession processes that operate in Arctic environments. For example, studies in the Arctic have shown that recovery of some vegetation communities can take from 20 to 75 years (Walker and Everett 1991; Forbes et al. 2001). However, despite the potential for changes in plant species composition (i.e., early species assemblages) on reclaimed areas, the overall Project related effects to plant populations and communities from changes in vegetation on reclaimed areas will be negligible (i.e., the assessment conclusion will remain the same). The Project footprint area to be reclaimed will be about 90 hectares in size.

The EIS did not underestimate the interacting effects of climate change and the Project in the impact predictions. In cases where there is uncertainty regarding ecological processes, the system can be described by a set of similarly adequate competing models (i.e., the EIS model and the model suggested by Dr. Gunn are equally parsimonious) (Krebs and Berteaux 2006). As noted above, the EIS distinguishes between impacts from development and natural variations in abundance and distribution, as requested by the Terms of Reference. Importantly, the EIS demonstrates that Project-related effects on the terrestrial valued components are negligible, and with the exception of vegetation, do not extend over the temporal scale at which large influences from climate change are anticipated. Further, the assessment included many ecological conservatisms such that conclusions were biased but reliable in the sense that actual impacts will be not be greater than predicted (i.e., effects were overestimated in EIS). The result is that the EIS has made reliable predictions about likely residual Project effects and their significance, and this has included consideration of climate change in accordance with the EIS Terms of Reference.

References

Forbes, B.C., J.J. Ebersole, and B. Strandberg. 2001. Anthropogenic disturbance and patch dynamics in Circumpolar Arctic ecosystems. Conservation Biology 15: 954-969.

Jackson, S. T., J. L. Betancourt, R. K. Booth, and S. T. Gray. 2009. Ecology and the ratchet of events: climate variability, niche dimensions, and species distributions. Proceedings of the National Academy of Sciences 106: 19685-19692.

Krebs, J. K., and D. Berteaux. 2006. Problems and pitfalls in relating climate variability to population dynamics. Climate Research 32: 143-149.

Mawdsley, J. R., R. O'Malley, and D. S. Ojima. 2009. A review of climate-change adaptation strategies for wildlife management and biodiversity conservation. Conservation Biology 23: 1080-1089.

Walker, D. A. and K. R. Everett. 1991. Loess ecosystems of Northern Alaska: regional gradient and toposequence at Prudhoe Bay. Ecological Monographs 61: 437-464.

http://capws/sites/capws2/1113650001postEisSubmission/Phases and Tasks/3_EIR Elements/3010 - Gap Analysis/Undertaking/121215_Response_Undertaking2_EIS_Analysis_Session.docx

TECHNICAL MEMORANDUM

DATE December 15, 2011 **PROJECT No.** 11-1365-0001 / 3030/ DCN-042

TO Veronica Chisholm and Stephen Lines
De Beers Canada Inc.

CC Amy Langhorne (Golder Associates Ltd.)

FROM Cameron Stevens and John Virgl **EMAIL** cameron_stevens@golder.com

RE: ADDITIONAL INFORMATION REGARDING ENERGETICS, POPULATION VIABILITY ANALYSIS AND EFFECTS OF ACCESS FROM THE WINTER ROAD

The purpose of this memorandum is to provide additional information in response to questions raised by the Government of the Northwest Territories (GNWT) Department of Environment and Natural Resources (ENR) regarding the energetics modelling, population viability analysis (PVA) and the potential effects from the winter road access.

On July 22, 2011, the technical memo entitled *Response to the Draft Caribou Comments Provided by the GNWT - ENR* [dated July 22, 2011] was submitted to ENR with responses to draft questions regarding the terrestrial assessment included in the Environmental Impact Statement (EIS).

On October 4, 2011 a meeting between De Beers Canada Inc. (De Beers) and ENR was held to review the responses provided. During that meeting, there were discussions about the technical aspects of the (EIS) related to caribou some of which led to further evaluation and refinement of the models used. The purpose of this memo is to provide an update on the analyses that have been completed.

1.0 CARIBOU ENERGETICS COMMENT (ADDENDUM)

The additional analyses presented in this section relate to the energetic model that was presented in the EIS. Three modifications were made to refine and evaluate the energetic model:

1) The Insect Harassment Index (IHI) formula was modified by first removing the proposed threshold (14 potential harassment days) at which caribou may tolerate insect activity levels (see Figure 7.5-4 in EIS; see also Figure 1 below). This was done because ENR suggested that the relative influence of insect harassment is stronger than that described in the EIS.

2) The IHI formula was also modified by increasing the proposed weight loss per every unit increase in IHI. This value is 0.148 kg in the EIS, and was calculated using a formula describing the percent change in autumn body mass for calves in a Norway study, combined with the assumption of a female caribou weighing 80 kg. Assuming that the potential weight of a cow in autumn is closer to 100 kg, the revised prediction is a 0.185 kg decrease in body weight with every 1 unit increase in IHI (Figure 1).

3) The third refinement was to more closely align the parturition rate-weight relationship described in the EIS to that used by Daniel et al. (2009), which was developed by Russell et al. 2005 for the Porcupine caribou herd. An important distinction between the Daniel et al. model and the EIS model is the rate of change in parturition across variation in body weight. For example, the EIS model predicts parturition rates decrease by 0.0625 units per 1 kg loss of body weight. In contrast, the Daniel et al. model predicts an approximate decrease of 0.02 units per 1 kg loss of body weight (Figure 2).

Figure 1: Model Summary for Effects from Disturbance Events and Insect Harassment on Caribou Fecundity Rate (i.e., Parturition Rate)

Unit Decrease in Parturition (Fecundity) Rates =

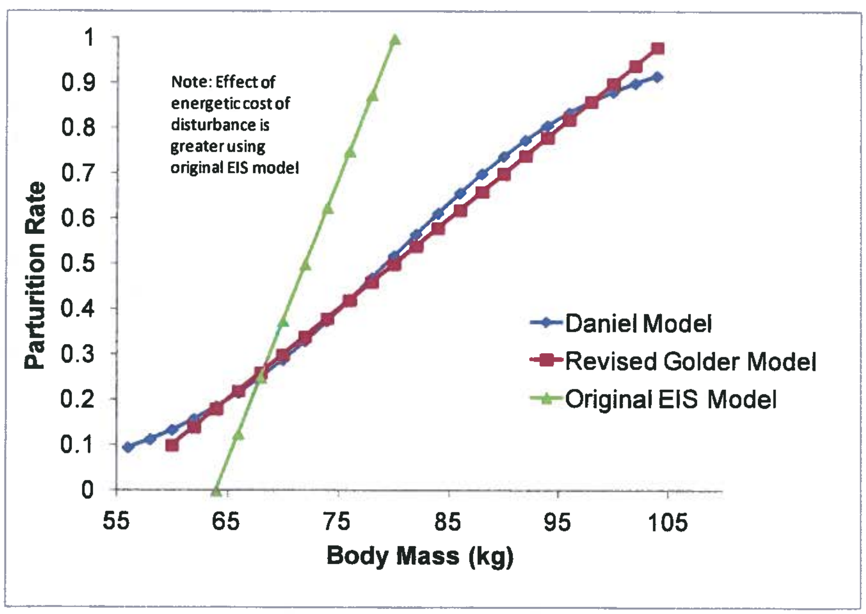
((IHI) x 0.185 kg) + (Disturbance Events x 0.55 x 0.0471 kg)] x 0.02

where:

i) a disturbance event is a ZOI encounter (or a day in a ZOI)
ii) IHI (Insect Harassment Index) is measured as oesterid harassment days;
iii) *Best (reference) parturition rate assumed to approach 1.0.*

ZOI = zone of influence; kg = kilogram.

Figure 2: Modelled Relationships Describing Parturition Rates as a Function of Body Weight, as Part of the Energetics Assessment



Results

Refinement of the energetic model to more closely match the relationship developed by Daniel et al. (2009) resulted in a smaller effect on parturition rate relative to the values produced in the EIS. In other words, the effects from the Project are less than that predicted in the EIS. For current (2010) baseline conditions with low levels of insect harassment, the modified model predicted a parturition rate of 0.941 and a reduction in fecundity by 0.7% relative to ideal conditions (i.e., the "reference, low IHI scenario") (Table 1). Under 2010 baseline conditions and average levels of insect harassment (14 IHI), the decrease in parturition rates relative to a landscape with no development and low insect levels was predicted to be 4.3% (Table 1). With the application of the Project and the Taltson Hydroelectric Expansion Project to a landscape with previous and existing developments and low insect harassment, the parturition rate is estimated to be 0.938 and reduced by 1% from a parturition rate of 0.948 (see yellow highlighted cell in Table 1). For comparison, this value is 3.1% in the EIS (see Table 7.5-15).

The incremental decrease in parturition rate from the Project and the Taltson Hydroelectric Expansion Project relative to current (2010) conditions is now predicted to be about 0.003 units or 0.3% (difference between 1% and 0.7%). The energetic model predicts that insect levels have the largest influence on fecundity, which is consistent with the results in the EIS. With the application of future conditions combined with high insect activity levels, parturition rate is predicted to decrease to 0.827, about 13% less than rates predicted during ideal conditions of no development and low insects. Based on the expected number of disturbance encounters for current landscape conditions with the Project and future developments (about 20), female caribou would have to increase their encounter rate per day during the summer-autumn period by approximately 50-times to result in no calf production the following spring.

Table 1: Effects of Various Landscape Developments and Insect Harassment Intensities on Fecundity Rates of Caribou (Revised Table 7.5-15 from EIS)

Scenario	Insect Harassment Index (IH)	Disturbance Encounters[(a)]	Mass Loss[(b)]	Parturtion Decrease[(c)]	Parturiton Rate	% relative decrease[(d)]
Reference, no insects	0	0	0.00	0.00	0.996	NA
Reference, low IHI	14	0	2.59	0.05	0.948	0.0
Reference, average IHI	23	0	4.26	0.09	0.915	3.5
Reference, high IHI	44	0	8.14	0.16	0.837	11.7
2000 baseline, low IHI	14	3	2.67	0.05	0.947	0.1
2000 baseline, average IHI	23	3	4.33	0.09	0.913	3.7
2000 baseline, high IHI	44	3	8.22	0.16	0.836	11.9
2006 baseline, low IHI	14	10	2.85	0.06	0.943	0.5
2006 baseline, average IHI	23	10	4.51	0.09	0.910	4.0
2006 baseline, high IHI	44	10	8.40	0.17	0.832	12.2
Current (2010) baseline, low IHI	14	14	2.95	0.06	0.941	0.7
Current (2010) baseline, average IHI	23	14	4.62	0.09	0.908	4.3

Table 1: Effects of Various Landscape Developments and Insect Harassment Intensities on Fecundity Rates of Caribou (Revised Table 7.5-15 from EIS) (continued)

Scenario	Insect Harassment Index (IH)	Disturbance Encounters[(a)]	Mass Loss[(b)]	Parturtion Decrease[(c)]	Parturiton Rate	% relative decrease[(d)]
Current (2010) baseline, high IHI	44	14	8.50	0.17	0.830	12.5
Application-future[(e)], low IHI	14	19	3.08	0.06	0.938	1.0
Application-future[(e)], average IHI	23	19	4.75	0.09	0.905	4.5
Application-future[(e)], high IHI	44	19	8.63	0.17	0.827	12.7

(a) Cause caribou to increase movement, run, become excited and metabolize stored energy (=mean residency time in ZOIs x 138 days [See Figure 7.5-7 in EIS]).

(b) Reduction = [(IHI x 0.185) + (disturbance events x 0.55 x 0.0471)] x 0.02

(c) Rate calculated as a function = -1.1 + weight (kg) x 0.02

(d) (reference value – parturition[(c)]) / reference value x100; where reference value = 0.948

(e) Includes existing developments on landscape plus the Project and Taltson Hydroelectric Expansion Project.

Note: the above table represents a summary of results for females where spring and summer conditions are favourable (i.e., potential body mass in autumn is near 105 kg when ignoring effects of insects and development)

IHI = Insect Harassment Index; % = percent.

2.0 CARIBOU POPULATION VIABILITY ANALYSIS (ADDENDUM)

The supplementary analyses presented in this section relates to issues raised on the purpose and uncertainty of the PVAs for caribou that were completed in the EIS.

The purpose of the PVAs was to meet the Terms of Reference, which asked for a description of methods used to distinguish between impacts from development and natural variations in caribou numbers. Population viability analyses are accepted scientific methods for evaluating different deterministic and stochastic processes on projected changes to population abundance. To meet the Terms of Reference, PVA models were used to determine the relative contribution of human-related factors (development activities, harvesting) and natural factors (insect harassment, extreme weather events) on potential changes in abundance of the Bathurst caribou herd. The use of PVA models provided a rigorous method for combining all the independent analysis on effects to caribou (i.e., habitat quantity and quality, changes in energetic/parturition rate from insect harassment and encounters with zones of influence from development) and other factors (e.g., harvest levels) into a comprehensive analysis.

The challenge of addressing uncertainty and delivering a reliable assessment was met, in part, by using a robust approach where model outcomes are compared. To provide confident and ecologically relevant impact predictions, the assessment of changes to habitat quality and energetics (i.e., parturition rates) included many ecological conservatisms such that the assessment outcome from the PVA work was clearly biased (i.e., effects were overestimated). For more information on the ecological conservatisms used in the EIS see Table 3 in memo: Response to the Draft Caribou Comments Provided by the GNWT - ENR dated July 22, 2011 (attached).

The use of specific inputs and ecological relationships describing natural (non-development related) factors in the models required clarification. It is important to re-iterate that issues of parameter uncertainty were addressed, in part, by using the sensitivity analysis in the EIS, and that the EIS results support the conclusion that the base structure of the models is reliable and grounded in reality. The sensitivity analyses showed that adult female survival was the most important parameter describing population trends followed by calf/yearling survival and fecundity, which are consistent with the results of population modelling of the Bathurst herd (Adamczewski et al. 2009; Boulanger et al. 2011), and other barren-ground herds. Here we provide the results of supplementary work to further support confidence in the predictability of the assessment using PVA models.

Importantly, the completed PVA tests were undertaken to demonstrate precision and reliability of the PVA modeling approach by comparing the reference case to the future case model using a natural range of parameter inputs (Figures 3 and 4). First we considered natural, temporal directional (i.e., not simply stochastic) changes in calf survival rates. Trends reflected the range of demographic values reported for the Bathurst Herd (0.28 to 0.80; Case et al. 1996; Gunn et al. 2005). For temporal directional variation in parturition, the range of values were those predicted from the energetic model (where one potential harassment day = a cost of 0.185 kg), and based on the assumption that insect activity, measured as an Insect Harassment Index (IHI), ranged from 1 to 44 potential harassment days on the landscape (see Section 1.0 above). The range of parturition values was also based on other (natural) environmental variables (e.g., summer foraging conditions) and the associated effect on body condition. For example, it was assumed that best environmental conditions combined with minimal insect harassment resulted in a cow weighing 105 kg (i.e., a parturition rate of close to 100%); whereas it was assumed that poor summer to autumn conditions combined with minimal insect harassed resulted in a cow weighing 90 kg (i.e., a parturition rate of 70%).

In the PVA tests, temporal changes in summer foraging conditions, insect activity, and calf survival rates were each modeled to consider minimum to maximum (increasing), maximum to minimum (decreasing) and average values. In total there were 27 additional cumulative effects tests to represent the 9 potential trends in parturition rates and three potential trends in calf survival. It is important to note that the refined (updated) energetic model was applied in all supplemental tests for cumulative effects (see Section 1.0 above).

Figure 3: Natural (non-development related), temporal changes in parturition rates included in base models for reference and future case PVAs where rates reflect effects predicted by the energetics model and an Insect Harassment Index (IHI; high = 44 IHI, and low = 1 IHI), as well as effects of other environmental factors (e.g., summer foraging conditions) on cow body condition.

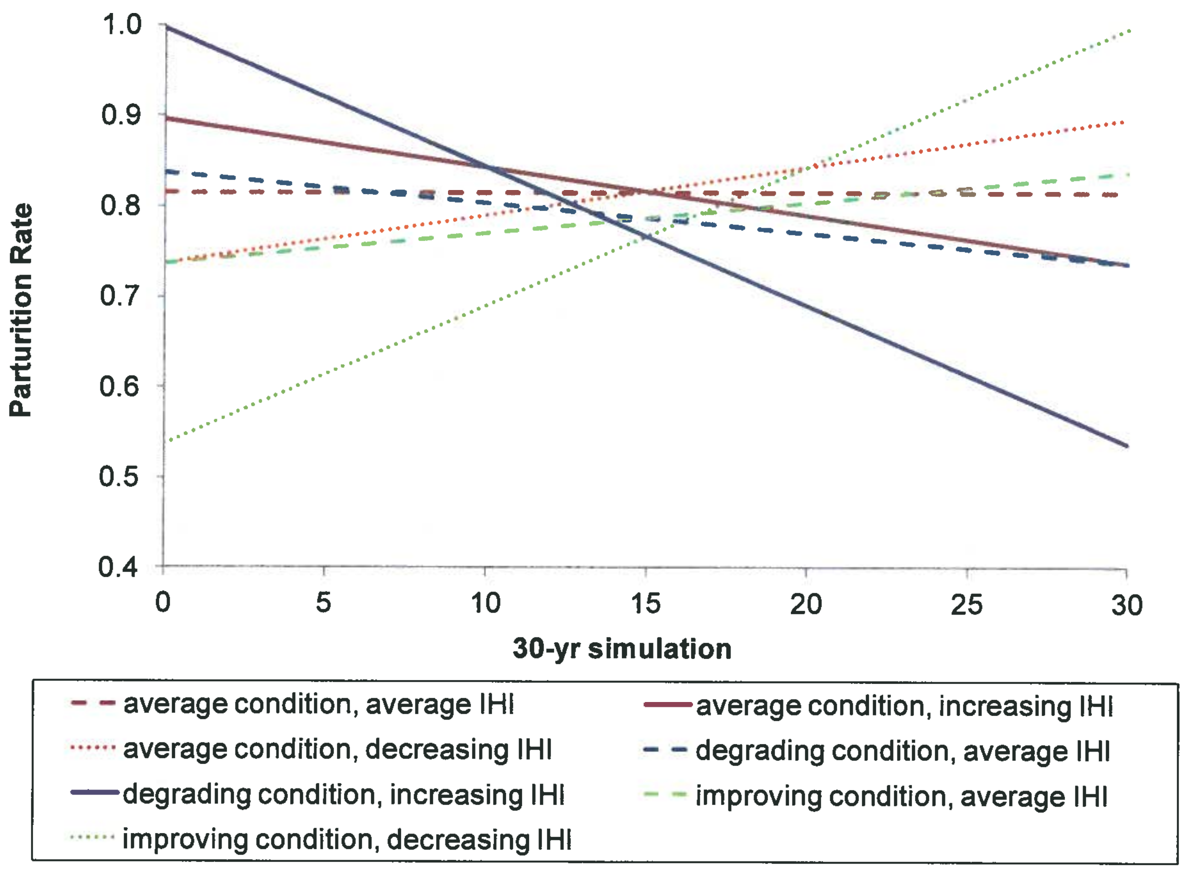
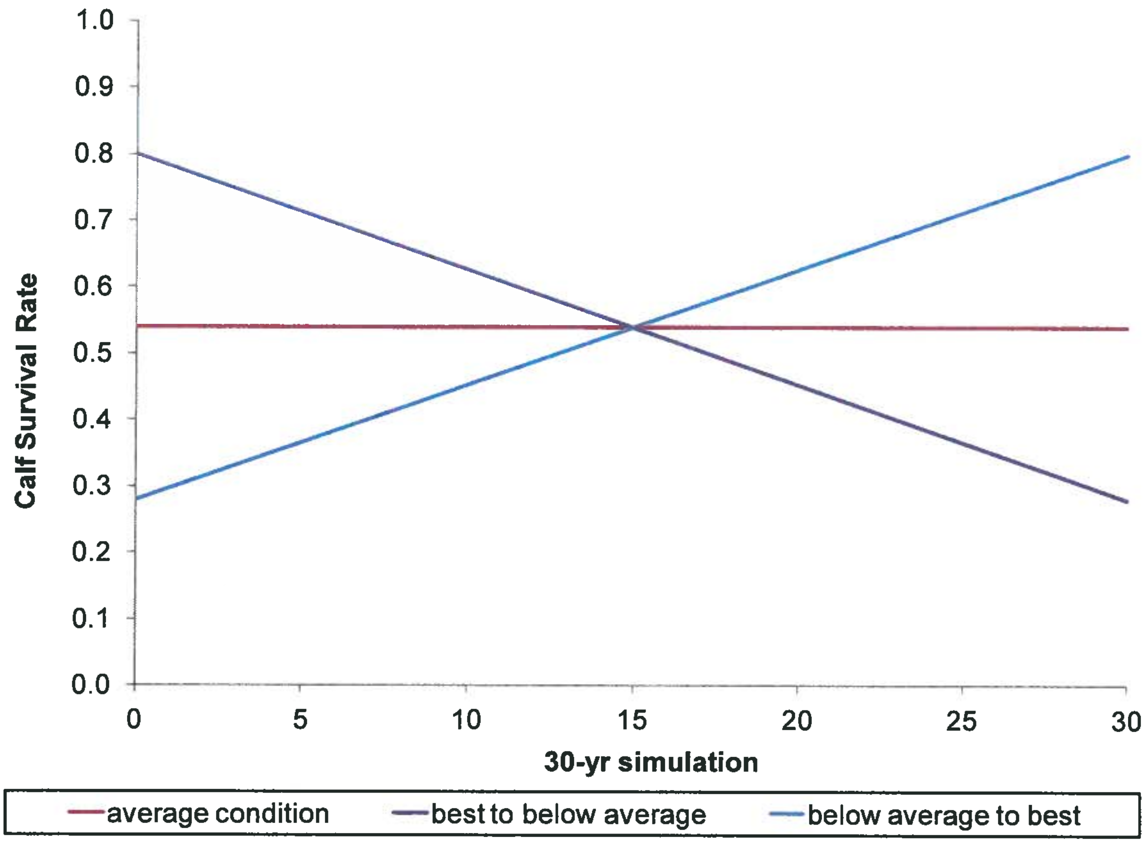


Figure 4: Natural (non-development related) temporal changes in calf survival rates included in base models for reference and future case PVAs; where rates reflect the range of demographic values reported for the Bathurst Herd (Case et al. 1996; Gunn et al. 2005).



Results

The results from the supplementary comparisons (i.e., new cumulative effects tests) demonstrate that the PVA approach used in the EIS provides reliable and precise effects predictions. Change to population persistence, measured using the D-statistic, and percent change in final abundance between reference (no development) and future cases (previous, existing, and future developments, including the Project) did not vary widely even when considering a natural range of trends in vital rates, insect harassment levels and other environmental conditions (e.g., summer forage conditions). The results provide further support for the conclusion in the EIS that the incremental and cumulative effects from the Project and other developments are predicted to not have a significant adverse effect on the abundance and distribution caribou populations.

The D-statistic varied from 0.045 to 0.104 (mean = 0.079, SD = 0.017) (Table 2). The scenario showing the smallest cumulative effect, as measured by the lowest D-statistic, was C3F8. The C3F8 models represented constant levels of moderate insect harassment (average IHI = 23), degrading environmental conditions (non-insect related) that affect parturition rates (from best to worst) and improving calf survival (from 0.28 to 0.80) over

30-year simulations. The scenario with the largest D-statistic was C2F4, representing decreasing insect harassment (from 44 to 1 IHI), environmental conditions that improve parturition rates over time (worst to best), as well as declining calf survival (from 0.80 to 0.28).

The percent change in abundance at year 30 of the simulations varied from -1.2 to -5.8% (mean = -4.4%, SD = 1.1) (Table 2). The scenario showing the smallest cumulative effect, as measured using percent change in final herd abundance between the reference and future cases, was C3F8. This result is consistent with the observed values for the D-statistic. The scenario showing the largest change in final herd abundance was C2F9. The C2F9 models included constant levels of moderate insect activity (average IHI = 23), improving environmental conditions that affect parturition rates (worst to best), and declining calf survival (from 0.80 to 0.28) over 30-year simulations.

Table 2: Scenarios (n = 27) of temporal trends in insect activity levels and other natural, environmental conditions and related effects to parturition and calf survival that were considered in cumulative effects modeling using PVA methods

Scenario	Environmental Trend Influencing Vital Rates[a]			Risk Curve Comparison		Herd Projections at Year 30 (abundance)		%change[d]
	Summer Condition	IHI Trend[b]	Calf survival	D-statistic[c]	P-value	Reference Case	Future Case	
C1F1	Constant Average	Increasing	Constant Average	0.102	0.0001	37022	34918	-5.68
C1F2	Constant Average	Decreasing	Constant Average	0.054	0.108	34877	34047	-2.38
C1F3	Degrading	Increasing	Constant Average	0.063	0.038	28954	27939	-3.51
C1F4	Improving	Decreasing	Constant Average	0.093	0.0004	25402	24161	-4.89
C1F5	Improving	Increasing	Constant Average	0.083	0.002	27349	25841	-5.51
C1F6	Degrading	Decreasing	Constant Average	0.084	0.0017	28323	27051	-4.49
C1F7	Constant Average	Constant Average	Constant Average	0.073	0.0097	35823	34083	-4.86
C1F8	Degrading	Constant Average	Constant Average	0.070	0.0149	31270	29992	-4.09
C1F9	Improving	Constant Average	Constant Average	0.085	0.0015	30615	29260	-4.43
C2F1	Constant Average	Increasing	Declining	0.080	0.0033	41545	39558	-4.78
C2F2	Constant Average	Decreasing	Declining	0.096	0.0002	38258	36193	-5.40
C2F3[e]	Degrading	Increasing	Declining	0.073	0.0097	33845	32590	-3.71
C2F4	Improving	Decreasing	Declining	0.104	0.0000	26627	25522	-4.15
C2F5	Improving	Increasing	Declining	0.064	0.0333	29797	28338	-4.90
C2F6	Degrading	Decreasing	Declining	0.074	0.0084	32376	31076	-4.02
C2F7	Constant	Constant	Declining	0.069	0.0171	39400	37637	-4.47

Table 2: Scenarios (n = 27) of temporal trends in insect activity levels and other natural, environmental conditions and related effects to parturition and calf survival that were considered in cumulative effects modeling using PVA methods (continued)

Scenario	Environmental Trend Influencing Vital Rates[a]			Risk Curve Comparison		Herd Projections at Year 30 (abundance)		%change[d]
	Average	Average						
C2F8	Degrading	Constant Average	Declining	0.058	0.0692	34923	34012	-2.61
C2F9	Improving	Constant Average	Declining	0.087	0.001	33441	31519	-5.75
C3F1	Constant Average	Increasing	Improving	0.098	0.0001	29482	27961	-5.16
C3F2	Constant Average	Decreasing	Improving	0.088	0.0009	29712	27976	-5.84
C3F3	Degrading	Increasing	Improving	0.052	0.134	22063	21343	-3.26
C3F4	Improving	Decreasing	Improving	0.103	0.0000	23197	22084	-4.80
C3F5	Improving	Increasing	Improving	0.088	0.0009	23306	22082	-5.25
C3F6	Degrading	Decreasing	Improving	0.095	0.0002	22928	21779	-5.01
C3F7	Constant Average	Constant Average	Improving	0.063	0.038	28782	27877	-3.14
C3F8	Degrading	Constant Average	Improving	0.045	0.263	25034	24724	-1.24
C3F9	Improving	Constant Average	Improving	0.087	0.001	25212	23977	-4.90

[a] where degrading and improving trends reflect the potential range of conditions; it was assumed that best summer conditions combined with low insect harassment resulted in a cow weighing 105 kg; whereas it was assumed that poor summer conditions with low insect harassed resulted in a cow weighing 90 kg.

[b] Increasing IHI indicates that body condition is degrading over time (1 to 44 IHI); decreasing IHI indicates that body condition is improving over time (44 to 1 IHI).

[c] D refers to the maximum difference in probability of threshold abundance between risk curves.

[d] (future – reference) / reference x 100; model structure is similar to the cumulative effects test in the EIS where the percent (%) decrease in final abundance between reference and future cases was 12.15% (see Table 7.5-19 in EIS).

3.0 UNCERTAINTY OF EFFECTS FROM HARVESTING ON CARIBOU DUE TO INCREASED ACCESS FROM THE PROJECT WINTER ACCESS ROAD

The additional information and analyses presented in this section relate to the increased access to the winter range of caribou (Bathurst, and Ahiak/Beverly) from the Project Winter Access Road and the potential related effects from harvest mortality.

During the late 1980s and early 1990s when the size of Bathurst caribou herd was about 350,000 animals, the annual harvest rate was estimated to be 4.5%, but may have been lower (Adamczewski et al. 2009). Annual harvest rates of less than 5% have little influence on caribou populations, particularly when numbers are increasing and high (Bergerud et al. 2008). However, harvest rates that increase disproportionately with decreasing populations or when populations are at low point in the natural cycle have a large adverse effect on the ability of caribou herds to stabilize and increase (Bergerud et al. 2008; Adamczewski et al. 2009; Boulanger et al. 2011). Similarly, in the EIS, PVA models suggested that changes in abundance of the Bathurst herd were most sensitive to adult female survival rate and harvest rate (Section 7.5.4.1.2).

The practices and techniques used for hunting caribou have also changed over the past 30 to 40 years. For example, previous techniques relied on snowshoes, dog teams, and slower snow mobiles with small wooden toboggans (Adamczewski et al. 2009). Caribou were not always accessible or were more difficult to locate, particularly when the herd was decreasing or at low levels. Subsequently, the number of animals harvested likely followed the population cycles of caribou (Adamczewski et al. 2009). Factors contributing to potentially higher harvest levels in the past were the need to obtain sufficient caribou to provide for dog teams, nomadic lifestyles, and much higher dependence on caribou as a food source (Sandlos 2007). In contrast, current hunting practices include the use of faster and long range snow mobiles with large light-weight toboggans. Trucks are used for hunting along the winter roads, and chartered aircraft have been used to access caribou in more remote locations. Overall, there likely has been an increase in the number of people successfully hunting caribou during recent years, but there is also less dependence on caribou as a food source (Sandlos 2007).

The effect on caribou populations from increased access to the winter range from the Project Winter Access Road is difficult to predict. A numerical analysis of the effect on caribou populations from increased access to the winter range from the Project Winter Access Road at km 271 cannot be completed due to the limited information on caribou harvested along winter roads beyond the Tibbitt-to-Contwoyoto winter road and Tlicho winter road. Although ENR has implemented monitoring/check (e.g., Ross Lake) stations at different locations on these roads to collect caribou (and other wildlife) harvest data, the information is often incomplete and typically underestimates harvest numbers (Adamczewski et al. 2009). The length of the winter road season can vary from year to year, which would also influence the number of caribou harvested. Similarly, unpredictability in the annual use of particular areas by caribou on the winter range can change accessibility to animals and produce variation in the number harvested, including the Bathurst and Ahiak/Beverly herds. In some winters, caribou may not be near the Winter Access Road. Rather, caribou may be well below the treeline, west or south of the Project. For example, from 2006 to 2010 the core winter area of collared Bathurst caribou appeared to be west/northwest of the anticipated Winter Access Road and outside the regional study area of the Project (Golder 2011, unpubl. data). But in other years, caribou may overwinter on the tundra and/or near the treeline closer to the Project and the Winter Access Road (see Figure 5.22 in Adamczewski et al. 2009).

To meet the Terms of Reference, the following additional information was used to evaluate the potential residual effects from the Winter Access Road on caribou. De Beers (2008) has detected no evidence of harvesting/hunting activity on the Snap Lake winter access road (i.e., private traffic is rarely observed on the winter access road), which occurs at kilometre 228 of the Tibbitt-to-Contwoyto Winter Road. The Winter Access Road for the Project will begin at kilometre 271 of the Tibbitt-to-Contwoyto Winter Road, and harvesting along the Winter Access Road is expected to be limited and similar to Snap Lake.

The increase in access to the region associated with the winter roads is limited to 8 to 12 weeks each year. Trucks with snow machines on the Tibbitt-to-Contwoyto Winter Road could be used to gain access to areas such as Cook Lake or Artillery Lake, where groups of individuals of the Bathurst caribou have previously over-wintered. Resident and aboriginal hunters are permitted to hunt from the Tibbitt-to-Contwoyto Winter Road, or use it to gain access to hunting areas, but the harvest for residents and non-residents is regulated. Snow machines can access the winter range through existing trails and along winter roads before they are open and after they are closed to vehicle traffic.

De Beers staff will be prohibited from hunting while on site, but has no authority to regulate hunting from the Winter Access Road for the Project. However, the GNWT has demonstrated that it is willing to implement caribou management actions when the population is at low levels such as the recent no hunting by outfitters, residents, and non-residents in North Slave and South Slave regions. A no hunting conservation zone was also established east of Yellowknife on Highway 4, which was largely due to the safety of cabin owners, but would have limited harvesting.

The incremental number of caribou harvested in the MacKay Lake - Kennady Lake region from improved access due to the Winter Access Road is predicted to not exceed the upper limits of current baseline values (low to moderate magnitude effects). The number of caribou hunted from the Winter Access Road will vary from year-to-year, but the incremental effect from increased access due to the Project is not predicted to change the properties of caribou populations (resilience, growth rate) from current baseline values (i.e., the effect is not predicted to exceed moderate magnitude). Subsequently, the increased access from the Project Winter Access Road is not expected to have a significant adverse effect on the abundance and distribution of caribou populations, or the continued opportunity for traditional and non-traditional use of caribou.

De Beers would support additional engagement and consultation with ENR and the communities to develop and define appropriate monitoring (e.g., support for monitoring (check) stations) to evaluate predictions and address uncertainties associated with the potential effects on the abundance and distribution of caribou populations from the Winter Access Road.

Closing

Please do not hesitate to contact the undersigned with any questions, or if additional detail is required.

Sincerely,

GOLDER ASSOCIATES

Cameron Stevens, Ph.D.
Biologist

John Virgl, Ph.D.
Associate, Senior Ecologist

CS/JV/lh

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References

Adamczewski, J., J. Boulanger, B. Croft, D. Cluff, B. Elkin, J. Nishi, A. Kelly, A. D'Hont, and C. Nicholson. 2009. Decline in the Bathurst caribou herd 2006-2009: a technical evaluation of field data and modelling (DRAFT). Technical Report. Yellowknife, NWT. 105 p.

Bergerud, A.T., S.N. Luttich, and L. Camps. 2008. The return of caribou to Ungava. McGill-Queen's University Press, Montreal, QC.

Boulanger, J., A. Gunn, J. Adamczewski, and B. Croft. A data-driven demographic model to explore the decline of the Bathurst caribou herd. Journal of Wildlife Management 75: 883-896.

Case, R., L. Buckland, and M. Williams. 1996. *The Status and Management of the Bathurst Caribou Herd, Northwest Territories, Canada*. Northwest Territories Renewable Resources, File Report No. 116. 34 pp.

Daniel, C., D. Russell, and M. Carlson. 2009. Modelling the effects of development on the Bathurst Caribou Herd. Demonstration Project.

Gunn, A., J. Boulanger, and J. Williams. 2005. Calf Survival and Fall Sex Ratios in the Bathurst Herd of Barren-ground Caribou 2000-4. Northwest Territories Department of Resources, Wildlife and Economic Development. Manuscript No. 164. 75 pp.

Russell, D.E., R.G. White, and C.J. Daniel. 2005. Energetics of the Porcupine caribou herd: a computer simulation model. Technical Report Series No. 431. Canadian Wildlife Service. Ottawa, Ontario. 64pp.

Sandlos, J. 2007. Hunters at the Margin. Native People and Wildlife Conservation in the Northwest Territories. UBC Press, Vancouver, BC.

TECHNICAL MEMORANDUM

DATE December 15, 2011 **DOCUMENT No.** 11-1365-0001/3010/DCN-046

TO Veronica Chisholm and Stephen Lines
De Beers Canada Inc.

CC Amy Langhorne and John Faithful (Golder Associates Ltd.)

FROM John Virgl and Cameron Stevens **EMAIL** cameron_stevens @golder.com

RE: QUESTION FROM STEPHEN ELLIS, AKAITCHO IMPACT MEASURES AGREEMENT (IMA) IMPLEMENTATION COORDINATOR (NWT TREATY #8 TRIBAL CORPORATION)

Mr. Stephen Ellis's Comment (from email dated December 1, 2011):

"My understanding from the caribou portion of the De Beers presentations was that the maximum cumulative decline in preferred Bathurst caribou habitat would be 7.2% (during the fall rut), and that most of this habitat loss has essentially already occurred prior to 2010.

1. First of all, is this correct?

2. Second, so that I am clear, this is De Beers assessment of the total cumulative contribution of development projects in the Bathurst fall rut habitat range to decreases in preferred habitat, correct (e.g. not just the Gahcho Kue project)?

Assuming I understand correctly the above, I am curious as to whether there is any understanding with regards to WHERE within the fall rut habitat this 7.2% might be located – I assume the preferred habitat loss is not randomly or evenly distributed throughout entire habitat range. Rather, the 7.2% is located in "blocks" or more or less "contiguous chunks" around focal points for development.

If this is the case, and given that in any given year during the fall rut the herd will not use the entire habitat range but rather a portion of it, could not this 7.2% increase for a given year if the herd's fall movements are focussed on a particular portion of the range where one of these "blocks" of decreased preferred habitat exist?

In other words, the "effective" range of the herd will change every year and be much smaller than the entire historical reference, and in those years where this "effective" range overlaps with a "block of decreased preferred habitat", could not the % of decreased preferred habitat for that particular year increase beyond 7.2%?

In asking this question, I am assuming that herds do not move randomly through the environment, but rather follow patterns (though we have a poor understanding of what these are).

This is a bit to mull over, but please ask for clarification if needed. I imagine we may need a bit of back and forth on this."

Response

The reported 7.2% in the Environmental Impact Statement (EIS), as Stephen Ellis (representative Treaty #8 Tribal Corporation) suggests, represents the cumulative direct and indirect decrease in preferred (high and good quality) habitats on the autumn/rut range and includes the Gahcho Kué Project (Project) plus the proposed Taltson Hydroelectric Project (future case). This information is provided in Table 7.5-10 in the EIS (Section 7.5.3.2). Stephen Ellis statement is correct that the majority of changes to preferred habitats have already occurred. Of the reported 7.2%, 1.4% is from the Project, 2.1% is from the proposed Taltson Hydroelectric Project, and the remaining (3.7%) is from previous and existing (2010 baseline) developments. Based on a visual inspection of the Resource Selection Function (RSF) maps for the autumn/rut range in Appendix 7.IV of the EIS, the majority of high quality habitats (i.e., dark green habitats on the RSF maps) are situated below the treeline; however, good quality habitats (i.e., light green habitats on the RSF maps) do occur within the vicinity of the Project and the proposed Taltson Hydroelectric Project (see attached Figures 7.IV-13 and 7.IV-18 from the EIS). Such changes to good quality habitats from reference to future conditions are captured in the 7.2% change as discussed above. The following equation was used to calculate the relative cumulative change in the amount of preferred habitats in seasonal home ranges (also see page 7-107 Section 7.5.3.2 in the EIS):

[('future case' area minus the 'reference case' area) / 'reference case' area] X 100

It is important to mention that indirect losses associated with the 7.2% change are not true losses in that habitats are not removed by development or are permanently lost to wildlife. The change reflects a reduction in the quality or effectiveness of the habitat in the zones of influence (ZOIs), where a ZOI is based on the probability distribution of occurrence. In other words, the ZOI does not mean that the area within a ZOI is devoid of wildlife, but rather there is a change in the likelihood that wildlife will occupy a unit of space (e.g., change in how caribou are distributed spatially). Unless the probability of occurrence is zero, wildlife will still be present within a ZOI. Also, on an annual basis the ZOI fluctuates and in some years indicates patterns of attraction (Golder 2011), so there is evidence that the ZOI is not fixed through time during development construction and operation.

In addition, the spatial extent of ZOI may depend on the size and type of mining operation, or the level of human activity. For example, Boulanger et al. (2009) detected a smaller and weaker ZOI for the underground Snap Lake Mine relative to the open-pit Ekati-Diavik mine complex. Mountain caribou showed higher avoidance of mines and camps in summer when activity levels were higher relative to winter (Polfus et al. 2011). For the assessment in the EIS, we assumed that the strength of disturbance coefficients (i.e., decreased habitat effectiveness) was constant within a ZOI of 15 km for the duration of each active mining operation, including the Project, independent of the type and size of the development. Another conservative assumption in the EIS was that all active mineral exploration developments exhibited a 5 km ZOI for the entire (5-year) duration of the exploration permits even though the site may have been occupied by the company for only 1 year or only for the summer months each year of the life of the permit.

For assessing direct and indirect changes to habitat, it is ecologically relevant to use a seasonal home range based on available multiple years of data. The inclusion of multiple years of data means that there are more collared animals and locations to use in generating a reliable estimate of the seasonal range. Each effects study area, including the autumn/rut home range, was a core area determined in a Geographical Information System (GIS) platform using multiple years of location data, and a kernel density function combined with a 95% volume contour. Other methods will generate larger home ranges (e.g., minimum convex polygon tool; Beyer 2004). But the main point is that it is ecologically relevant to use the 'historical' seasonal home range based on over a decade of study, rather than a home range specific to a given year. Although a seasonal home range for a specific year would be smaller depending on the size of the herd at that point in time, caribou are highly mobile and can access broader geographic areas, and avoid human development on the landscape. Thus, the seasonal range for the autumn/rut period in the EIS should accurately capture all available 'core habitat blocks' for caribou in the Bathurst herd. Given the temporal boundary of the assessment and the life of the Project being almost 15 years (construction and operation), it is ecologically relevant to use a 'historical' seasonal home range for the assessment.

References

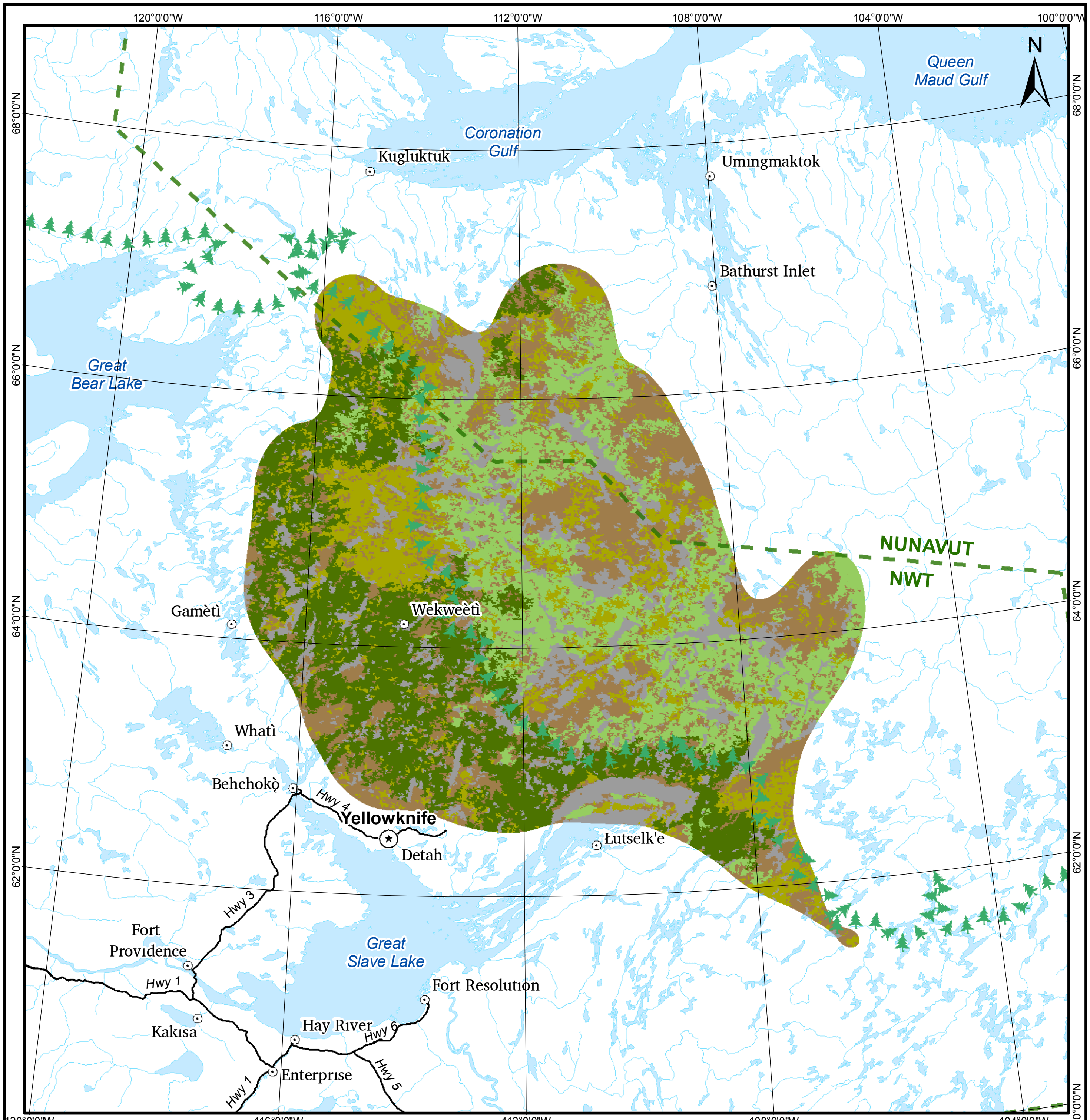
Beyer, H. L. 2004. Hawth's Analysis Tools for ArcGIS. Available at http://www.spatialecology.com/htools.

Boulanger, J., K. Poole, A. Gunn, and J. Weirzchowski. 2009. The zone of influence for migratory tundra caribou around Canada's Arctic diamond mines: estimation and implications. Draft manuscript.

Golder (Golder Associates Ltd.) 2011. Analysis of environmental effects from the Diavik Diamond Mine on wildlife in the Lac De Gras Region. Submitted to Ms. Colleen English, Diavik Diamond Mines Inc, Yellowknife, NWT. Report # 10-1328-0028. 66 pages plus appendices.

Polfus, J.L., M. Hebblewhite, and K. Heinemeyer. 2011. Identifying indirect habitat loss and avoidance of human infrastructure by northern mountain woodland caribou. Biological Conservation 144:2637-2646.

http://capws/sites/capws2/1113650001postEisSubmission/Phases and Tasks/3_EIR Elements/3010 - Gap Analysis/Question_Steve Ellis/121215_Response_Question_Stephen_Ellis.docx



LEGEND

- Territorial Capital
- Populated Place
- Highway
- Watercourse
- Waterbody
- Territorial/Provincial Boundary
- Treeline

Resource Selection Function

- High
- Good
- Low
- Poor
- Nil

NOTES
Base data source: The Atlas of Canada

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GAHCHO KUÉ PROJECT

Habitat Suitability for Bathurst Caribou in Autumn: Reference Conditions

PROJECTION:	DATUM:
Canadian Lambert Conf. Conic	NAD83

Scale: 1:5,000,000
100 50 0 100
Kilometres

DE BEERS CANADA

FILE No:			DATE:
KLOI-07-005-GIS			November 23, 2010
JOB NO: 09-1365-1004	REVISION NO: 2		
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Figure 7.IV-13

LEGEND

- Gahcho Kué Project
- Existing Mine
- Territorial Capital
- Populated Place
- Highway
- Watercourse
- Waterbody
- Territorial/Provincial Boundary
- Treeline
- Development Location
- Existing Transmission Line
- Proposed Taltson Transmission Line

Resource Selection Function

- High
- Good
- Low
- Poor
- Nil

NOTES
Base data source: The Atlas of Canada

GAHCHO KUÉ PROJECT

Habitat Suitability for Bathurst Caribou in Autumn: Future Case

PROJECTION:	DATUM:
Canadian Lambert Conf. Conic	NAD83

Scale: 1:5,000,000

100 50 0 100
Kilometres

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Figure 7.IV-18

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