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January 19, 2015

Mackenzie Valley Environmental Impact Review Board
200 Scotia Centre
P.O. Box 938
Yellowknife, NT
X1A 2N7
Attn: Chuck Hubert, Senior Environmental Assessment Office

Re: EA1314-01 Jay Project, Dominion Diamond Corporation Developer's Assessment Report Adequacy Review

Dear Mr. Hubert:

With reference to my letter of December 15, 2014 to the Chair of the Mackenzie Valley Environmental Impact Review Board (MVEIRB), please find attached the following information in response to the Adequacy Review document provided by the MVEIRB for the Jay Project on November 28, 2014. Note that we have included a tracking number to account for individual Adequacy Review items.

- Item 2.1 – Contractors and subcontractors honouring commitments (DAR-MVERIB-1)
- Item 4.1 – Criteria for selecting the preferred alternative (DAR-MVERIB-3)
- Item 8.1 – Times when caribou are particularly sensitive to potential impacts (DAR_MVERIB-8)
- Item 8.2 – Assessment Methodology – temporal trends (DAR-MVERIB-9)
- Item 8.4 – Approach to impact classification and significance – significance determination (DAR-MVERIB-11)
- Item 8.5 – Monitoring (DAR-MVERIB-12)
- Item 8.7 – Effects of 2014 Fires on Caribou Winter Range (DAR-MVERIB-14)
- Item 8.9 – Caribou baseline vs background (DAR-MVERIB-16)
- Item 9.1 – Inadequate Cumulative Effects Baseline (DAR-MVERIB-17)
- Item 9.2 – Significance Determination for Water Quality (DAR-MVERIB-18)
- Item 9.3 – Residual Impact Classification and Significance Definition of Criteria (DAR-MVERIB-19)
- Item 9.4 – Geographic Scope of the Assessment (DAR-MVERIB-20)
- Item 9.5 – Biophysical Environment (DAR-MVERIB-21)
- Item 9.7 – Permafrost Assumptions (DAR-MVERIB-23)
- Item 10.1 – Risk assessment - health and safety (DAR-MVERIB-24)

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- Item 10.2 – Risk assessment – likelihood categories (DAR-MVERIB-25)

Responses to the following Adequacy Review items are provided as part of a standalone report:

- Item 11.1 – Non-confidential details about socio-economic agreements
- Item 11.2 – Barriers to employment, advancement and retention
- Item 11.3 – Effectiveness of past or present socio-economic benefit initiatives
- Item 11.4 – Collaboration with communities to address potential social impacts
- Item 11.5 – Current and proposed initiatives to address potential social impacts

The timelines for proposed responses to the Adequacy Review information requests were provided in Table 1 of my December 15 letter, and the items provided herein correspond to the information that were scheduled for January 19, 2015. Of note, the first batch of responses was provided on December 18, 2015.

Accompanying this letter, we have also provided two memos outlining updates to the air quality and water quality assessments:

- Jay Project - Air Quality Assessment Update
- Jay Project - Lac De Gras Hydrodynamic Model Updates

Yours sincerely,

Richard Bargery
Manager, Permitting Jay Project
Dominion Diamond Corporation

Attach.

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Information Request Number:	DAR-MVEIRB-1
Source:	MVEIRB Jay Project Adequacy Review Item 2.1
Subject:	Contractors and subcontractors honouring commitments
DAR Section(s):	1.2.3 and 14.1.3

Preamble (MVEIRB):

Dominion is asked to describe how it will ensure that its contractors and subcontractors honour commitments made by Dominion. In Section 14.1.3.2 of the DAR on page 14-32, Dominion responds by stating that “Contractors are encouraged to adhere to the hiring targets identified in the Ekati SEA…”. A clear description of how Dominion will not simply encourage, but ensure that Dominion commitments are honoured is required before the response to this item can be considered adequate.

Request (MVEIRB):

Please describe how Dominion will not just encourage, but ensure that commitments described in the Socio-economic Agreement, including commitments for hiring, procurement and others are honoured by contractors and subcontractors.

Response:

With respect to the application of employment targets set out in the Socio-Economic Agreement (SEA) to contractors, Section 4.5.1 of the SEA states the following:

> *“[Dominion Diamond] hereby commits to take all reasonable steps to ensure that its Contractors at the Project adopt a hiring policy that is consistent with this Agreement. [Dominion Diamond] shall, where appropriate, in connection with bids for contracts on the Project:*
>
> *(i) require all Contractors to expressly state their commitment to hiring Northern Residents;*
> *(ii) evaluate bids on the basis of whether appropriate commitments to hire Northern Residents are included or planned for in the bid;*
> *(iii) incorporate the successful bidder’s commitments to hire Northern Residents into the contract document; and*
> *(iv) require all contractors to regularly report on their Northern Resident hires and to explain their performance to management.”*

The Ekati Mine SEA sets targets for northern and northern Aboriginal hiring at 33% and 15%, respectively, during construction and at 62% and 31%, respectively, during operations. The Ekati Mine SEA sets a target of 70% northern purchase of goods and services. The Ekati Mine has performed well against these, and other targets and reports on its performance annually.

Dominion Diamond implements its SEA commitments and strives to maintain a high proportion of Northern contractors or, where necessary, contractors who are committed to high Northern content. Over the 13 years from 1999 to 2012, the Ekati Mine direct business expenditures totalled $5.3B, of which 76% was Northern and 26% was Aboriginal businesses. Although these are high levels of achievement, Dominion Diamond is continually working to improve on past performance. For example, Dominion recently increased the number of Northern trades apprenticeships at the Ekati Mine, including apprenticeships through contractors. Also, the Ekati Mine recently made a decision to contract for a supply of core boxes to a Northern Aboriginal community.

In addition to the targets established through the SEA, the four Ekati Mine Impact Benefit Agreements provide additional means and opportunities for preferential contracting of Northern Aboriginal companies. The details of these programs are confidential to each IBA and cannot be published.

All bids for contracts at the Ekati Mine are evaluated through a rigorous evaluation process that includes Northern/Northern Aboriginal ownership and content as a standard evaluation criteria against which bidders are rated.

The standard Ekati Mine contract that all contractors are required to accept includes the SEA Northern hire targets and a requirement for all contractors to strive for achievement.

Once a contact is awarded, regular contract performance meetings are held with contractor management to review all aspects of contract performance, including SEA Northern hire targets. The performance meetings are organized by the Ekati Mine Procurement Team, who are accountable for all aspects of contractor performance, including SEA northern hire targets.

Contractors are given access to Ekati Mine resources, such as the Aboriginal employment coordinators, to assist in achieving SEA Northern hire targets.

References:

BHP Diamonds Inc. and the Government of the Northwest Territories. 1996. Socio-Economic Agreement, BHP Diamonds Project.

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Information Request Number:	DAR-MVEIRB-3
Source:	MVEIRB Jay Project Adequacy Review Item 4.1
Subject:	Project Alternatives
DAR Section(s):	Section 2.4.7.4

Preamble (MVEIRB):

Dominion used technical feasibility, economic viability, environmental considerations, and socio-economic considerations as the four broad accounts for the multiple accounts analysis. For each account, sub-accounts (potential impact issues) were identified as the basis for the assessment of each account. Dominion described the indicators used for each sub-account; however, Dominion primarily included a list of the differentiating indicators. A level of transparency is needed to ensure that Dominion considered all of the potential impacts of concern including those which were identified as non-differentiating.

Request (MVEIRB):

Please confirm that all of the indicators described (differentiating and non-differentiating) represent all of the indicators considered. If it does not, please provide a comprehensive list of the indicators considered for each account and sub-account and, if they were identified as non-differentiating, why.

Response:

Both the differentiating and non-differentiating evaluation criteria (sub-accounts and indicators) are discussed in the Project Alternatives, Section 2 of the Developer’s Assessment Report (DAR).

The evaluation criteria were developed based on the key lines of inquiry (KLOI) in the Jay Project Terms of Reference (MVEIRB 2014).

Where a KLOI was non-differentiating for the alternatives, this was discussed in the text of the Project Alternatives (Section 2). Table 3-1 is a summary of all the non-differentiating evaluation criteria that were considered, but not included in the alternatives analysis ranking. Table 3-1 includes explanations for why these criteria are considered non-differentiating and the section reference for where this information is included in the DAR.

Table 3-1 Summary of Non-Differentiating Evaluation Criteria

Level	DAR Section Reference	Evaluation Criteria Account	Non-differentiating Criteria	Explanation for Non-differentiating Status
Level 1 Assessment – Alternative Means of Carrying Out the Project	2.4.7.4.1	Technical Feasibility	Dike Design	The Diavik- and Meadowbank-style dike designs that were considered for the Jay Dike involve use of proven technology for mines operating in northern Canada. Therefore, the dike design is considered to be non-differentiating along the dike alignment alternatives that were identified.
	2.4.7.4.3	Environmental Considerations	Water Quality	The alternatives would be operated such that minewater would meet the same discharge requirements (i.e., water quality would meet discharge criteria), and therefore, the dike alternatives would not be differentiating on the receiving water quality in the environment. However, some alternatives may have more substantial water management requirements, and consider a different range of water quality mitigation and adaptive management options, to meet the discharge requirements. Therefore, the water management requirements for the dike alignment alternatives were evaluated under the Technical Feasibility category (Section 2.4.7.4.1).
			Caribou	Potential effects on caribou, including loss of habitat and loss of connectivity of migration routes, were considered for evaluating the dike alternatives. However, it was determined that the three dike alternatives for developing the mine would have essentially the same potential effects on caribou, because they have the same waste rock storage requirements and the same haul road access requirements, which are the two main components relating to the dike alternatives that could affect caribou habitat and migration. Therefore, the potential effects on caribou were non-differentiating for the three dike alternatives. The potential effects on caribou were evaluated in in the Level 2 assessments for the road and waste rock storage alternatives assessments.
	2.4.7.5	Social and Economic Considerations	Socio-economic benefits	The socio-economic benefits of the Project were evaluated in the pre-screening assessment, where it was identified that open-pit mining typically provides more job opportunities for Northern residents. The workforce required for construction of all three of the dike alignment alternatives would be similar and therefore non-differentiating. A socio-economic criterion was not identified that would differentiate the three dike alternatives, which all involve open pit mining.
Level 2 Assessment – Road Alternatives	2.5.1.2.3	Environmental Considerations	Caribou migration	The main caribou migration route in the Project area runs northwest from the Lac du Sauvage-Lac de Gras Narrows. The three road alternatives must run in an approximately east-west direction to connect the Jay Pit to the Misery Haul Road, and as such, will cross the main caribou migration path and are predicted to have similar effects on caribou movement. Therefore, the road alignments were considered non-differentiating for the potential to affect the caribou migration. The potential effects on caribou due to the esker crossings of each road alignment alternative were evaluated because the method/design of the crossings varies for each alternative.

Table 3-1 Summary of Non-Differentiating Evaluation Criteria

Level	DAR Section Reference	Evaluation Criteria Account	Non-differentiating Criteria	Explanation for Non-differentiating Status
	2.5.1.2.4	Social and Economic Considerations	Traditional land use	The esker has been identified as an important location for caribou hunting, trapping, and as a travel route in both the past and present. As such, it holds particular importance to the local Aboriginal communities and to the archaeological record. The potential effects on caribou due to the design of the esker crossings of each alternative were considered differentiating and were evaluated under Environmental Considerations (Section 2.5.1.2.3). There were no additional differentiating factors identified for the potential effects on the esker relating to traditional land use. The three road alternatives must run in an approximately east-west direction to connect the Jay Pit to the Misery Haul Road, and therefore, they all require an esker crossing. The potential effects on overall traditional land use due to the esker crossings of each of the alternatives was considered to be similar, and therefore, non-differentiating.
			Potential access for non-traditional land users	Because the mine roads will have controlled access as part of the mine, they will not provide access to non-traditional land users, and this would not be a differentiating factor.
Level 2 Assessment – Waste Rock Storage Alternatives	2.5.2.2.1	Technical Feasibility	Waste rock storage area design	Because the design of the waste rock storage area (WRSA) will be the same regardless of the location, it does not differentiate the alternatives for waste rock storage. The foundation topography, the pile layout, and height can all factor in to the construction method used to develop the pile. All the WRSA alternatives would be operated with a similar construction method and sequencing, so this criteria was considered non-differentiating.
	2.5.2.2.2	Project Economic Viability	Capital and Closure and Reclamation Costs	Capital and reclamation/closure costs were not considered to be differentiating between the alternatives because the requirements for start-up and closure/reclamation are considered to be approximately the same for all alternatives.
	2.5.2.2.3	Environmental Considerations	Water Quality	Because surface minewater runoff from the WRSA will be monitored and managed as required, potential effects on water quality and aquatic habitat are considered non-differentiating.
			Caribou	The potential effect of the WRSAs on caribou migration was considered in the waste rock storage alternatives assessment based on the location of the WRSAs. However, caribou access ramps are likely to be required for the WRSAs to facilitate safe ascent and descent routes if caribou find their way onto the WRSA. The number of these ramps and their design are expected to be similar for all three WRSA alternatives; therefore, this factor was considered non-differentiating.
	2.5.2.3	Social and Economic Considerations	Traditional land use	The proximity of the WRSA alternatives to archaeological sites was considered. However, there were no archaeological sites within 150 m of any of the alternatives; therefore, this factor was non-differentiating.

References:

MVEIRB (Mackenzie Valley Environmental Impact Review Board). 2014. Revised Terms of Reference (EA1314-01) Jay Project, Dominion Diamond Ekati Corporation. July 17, 2014. Yellowknife, NWT, Canada.

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Information Request Number:	DAR-MVEIRB-8 – Question 1
Source:	MVEIRB Jay Project Adequacy Review Item 8.1
Subject:	Barren-Ground Caribou - Times when caribou are particularly sensitive to potential impacts
DAR Section(s):	12.2.2.3 and 12.6.1.2

Preamble (MVEIRB):

In the TOR, the temporal scope requires (p. 15) that "The developer will place special focus on the consideration of time during the development when . . . valued components are particularly sensitive to potential impacts . . ."

The DAR notes a recent 73% decline of the Bathurst herd since 2012 but does not identify the accelerated decline as a time of particular sensitivity. Yet the sensitivity will be increased as calf productivity is reduced and cow death rates are high during the accelerated decline (Boulanger et. al. 2014b). The reduced productivity and high death rate reduce the herd's resilience to cope to increased industrial activities. While Dominion does acknowledge that resilience is reduced during low abundance, this is not analyzed or the implications described for monitoring, mitigation and assessing effects. There is uncertainty about causes of the accelerated decline which then requires a cautious approach to factors including industrial development. Traditional knowledge states that during low numbers and for recovery, respect for caribou has to be increased including how people behave toward caribou (Legat 2001).

Request (MVEIRB):

Please describe if and how the accelerated decline since 2012 is a time of particular sensitivity to potential impacts. Please provide an analysis and description of any particular sensitivity relative to assessing potential impacts and designing adaptive management.

In addition, please provide the document referenced in Section 12. 8, p 12-140, of the DAR titled "Boulanger J, Croft B, Cluff D. 2014. Trends in size of the Bathurst caribou herd from the 2014 calving ground reconnaissance survey. Integrated Ecological Research. July 31, 2014."

Response:

Section 3.5 of the TOR, in its entirety, appears below:

> *"3.5 Temporal scope*
>
> *The developer will use temporal boundaries for this environmental assessment according to potential long-term impacts on valued components, rather than on a single generic timeline. In all cases, the temporal boundary may not end with the duration of the operating phase of the Jay Project.*
>
> *For project-specific (that is, non-cumulative) impacts, the temporal scope will include all phases of the Jay Project lifespan including construction, operation, closure and reclamation, and extends*

> *until no potentially significant adverse impacts are predicted. For cumulative impacts, the temporal scope includes the period of the effects of past, present and reasonably foreseeable future projects that are predicted to combine with the impacts of the Jay Project.*
>
> *The developer will place special focus on the consideration of time during the development when activities are particularly intense (such as during the initial construction phase) or when valued components are particularly sensitive to potential impacts (such as during wildlife migration periods, or spawning and incubation periods for fish, key harvesting periods, and annual cultural gatherings). The developer will also give special attention to appropriate temporal boundaries for considering any impacts that may require long-term monitoring and management after closure, such as when water quality criteria are met to allow for the reconnection of the diked area with Lac du Sauvage and the re-establishment of an aquatic ecosystem in the (previously) diked area of Lac du Sauvage.*
>
> *In its response to Section 3.3 the developer is required to define and provide rationale for the specific temporal boundaries it used to examine the potential impacts on each of the valued components in its impact assessment."*

Three separate methods of temporal categorization relating to the content of Section 3.5 of the TOR were presented in the DAR for the assessment of effects on barren-ground caribou: the assessment cases (i.e., Base Case (reference conditions and 2014 baseline conditions), Application Case, and Reasonably Foreseeable Development Case); the Project phases (construction, operation, and closure); and four seasons within each year. Rationale for each of these temporal scales was provided in the DAR.

The state of the Bathurst herd was not regarded as a temporal phase but rather as a population phase, one that history suggests is recurrent. Beyond the temporal boundary of the Project, the DAR recognizes (page 12-134; Section 12.6.2) that resilience in barren-ground caribou is positively related to population size and trend, and cites the 2014 reconnaissance survey results of the Bathurst herd (Boulanger et al. 2014b) that suggest a large decline may have occurred between 2012 and 2014. Based on the pathways analysis in the DAR (Section 12.3.2.2), the sensitivity of the Bathurst caribou herd to potential impacts of the Project at any phase in its population cycle are through the primary pathways associated with the Project (and other human developments). Those primary pathways, as listed in DAR Section 12.3.2.2.3 are:

- Direct loss and fragmentation of habitat from the Project footprint causes changes in caribou abundance and distribution;
- Sensory disturbance (lights, smells, noise, dust, viewscape) and barriers to movement causes changes to caribou distribution and behaviour, and changes to energetics and reproduction; and,
- Increased traffic on the Misery Road and Jay Road and the above-ground power line along these roads may create barriers to caribou movement, change migration routes, and reduce population connectivity.

Density-dependent resource selection in a declining population should allow more selective use of habitat and use of smaller seasonal ranges (McLoughlin et al. 2006), which suggests habitat should be less limiting at the low phase of a population cycle. Additional analysis provided in response to Adequacy Review Item 8.2 (DAR-MVEIRB-9) detected decreasing trends in the size of post-calving and autumn seasonal ranges. Russell (2014) also demonstrated a significant increasing trend in total annual cumulative biomass on the Bathurst caribou spring to autumn ranges (May 1 to November 10) for three vegetation classes (shrub, herb-shrub, and lichen). Consequently, the remaining mechanism of interest to assess the resilience of a declining population is the potential of developments to disrupt migration routes, reduce population connectivity, and impose added energetic costs on Bathurst herd caribou. The additional energetic costs from changes in movement and behaviour associated with the Project and other developments are not expected to decrease population resilience and increase the risk to the Bathurst herd to be self-sustaining or ecologically effective at any phase of the population cycle. Analysis in the DAR showed that development-related effects have little influence on survival and reproduction in caribou, and the strength of these effects are predicted to be independent of population size relative to other factors, such as forage conditions on seasonal ranges, insect harassment, and harvesting (Weladji et al. 2003; Adamczewski et al. 2009; Boulanger et al. 2011; Chen et al. 2014).

The vital rates noted in the preamble to the Adequacy Review item are adult female survival and calf productivity. Boulanger et al. (2014a) showed increasing adult female survival from 2009 to 2012 and suggested the rapid rate of decline of the Bathurst herd observed from 2006 to 2009 (Boulanger et al. 2011; Nishi et al. 2014) had slowed substantially by 2012. The improved adult female survival from 2009 to 2012 was thought to reflect the limited harvest strategy for the Bathurst herd that was put in place after the 2009 survey (Boulanger et al. 2014a) and in keeping with modelling results that showed the potential for harvesting to lead to accelerated population decline (Boulanger et al. 2011). The 2014 reconnaissance data suggested a rapid decline from 2012 to 2014, which will be tested with a calving ground photo census in 2015 (Boulanger et al. 2014b).

The population model being completed in response to Adequacy Review Item 8.6 (DAR-MVEIRB-13) will follow the approach of De Beers (2010), which will incorporate the results of the habitat analyses and the energetics model completed in the DAR. That modelling is scheduled to be provided to the Review Board on February 2, 2015. To explicitly assess the effects of the Project on the current population phase of the Bathurst caribou herd, adult female survival and calf productivity rates consistent with the 2014 reconnaissance survey estimates will be included in model runs. The relative contributions of various natural and human disturbances will be assessed for their effects on population abundance and resilience. The results of these analyses could be used to inform regional cumulative effects assessment and adaptive management by the Government of the Northwest Territories (GNWT).

A response to the second part of the request, provision of the Boulanger et al. 2014b reference, was provided in December 2014.

References:

Adamczewski JZ, Boulanger J, Croft B, Cluff D, Elkin B, Nishi J, Kelly A, D'Hont A, Nicholson C. 2009. Decline of the Bathurst Caribou Herd 2006-2009: A technical evaluation of field data and modeling. Draft technical report December 2009. GNWT.

Boulanger J, Croft B, Adamczewski J. 2014a. An Estimate of Breeding Females and Analyses of Demographics For The Bathurst Herd of Barren-ground Caribou: 2012 Calving Ground Photographic Survey. Integrated Ecological Research Unpublished File Report No. 142 for Environment and Natural Resources, GNWT. 81 pp.

Boulanger J, Croft B, Cluff D. 2014b. Trends in size of the Bathurst caribou herd from the 2014 calving ground reconnaissance survey. Integrated Ecological Research. Unpublished report to Government of the Northwest Territories, July 31, 2014.

Boulanger J, Gunn A, Adamczewski J, Croft B. 2011. A Data-Driven Demographic Model to Explore the Decline of the Bathurst Caribou Herd. Journal of Wildlife Management 75:883-896.

Chen W, White L, Adamczewski JZ, Croft B, Garner K, Pellissey JS, Clark K, Olthof I, Latifovic R, Finstad GL. 2014. Assessing the impacts of summer range on Bathurst caribou's productivity and abundance since 1985. Natural Resources 5:130-145.

De Beers. 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.

Legat, A., G. Chocolate, B. Gon, S.A. Zoe, and M. Chocolate. 2001. Relationship between caribou migration patterns and the state of caribou habitat - Final Report from Dogrib Treaty 11 Council. Yellowknife: West Kitikmeot Slave Study Society.

McLoughlin PD, Boyce MS, Coulson T, Clutton-Brock T. 2006. Lifetime reproductive success and density-dependent, multi-variable resource selection. Proceedings of the Royal Society B 273:1449-1454.

Nishi, JS, Croft B, Boulanger J, Adamczewski J, Kelly A. 2014. An estimate of breeding females in the Bathurst herd of barren-ground caribou, June 2009. EcoBorealis Consulting Inc. Unpublished File Report No. 144 for Environment and Natural Resources, GNWT. 101 pp.

Russell, D. 2014. Kiggavik Project Effects: Energy-Protein and Population Modeling of the Qamanirjuaq Caribou Herd. Prepared for EDI Environmental Dynamics Inc.

Weladji RB, Holand O, Almoy A. 2003. Use of climatic data to assess the effect of insect harassment on the autumn weight of reindeer (*Rangifer tarandus*) calves. Journal of Zoology 260:79-85.

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Information Request Number:	DAR-MVEIRB-9
Source:	MVEIRB Jay Project Adequacy Review Item 8.2
Subject:	Barren-Ground Caribou - Assessment Methodology – temporal trends
DAR Section(s):	12.2.2.1, Figure 12.4-2, and Figure 12.4-3

Preamble (MVEIRB):

The Terms of Reference require the proponent to identify the natural range of background conditions and current baseline conditions, and analyze for discernible trends over time in each valued component relative to natural or existing variability.

The DAR does not analyze or describe annual trends in seasonal caribou distribution. While the DAR displays annual background conditions for summer movement rates or insect harassment indices, there is no analysis or integration of annual trends that will influence the exposure or sensitivity of caribou. 2014 was a record drought year and this is not examined as to whether there is a trend in drought years.

Request (MVEIRB):

1. Please describe any annual trends in seasonal distribution (especially summer and fall such as a delayed fall migration to below the treeline) and relate these to trends in exposure of caribou to the project. The trends in annual sample for number of satellite collars is needed with a description of how these trends influence the certainty of any trends in distribution.

2. Please analyze annual trends in environmental conditions such as insect harassment and summer drought (including mushroom indices) and relate these to trends in increased sensitivity of caribou to potential impacts. The CircumArctic Rangifer Monitoring and Assessment Network has a retrospective climate database for the seasonal ranges of the Bathurst herd that may be useful.

Response:

1. Trends in Seasonal Ranges

Methods

In the DAR, seasonal ranges for the Bathurst caribou herd were calculated using satellite collar data (courtesy of GNWT-ENR) and a 95% kernel density (i.e., probability density) estimate (Section 12.4.1). Range estimates for the Bathurst herd included satellite collared caribou locations from January 1996 through October 2013. All location data from all years were pooled for each season and the multi-annual 95% kernel for each season was taken to represent the seasonal range.

For each of the four seasons, kernel density analyses were completed independently for each calendar year; for winter ranges, the data represent the pair of years comprising a given winter (e.g., winter 2004-2005 includes data from 1 November 2004 to 30 April 2005). Each 95% kernel for each season in each year was edited to remove small outlier polygons, leaving a single polygon for each season in each year. The following attributes were calculated in a geographic information system (GIS):

- Seasonal range polygon areas;
- Seasonal range polygon centroids (the central geographic latitude and longitude coordinates of the polygon);
- Area of overlap between each seasonal range polygon and the polygon for the same season in the previous year;
- The date after September 1 of each year of the first observation of each radio-collared caribou below the treeline;
- Distance from each autumn range polygon centroid to the nearest point on the treeline; and,
- Distance from each autumn range polygon centroid to the subsequent winter range polygon centroid.

From the animal location files for each year, the date of the first observation of each animal below the treeline on or after September 1 was determined for each year. Mean date of arrival below the treeline was determined for each year and the trend over time of arrival dates was determined through linear regression.

Changes in seasonal distributions were assessed through analyses of range size and year-to-year range overlap. Seasonal range polygon areas were analyzed to determine if there were any trends through time in seasonal range sizes. Year-to-year overlap of seasonal ranges were analyzed to determine if there were trends in year-to-year range fidelity within any season. The calculation of range overlap followed Faille et al. (2010):

$$proportional\ overlap = \frac{Area_{12}}{Area_1 + Area_2 - Area_{12}}$$

Where $Area_1$ is the range size in year 1, $Area_2$ is the range size in year 2, and $Area_{12}$ is the common area of the ranges for the two years.

To determine if there were trends in autumn migration patterns, three attributes were assessed: the distance between the autumn range centroid and the treeline; the mean date of arrival of collared caribou below the treeline (restricted to animals that were observed below the treeline during winter); and the distance between autumn and winter range centroids for each year.

Results

Number of Active Radio-collars

The number of caribou with radio-collars has varied over time (Table 9-1). From 1996 to 2013, there was an increasing trend in the number of functioning collars in spring (linear regression, number of collars = -1,145 + 0.58 × Year, $P < 0.01$) and post-calving (linear regression, number of collars = -1,070 + 0.54 × Year, $P < 0.01$), but no significant trend in functioning collars in autumn (linear regression, number of collars = -338 + 0.18 × Year, $P = 0.28$) or winter (linear regression, number of collars = -502 + 0.26 × Year, $P = 0.14$). In summary, there is a trend showing an annual increase of 0.58 collars active in the spring (following late winter collar deployment), but the relative increase over time declines through the year, likely as a result of caribou mortality and collar failure. Increases in active collar numbers were generally achieved by 2005 with relative stability since then (Table 9-1).

Table 9-1 Numbers of Active Radio-collars on Bathurst Herd Caribou at the Start of Each Season in Each Year Based on Telemetry Location data provided by GNWT-ENR

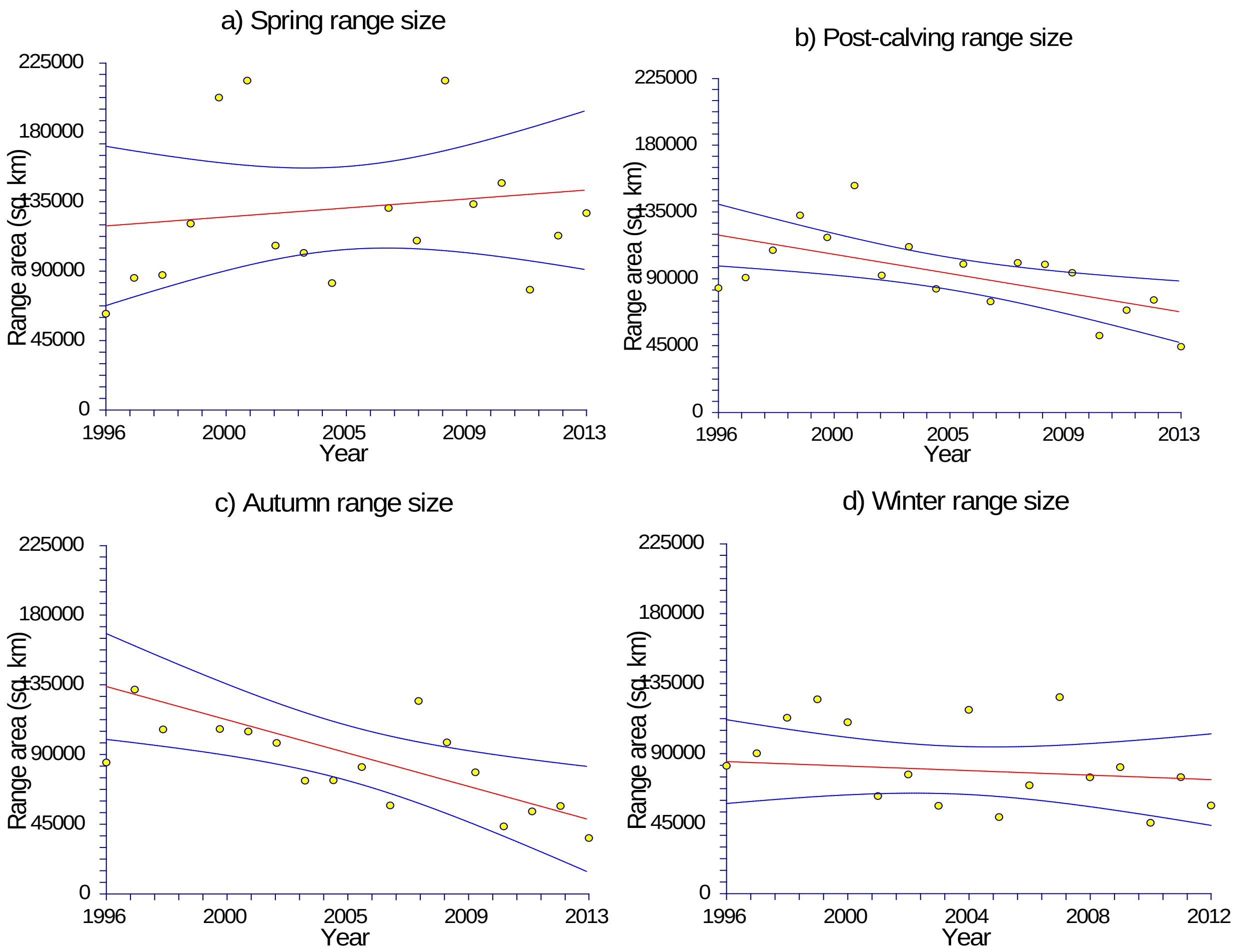
Year	Spring	Post-calving	Autumn	Winter
1996	10	10	10	10
1997	7	8	7	7
1998	15	10	19	19
1999	16	13	14	14
2000	13	13	12	12
2001	14	13	10	10
2002	12	11	10	10
2003	13	11	10	10
2004	7	6	15	15
2005	21	19	18	18
2006	15	15	14	14
2007	21	20	19	19
2008	15	15	12	12
2009	17	14	13	13
2010	21	19	15	15
2011	18	18	12	12
2012	23	22	17	17
2013	17	13	11	nd

nd = no data for 2014 winter season at time of completing the DAR

Seasonal Range Sizes

Trends through time in seasonal range sizes were analyzed using linear regression. Spring range size did not change significantly from 1996 to 2013 (Figure 9-1a, $t = 0.56$, $P = 0.59$). Post-calving range size decreased by 3,047 km^2 / year from 1996 to 2013 (Figure 9-1b, $t = -3.12$, $P < 0.01$). Autumn range size decreased 5,055 km^2 / year from 1996 to 2013 (Figure 9-1c, $t = -3.09$, $P < 0.01$). Winter range size did not change significantly from 1996/1997 to 2012/2013 (Figure 9-1d, $t = -0.52$, $P = 0.61$). Post-calving and autumn ranges of the Bathurst caribou herd became more concentrated from 1996 to 2013.

Figure 9-1 Trends (red lines) and 95% Confidence Intervals (blue lines) in 95% Kernel Range Sizes (km^2) of the Bathurst Caribou Herd for Each Season

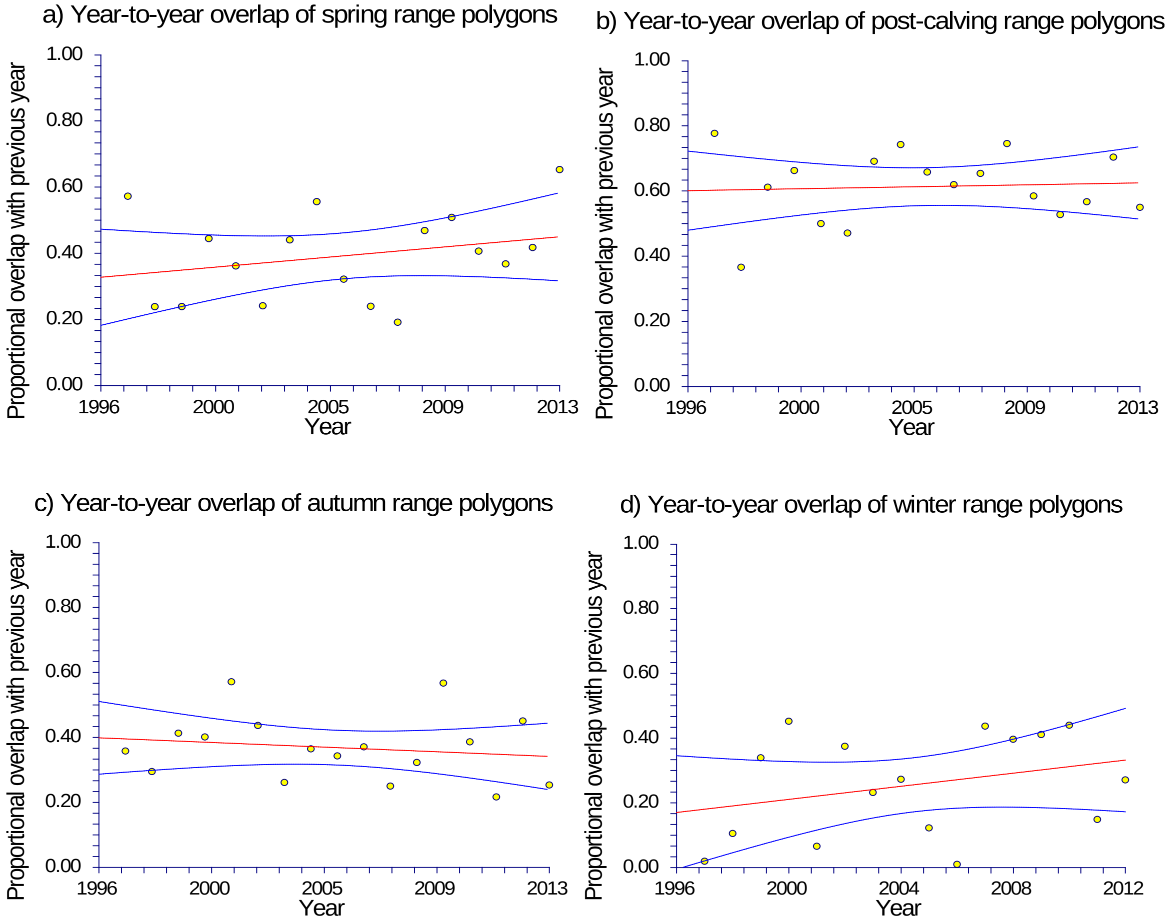


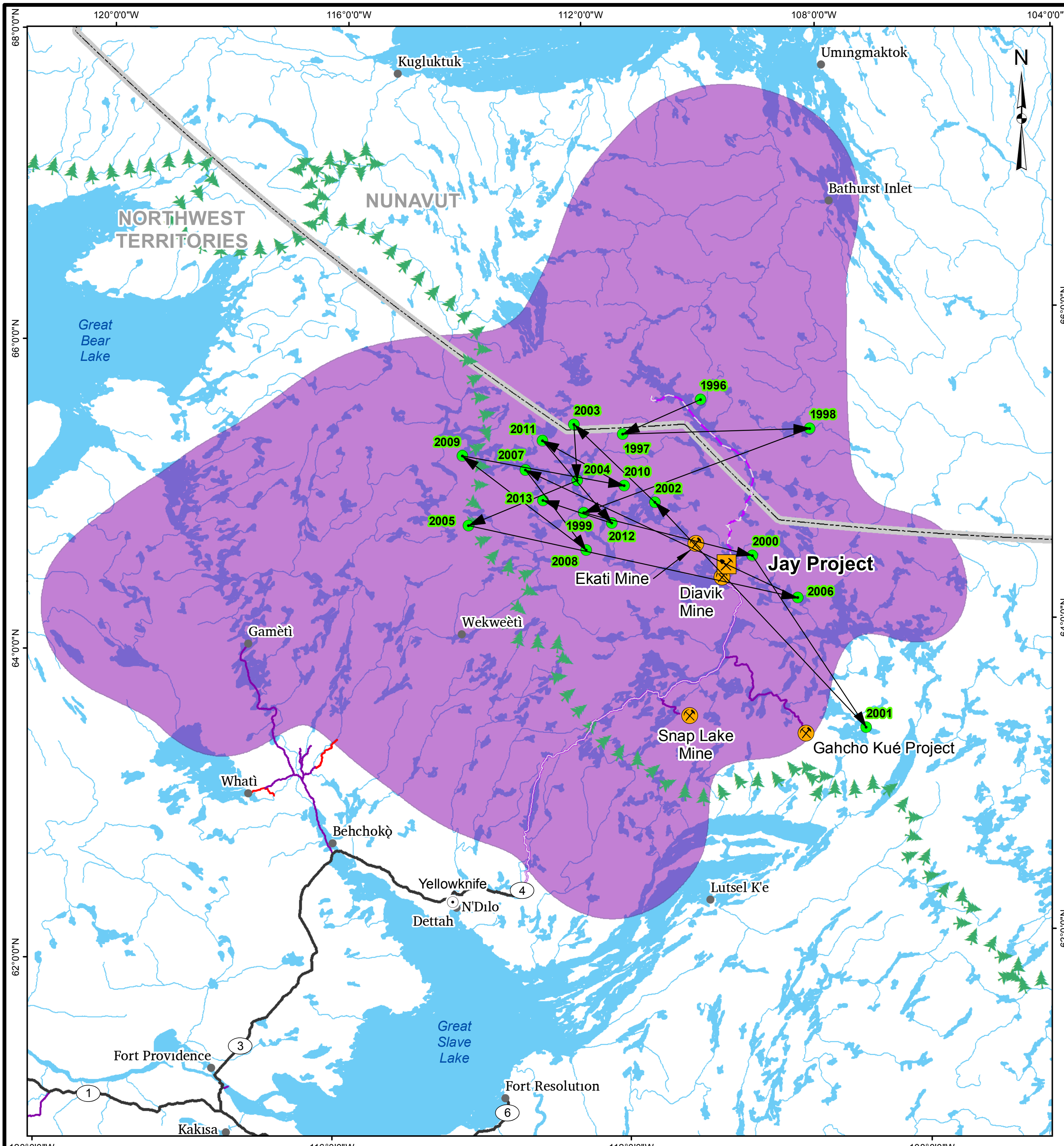
Year-to-year Range Fidelity

Trends through time for the amount of range fidelity were analyzed using linear regression applied to the degree of overlap observed among ranges for the same season in consecutive years. There were no significant trends observed in the year-to-year proportion of overlap among seasonal ranges for any season in the 1996 to 2013 period: spring range overlap (Figure 9-2a, t = 1.08, P = 0.30); post-calving range overlap (Figure 9-2b, t = 0.25, P = 0.80); autumn range overlap (Figure 9-2c, t = -0.66, P = 0.52); and winter range overlap (Figure 9-2d, t = 1.20, P = 0.25). These results suggest that the tendency of the Bathurst caribou herd to return to a seasonal range used in the same season in the previous year did not change during the study period.

The centroids of the ranges used in each year are presented separately for each season in Maps 9-1 to 9-4.

Figure 9-2 Trends (red lines) and 95% Confidence Intervals (blue lines) in Year-to-year 95% Kernel Range Overlap for the Bathurst Caribou Herd for Each Season





LEGEND

- JAY PROJECT
- EXISTING MINE OR PROJECT
- POPULATED PLACE
- HIGHWAY
- ALL-SEASON ROAD
- WINTER ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- TERRITORIAL/PROVINCIAL BOUNDARY
- TREELINE
- WATERCOURSE
- WATERBODY
- CENTROID
- CENTROID CONNECTOR
- MULTI-ANNUAL SPRING RANGE, APRIL 15 TO JUNE 14, 1996 TO 2013

100 0 100

SCALE 1:4,000,000 KILOMETRES

REFERENCE

CENTROIDS DERIVED FROM COLLAR DATA OBTAINED FROM ENR, 2013
WATER OBTAINED FROM ATLAS OF CANADA
NATURAL RESOURCES CANADA, CENTRE FOR TOPOGRAPHIC INFORMATION, 2012
PROJECTION: CANADA LAMBERT CONFORMAL CONIC

DOCUMENT

POST-DAR CARIBOU IR

PROJECT

DOMINION DIAMOND™

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

ANNUAL SPRING RANGE CENTROIDS FOR THE BATHURST CARIBOU HERD 1996 TO 2013

Golder Associates

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GIS	ANK	15/01/15		
CHECK	JR	15/01/15	MAP 9-1	
REVIEW	JV	15/01/15		

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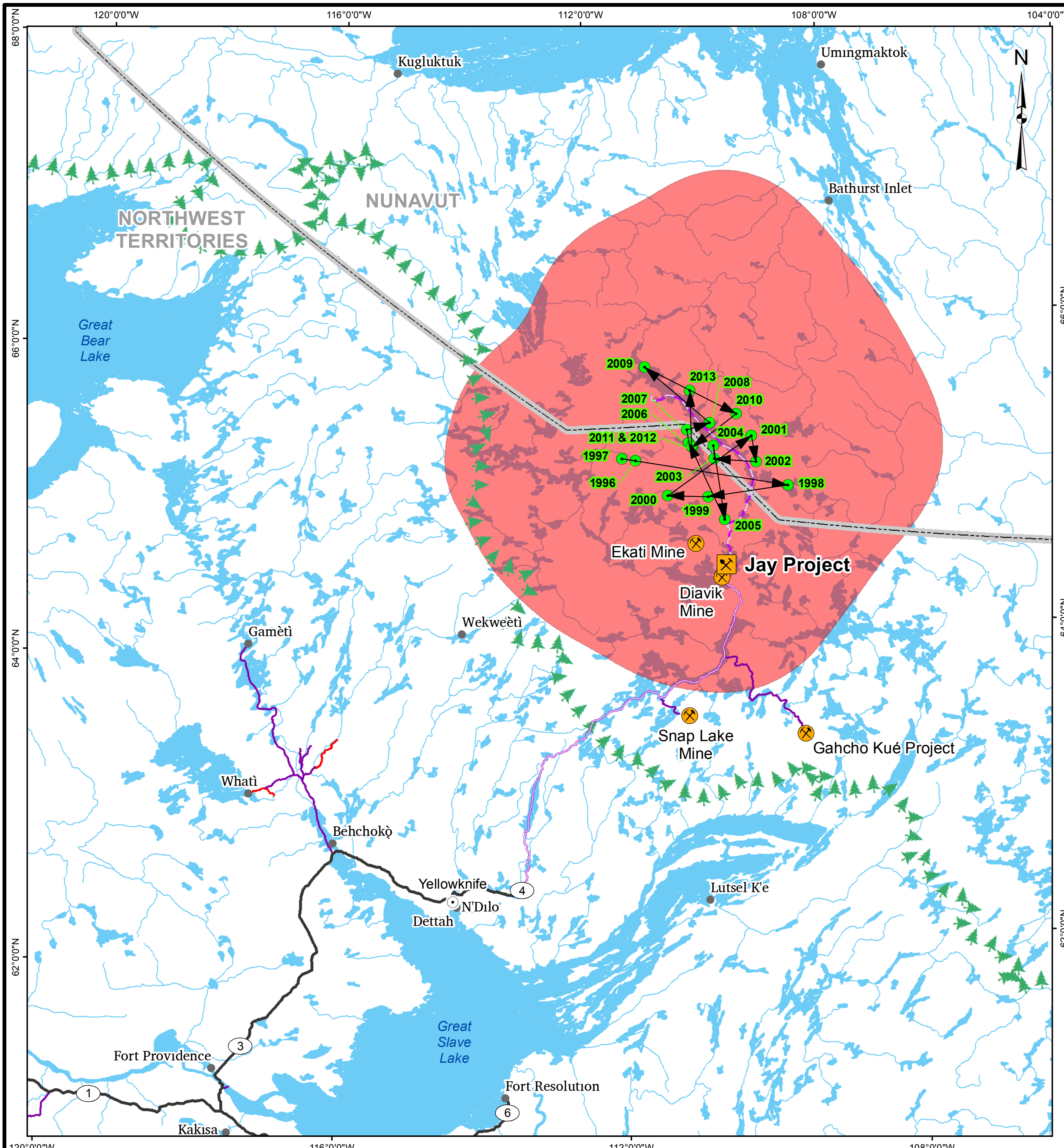

LEGEND

- JAY PROJECT
- EXISTING MINE OR PROJECT
- POPULATED PLACE
- HIGHWAY
- ALL-SEASON ROAD
- WINTER ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- TERRITORIAL/PROVINCIAL BOUNDARY
- TREELINE
- WATERCOURSE
- WATERBODY
- CENTROID
- CENTROID CONNECTOR
- MULTI-ANNUAL POST-CALVING RANGE, JUNE 15 TO AUGUST 31, 1996 TO 2013

100 0 100

SCALE 1:4,000,000 KILOMETRES

REFERENCE

CENTROIDS DERIVED FROM COLLAR DATA OBTAINED FROM ENR, 2013
WATER OBTAINED FROM ATLAS OF CANADA
NATURAL RESOURCES CANADA, CENTRE FOR TOPOGRAPHIC INFORMATION, 2012
PROJECTION: CANADA LAMBERT CONFORMAL CONIC

DOCUMENT

POST-DAR CARIBOU IR

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

ANNUAL POST-CALVING RANGE CENTROIDS FOR THE BATHURST CARIBOU HERD 1996 TO 2013

Golder Associates

PROJECT		13-1328-0041
DESIGN	JR	31/01/15
GIS	ANK	15/01/15
CHECK	JR	15/01/15
REVIEW	JV	15/01/15

FILE No. POSTDAR_IR_Wild_008_GIS

SCALE AS SHOWN REV. 0

MAP 9-2

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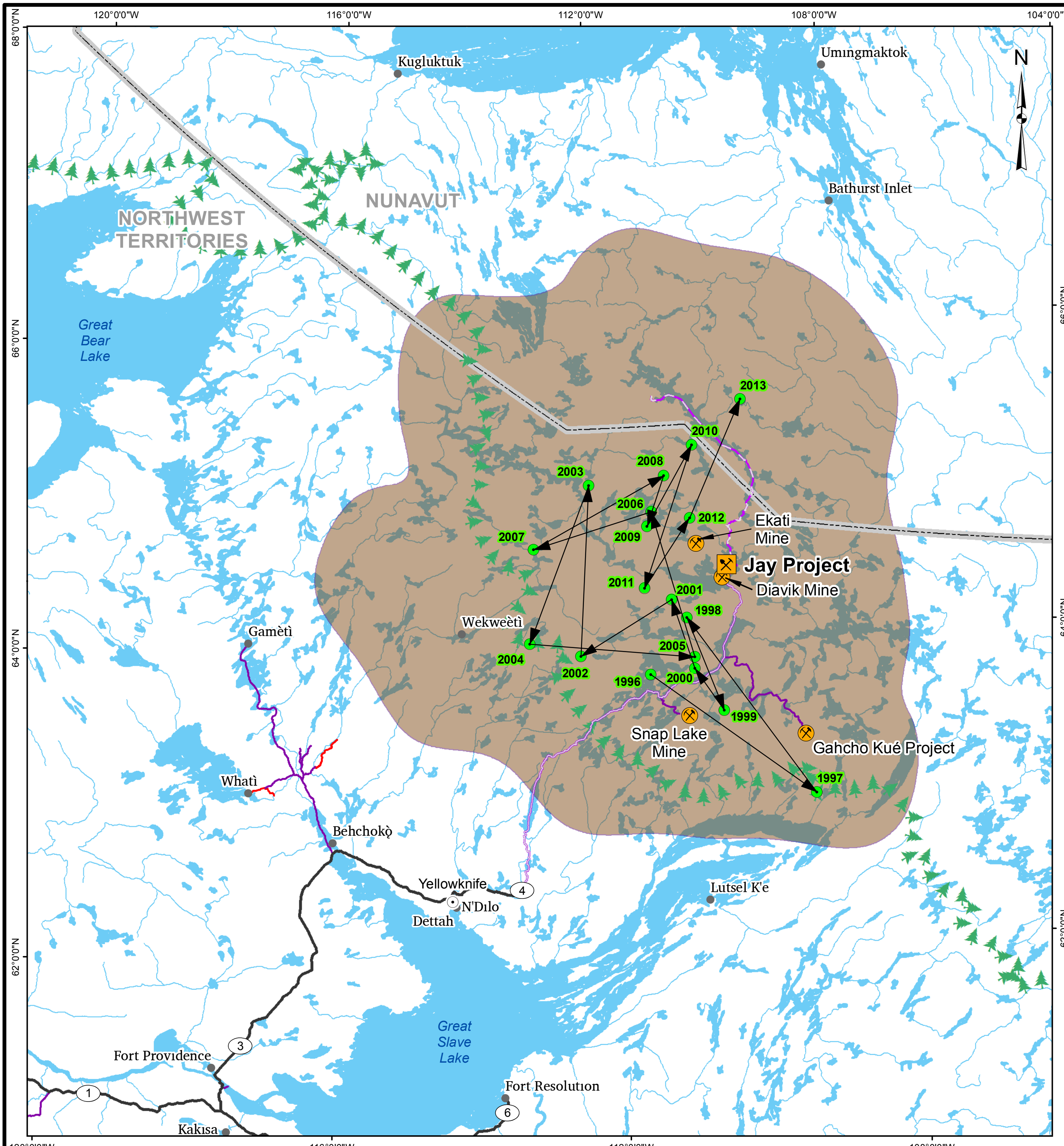

LEGEND

- JAY PROJECT
- EXISTING MINE OR PROJECT
- POPULATED PLACE
- HIGHWAY
- ALL-SEASON ROAD
- WINTER ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- TERRITORIAL/PROVINCIAL BOUNDARY
- TREELINE
- WATERCOURSE
- WATERBODY
- CENTROID
- CENTROID CONNECTOR
- MULTI-ANNUAL AUTUMN RANGE, SEPTEMBER 1 TO OCTOBER 31, 1996 TO 2013

100 0 100

SCALE 1:4,000,000 KILOMETRES

REFERENCE

CENTROIDS DERIVED FROM COLLAR DATA OBTAINED FROM ENR, 2013
WATER OBTAINED FROM ATLAS OF CANADA
NATURAL RESOURCES CANADA, CENTRE FOR TOPOGRAPHIC INFORMATION, 2012
PROJECTION: CANADA LAMBERT CONFORMAL CONIC

DOCUMENT

POST-DAR CARIBOU IR

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

ANNUAL AUTUMN RANGE CENTROIDS FOR THE BATHURST CARIBOU HERD 1996 TO 2013

Golder Associates

PROJECT		13-1328-0041	FILE No. POSTDAR_IR_Wild_005_GIS	
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GIS	ANK	15/01/15	**MAP 9-3**	
CHECK	JR	15/01/15		
REVIEW	JV	15/01/15		

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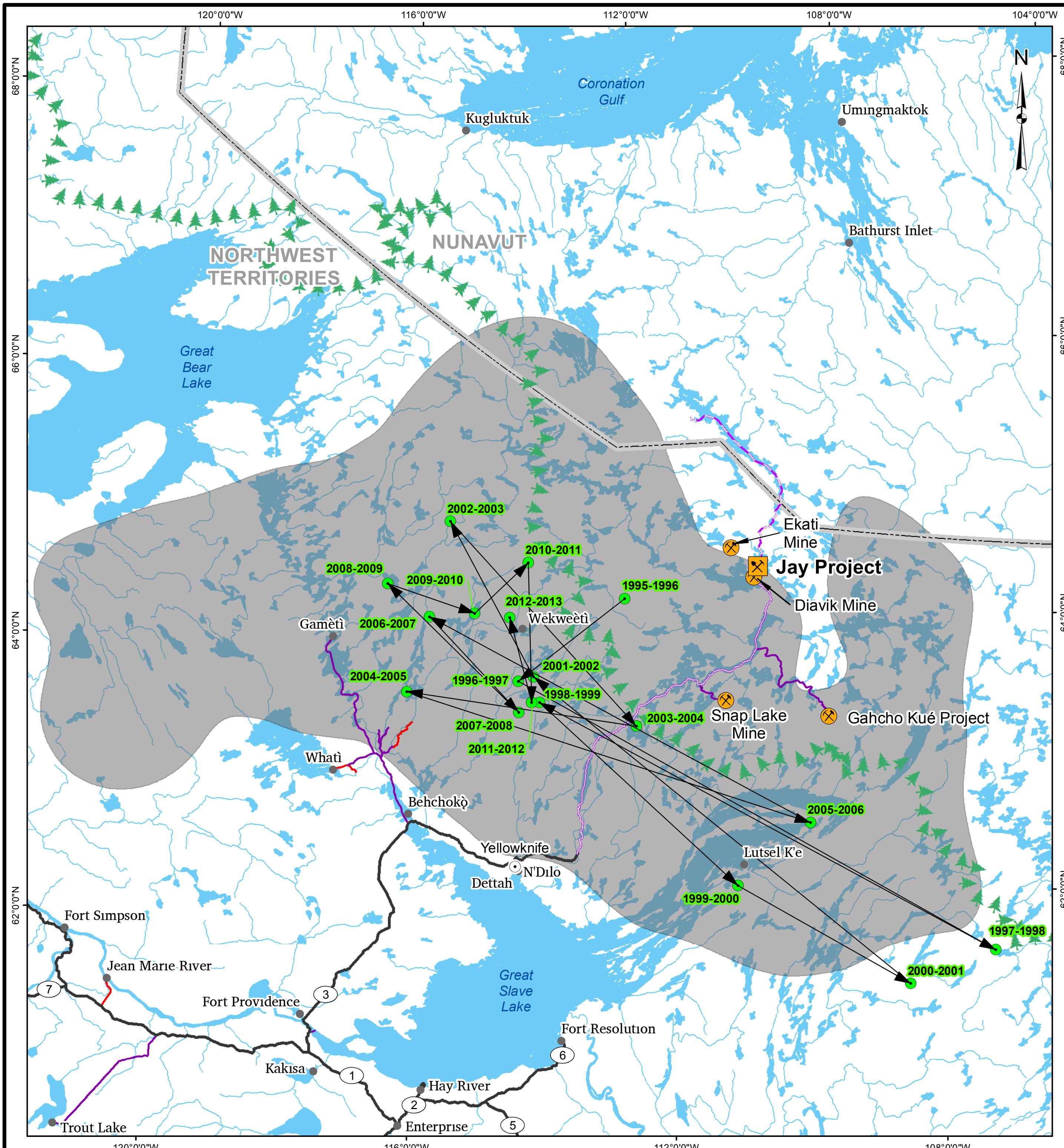

LEGEND

- JAY PROJECT
- EXISTING MINE OR PROJECT
- POPULATED PLACE
- HIGHWAY
- ALL-SEASON ROAD
- WINTER ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- TERRITORIAL/PROVINCIAL BOUNDARY
- TREELINE
- WATERCOURSE
- WATERBODY
- CENTROID
- CENTROID CONNECTOR
- MULTI-ANNUAL WINTER RANGE, NOVEMBER 1 TO APRIL 30, 1996 TO 2013

100 0 100

SCALE 1:4,500,000 KILOMETRES

REFERENCE

CENTROIDS DERIVED FROM COLLAR DATA OBTAINED FROM ENR, 2013
WATER OBTAINED FROM ATLAS OF CANADA
NATURAL RESOURCES CANADA, CENTRE FOR TOPOGRAPHIC INFORMATION, 2012
PROJECTION: CANADA LAMBERT CONFORMAL CONIC

DOCUMENT

POST-DAR CARIBOU IR

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

ANNUAL WINTER RANGE CENTROIDS FOR THE BATHURST CARIBOU HERD 1995-1996 TO 2012-2013

Golder Associates

PROJECT		13-1328-0041	FILE No. POSTDAR_IR_Wild_006_GIS
DESIGN	JR	31/01/15	SCALE AS SHOWN REV. 0
GIS	ANK	15/01/15	
CHECK	JR	15/01/15	MAP 9-4
REVIEW	JV	15/01/15	

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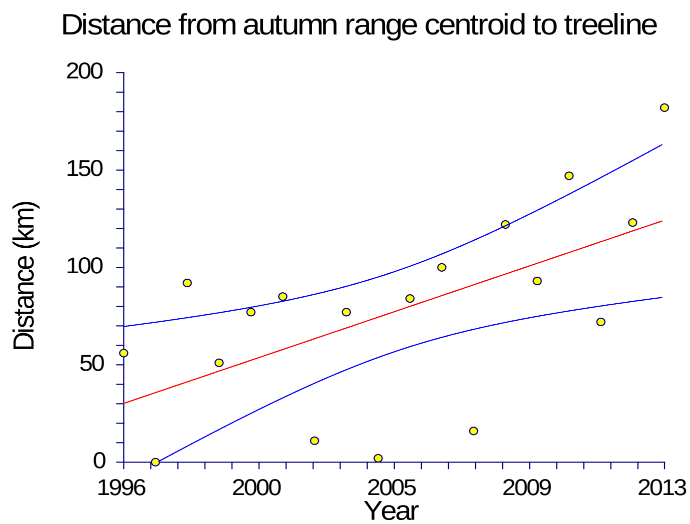
Location of Autumn Range Relative to the Treeline

From 1996 to 2013, there was a significant increase in the distance between the centroid of the autumn range and the nearest point on the treeline (Figure 9-3, linear regression, $t = 2.96$, $P < 0.01$). The autumn ranges moved an average of 5.5 km further from the treeline each year. Map 9-3 and Figure 9-3 illustrate the changes in centroid locations from 1996 to 2013.

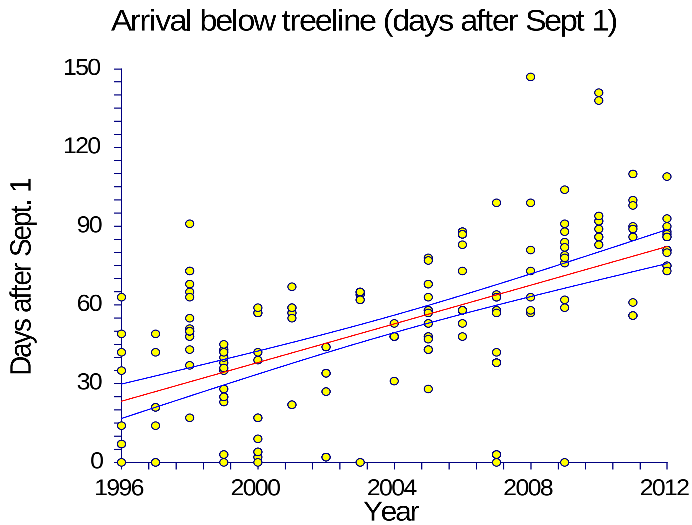
Figure 9-3 Trend (red line) and 95% Confidence Interval (blue lines) in the Distance (km) from the Annual Autumn Range Centroid to the Treeline for the Bathurst Caribou Herd



Autumn/Winter Arrival Date below Treeline

For animals that overwintered below the treeline, from 1996 to 2013, the date of arrival at the treeline changed significantly (Figure 9-4, linear regression, $t = 10.37$, $P < 0.001$). Arrival below the treeline was delayed by an additional 3.7 days per year.

Figure 9-4 Trend (red line) and 95% Confidence Interval (blue lines) in the Number of Days after September 1 of each Year that Individuals from the Bathurst Caribou Herd Arrived below the Treeline

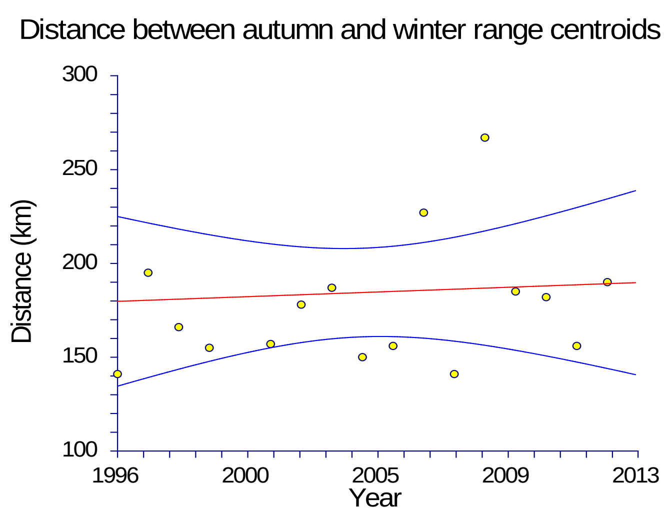


Note: circles denote values for each individual that spent at least part of each winter below the treeline.

Distance Between Autumn Range and Winter Range

While animals were distributed further north during autumn and moved below the treeline later in the year, there was no trend in the distance between autumn range centroids and the corresponding winter range centroids (Figure 9-5, t = 0.26, P = 0.80).

Figure 9-5 Trend (red line) and 95% Confidence Interval (blue lines) in the Distances (km) between the Autumn Range Centroid and the Centroid for the Subsequent Winter



Summary

Following the approach used in the DAR, seasonal ranges were assessed separately in these analyses. As there were no broad-scale trends detected in environmental variables (Section 2 below), there was no attempt to relate environmental variables to seasonal range attributes.

Analyses presented here show no trends from 1996 to 2013 in range fidelity in any season. There were trends showing smaller post-calving and autumn seasonal range sizes from 1996 to 2013, but no trend for spring or winter range sizes in the same period. There was a trend observed for autumn ranges to shift father away from the treeline from 1996 to 2013 and for collared caribou to migrate south to the treeline later in the year. Interpreting causes and effects of trends in seasonal range sizes over this period is complicated by the large decline in the Bathurst caribou herd. The Bathurst herd declined from approximately 151,000 breeding females in 1996 to approximately 16,000 breeding females in 2012 (Boulanger et al. 2014a), with a further decline suggested to have occurred by 2014 (Boulanger et al. 2014b). More selective use of resources may yield shifted and smaller seasonal ranges, consistent with density-dependent resource selection (McLoughlin et al. 2006).

A recent analysis of movement of collared Bathurst cows from July 1 to August 31 for 2009 through 2013 indicated that most collared cows remained in the proximity of Contwoyto Lake during this period and well north of the Ekati and Diavik mines (Golder 2014). These results are supported by the additional seasonal range analyses in this response, and may be related partially to the decrease in population size. Caribou are considered sensitive to disturbance during the post-calving period because calves are maturing and still dependent on maternal cows. Encounters with the Ekati and Diavik mines may be more likely to occur later in the autumn when female caribou and calves may be more resilient to disturbance. Overall, the observed changes in seasonal ranges and in the timing of autumn migration are not expected to alter the residual impact classification and determination of significance provided in the DAR for cumulative effects to caribou from the Project and other developments.

2. Trends in Environmental Conditions

Methods

A retrospective set of environmental variables derived from the National Aeronautics and Space Administration's (NASA's) Modern Era Retrospective-Analysis for Research and Applications (MERRA) satellites (Russell et al. 2013) for the Bathurst caribou summer range was acquired from CircumArctic Rangifer Monitoring and Assessment Network (CARMA) via Don Russell. This data set includes a range of years from 1979 to 2009. More recent data are not included in the CARMA data set because they have not been acquired from NASA (Russell 2014, pers. comm).

Mean daily temperature (°C), total daily precipitation (mm), total seasonal precipitation (mm) and a Keetch Byram drought index (KBDI) were obtained from the CARMA dataset and analyzed for interannual patterns. These variables were assessed for the period of June 15 to October 31, similar to the DAR (i.e., post-calving to autumn range). A mushroom growth index variable was not present in the CARMA dataset, and no formula could be found in the scientific literature to calculate such an index based on climate variables. Interannual patterns in temperature and precipitation at the Diavik and Snap Lake mines from 1998 to 2014 were also assessed. For the analysis of Diavik and Snap Lake variables, annual data were excluded from the analysis if greater than or equal to 5% of observations for the period were missing. This criterion resulted in the preclusion of analysis for annual patterns in total daily and total seasonal precipitation variables. Annual variability in potential insect harassment days (PHDs; Weladji et al. 2003) was presented in Section 12.4.2.3 of the DAR.

An information theoretic approach (Burnham and Anderson 2002) was used to evaluate relative support for temporal patterns in response variables. The approach included evaluation of three candidate models for each climate variable. The information theoretic approach for model selection is based on the principal of parsimony which balances the trade-off between model bias of unexplained variation and estimate precision, both which depend on the number of model parameters given a fixed amount of data (Burnham and Anderson 2002). Models are scored using Akaike's Information Criteria (AIC), which evaluates model fit relative to the number of model parameters and includes a penalty of 2.0 AIC units for each model parameter. Thus, each model parameter must be informative enough to overcome the statistical penalty relative to a simpler model. The model with the lowest AIC score represents the most parsimonious (most plausible) explanation of patterns in the data. The information theoretic approach is widely accepted and used in the scientific literature. For each climate variable, the three models evaluated included year as a continuous variable to identify a temporal trend, year as a categorical variable to test for annual differences, and a null model that included only a y-intercept term, which predicts no change over time. The candidate set for total seasonal precipitation only included a temporal trend and null since annual values contain no within-year variation to estimate "year" effects.

Results

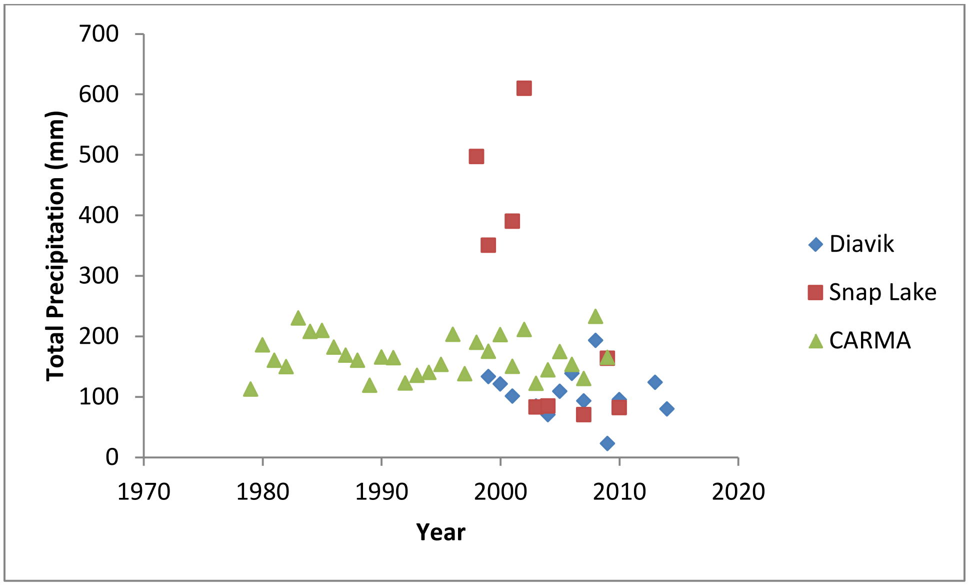
Among the CARMA, Diavik, and Snap Lake data sets, total seasonal precipitation was the only variable where a temporal trend was supported but only in the Snap Lake data set (Table 9-2). Thus, for the climate variables analyzed, temporal trends do not appear to be occurring at broad spatio-temporal scales in the Bathurst post-calving to autumn range. A decline in total seasonal rainfall observed at Snap Lake resulted from exceptionally large amounts of rainfall in 1998, 1999, 2001, and 2002 (Figure 9-6). These appear to be exceptional years because subsequent annual values of rainfall at Snap Lake are within the range of values observed for the CARMA and Diavik data sets. The null model (y-intercept only) was the most parsimonious explanation of patterns of mean daily temperature, total daily precipitation, and total seasonal precipitation in the CARMA data and for total seasonal precipitation in Diavik data. A model of annual differences was the most parsimonious explanation of the drought index and also for mean daily temperature at Diavik and Snap Lake (Table 9-2; Figure 9-7).

Table 9-2 Model Section Results Describing Variation of Different Climate Variables During June 15 to October 31 from CARMA, Diavik and Snap Lake Data Sources

Data Set	Period	Variable	Model	Log Likelihood	K	AIC	ΔAIC	AICW
CARMA	1979 to 2009	drought index (KBDI)	annually variable	-17134.93	31	22103.44	0.0	1.00
			temporal trend	-17511.52	2	22798.63	695.2	0.00
			intercept only	-17523.33	1	22820.24	716.8	0.00
		mean daily temperature	intercept only	-16066.80	1	19907.19	0.0	0.61
			temporal trend	-16066.26	2	19908.10	0.9	0.40
			annually variable	-16042.58	31	19918.75	11.6	0.00
		total daily precipitation	intercept only	-9629.23	1	7032.05	0.0	0.73
			temporal trend	-9629.23	2	7034.04	2.0	0.27
			annually variable	-9606.49	31	7046.56	14.5	0.00
		total seasonal precipitation	intercept only	-151.62	1	217.27	0.0	0.77
			temporal trend	-151.62	2	219.27	2.0	0.23
Diavik	1999 to 2014	mean daily temperature	annually variable	-7240.41	15	8625.07	0.0	0.99
			temporal trend	-7258.31	2	8634.86	9.8	0.01
			intercept only	-7261.02	1	8638.29	13.2	0.00
		total seasonal precipitation	intercept only	-66.03	1	97.16	0.0	0.83
			temporal trend	-65.88	2	98.87	1.7	0.17
Snap Lake	1998 to 2010	mean daily temperature	annually variable	-5451.46	11	6514.02	0.0	1.00
			intercept only	-5488.40	1	6565.89	51.9	0.00
			temporal trend	-5488.07	2	6567.24	53.2	0.00
		total seasonal precipitation	temporal trend	-57.22	1	92.89	0.0	0.65
			intercept only	-66.03	2	96.92	4.0	0.35

K = number of model parameters; AIC = Akaike's Information Criterion; ΔAIC = AIC unit difference of model relative to the lowest model AIC score; AICw = relative model weight of evidence among the candidate set.

Figure 9-6 Total Seasonal Precipitation Recorded for the Period of 1979 to 2014 within the Bathurst Caribou Post-calving to Autumn Range



No broad-scale increasing or decreasing trends were evident for any of the climate variables from three different data sources within the Bathurst post-calving to autumn range. Temporal increases in mean temperature for Bathurst caribou have been reported in the Contwoyto Lake area based on historical local weather observations (Witter et al. 2012). The results from the CARMA, Diavik, and Snap Lake data sets support that climate varies annually due to local climatic conditions and are not becoming more extreme relative to 1979. Climate warming is expected to increase the duration and intensity of insect harassment on caribou because of earlier insect emergence, greater insect abundance, and increased insect distribution (Weladji and Holland 2003; Vors and Boyce 2009). Insect harassment can decrease forage intake, milk production, and calf growth and possibly survival (Helle and Tarvainen 1984; Russell et al. 1993; Hagemoen and Reimers 2002; Weladji et al. 2003). It is assumed that caribou that encounter extreme local weather will seek out alternate local climates that are more favourable to fitness. For example, Traditional Knowledge indicates that caribou may remain at barren-ground areas during warm summers to avoid insect harassment in the forest (DAR Section 12.3.2). As well, it has been hypothesized that caribou also use developed areas to avoid insect harassment (Gunn et al. 1998; BHP Billiton 2004; Rescan 2007).

The results of the climate variable analyses detected no significant regional scale increasing or decreasing trends in temperature, drought, and precipitation on the Bathurst caribou post-calving to autumn range. There are no expected changes to the residual impact classification and determination of significance provided in the DAR for cumulative effects to caribou.

Figure 9-7 Mean Values (± 2 SD) by Year of Keetch Byram Drought Index (KBDI; a) Reported by CARMA, and Mean Daily Temperature at the Diavik Diamond (b) and Snap Lake Mines (c)

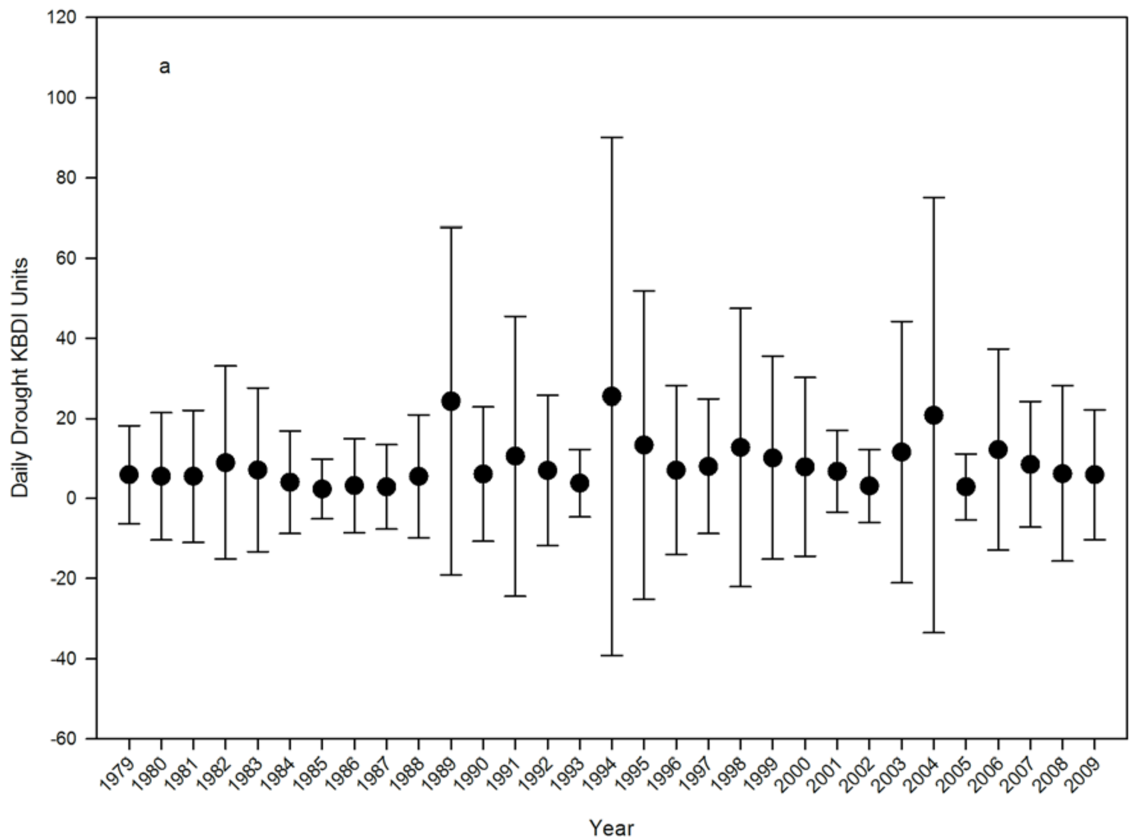
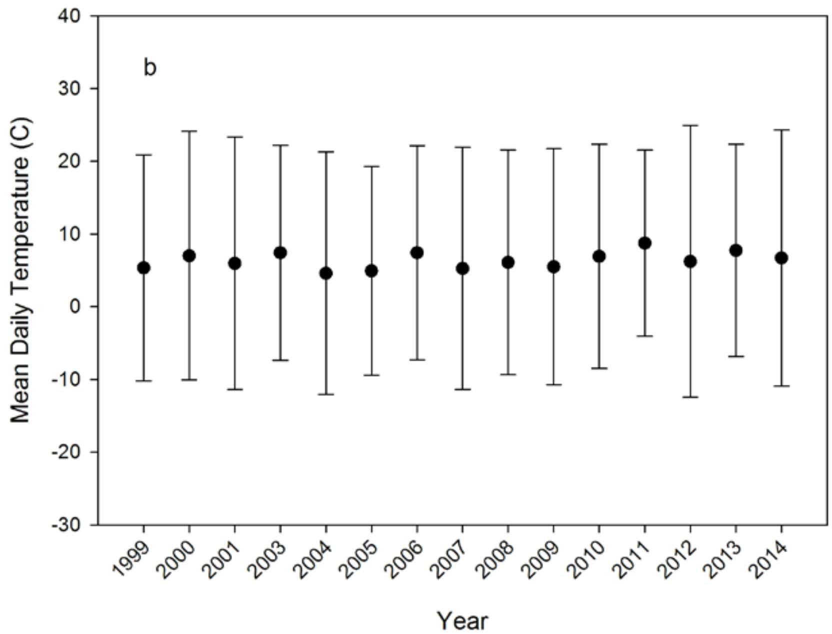
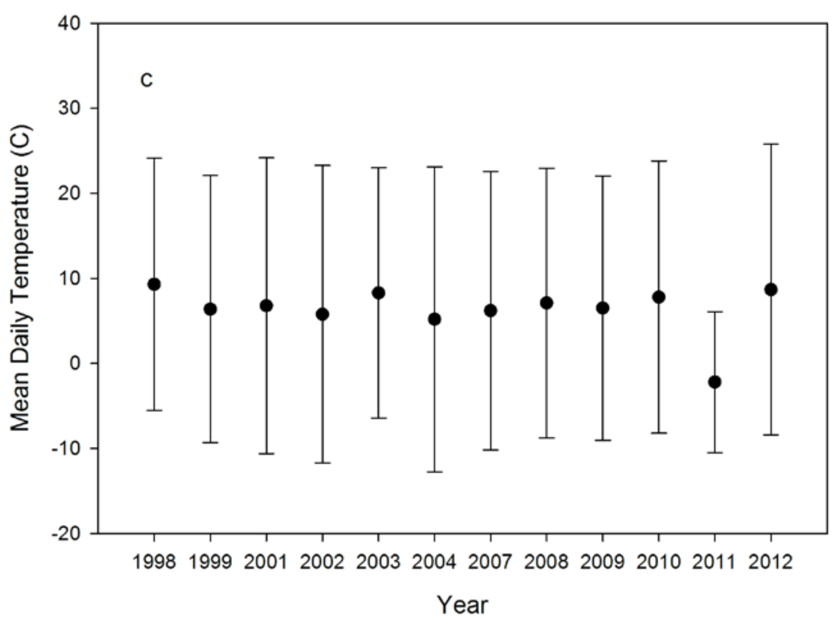


Figure 9-7 Mean Values (± 2 SD) by Year of Keetch Byram Drought Index (KBDI; a) Reported by CARMA, and Mean Daily Temperature at the Diavik Diamond (b) and Snap Lake Mines (c) (continued)





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Personal Communications:

Russell, DE. 2014. Caribou Biologist, retired. Shadow Lake Environmental Consultants. E-mail. December 27, 2014.

Information Request Number:	DAR-MVEIRB-11
Source:	MVEIRB Jay Project Adequacy Review Item 8.4
Subject:	Barren-Ground Caribou - Approach to impact classification and significance – significance determination
DAR Section(s):	7.3.3 and 12.6

Preamble (MVEIRB):

The TOR requires that Dominion “identify, and provide an opinion on the significance of any residual adverse impacts predicted to remain after any mitigation measures and indicate the methodologies for reaching such conclusions.” The DAR’s approach relies on defining the assessment endpoint for barren-ground caribou as a self-sustaining and ecologically effective population (Table 12.1-1). Assessment endpoints are the qualitative expressions used to assess the significance of effects on VCs and represent the key properties of VCs.

However, given the extent of the decline of the Bathurst herd since 2012, it is questionable whether the Bathurst herd is a self-sustaining and ecologically effective population. It is noteworthy that based on information preceding the current collapse, MVEIRB’s Gahcho Kue Panel (2013) had ruled that the Bathurst herd may already be at a threshold where any additional changes have social and cultural significance.

Likewise, the DAR defines the magnitude of effects as depending on whether the amount of change to the measurement indicator is sufficiently large that the resulting range of residual effects are near or exceeding the predicted resilience limits and adaptive capacity of the VC (Table 12 6-1). The evaluation and classification of magnitude considers the adaptive capacity and resilience of caribou to absorb effects from the Project and other disturbances, and continue as a self-sustaining and ecologically effective population. Resilience is the ability of a population to recover or bounce back from disturbance.

Request (MVEIRB):

The accelerated decline of the Bathurst herd since 2012 is unprecedented in caribou management and Dominion needs to discuss the implications and revise the terminology to determine significance. Dominion will provide a revised definition for the assessment endpoint and re-assess the significance of the residual at reproduction, inter-birth interval, age-specific survival rates, lifespan of individuals, habitat selection, and seasonal ranges and migratory behavior. In a population that has declined for a number of years, assumptions about these traits should be described and their implications for resilience and significance of effects re-examined.

Response:

Section 6 of the DAR provides the description and rationale for the assessment approach. Identification of assessment endpoints for VCs in the DAR was determined partially from the outcome of the community sessions, including local and traditional knowledge, and the public and regulatory engagement process (Section 4). Assessment endpoints are properties of VCs that are to be protected for future generations of people (i.e., incorporates sustainability) but is typically not measurable. Measurement indicators represent attributes of the environment and VCs that, when changed, could result in, or contribute to, an effect on assessment endpoints. Measurement indicators also provide the primary factors for discussing the uncertainty of effects on VCs, and subsequently, can be key variables for study in follow-up and monitoring programs. The variables of habitat quantity, habitat configuration and connectivity, habitat quality, survival and reproduction, and abundance and distribution used as measurement indicators for caribou in the DAR meet these criteria. The vital rates and behavioural life history traits mentioned by the Review Board (e.g., age at first reproduction, inter-birth interval, age-specific survival rates, habitat selection, seasonal ranges and migratory behaviour) are considered attributes of resilience and adaptive capacity. The magnitude of changes in measurement indicators and inferences about how the attributes of resilience and adaptive capacity may respond to these changes are used to predict effects on the maintenance of a self-sustaining and ecologically effective population. Most attributes of resilience and adaptive capacity have no or little direct link to the measurement of Project-related effects and mitigation effectiveness in monitoring programs. The use of assessment endpoints and measurement indicators in the DAR is consistent with environmental assessments recently completed in the Northwest Territories for the Gahcho Kué (De Beers 2010) and NICO (Fortune 2011) projects, and is appropriate for meeting the TOR.

The sensitivity of effects to caribou during different phases of the population cycle were not explicitly assessed but the DAR acknowledged the relationship between the resilience of caribou and population size and that resilience to cumulative effects is likely greater when the population is increasing and high. A qualitative analysis and assessment was completed as part of the response to Adequacy item 8.1 (DAR-MVEIRB-8). A quantitative analysis and assessment will be completed by February 2, 2015, and will consider the current status and trajectory of the Bathurst caribou herd as requested in Adequacy item 8.6. Implications of changes in vital rates will be explicitly included as part of this analysis.

In addition to being consistent with the engagement processes, the concept of self-sustaining and ecologically effective populations is rooted in conservation biology (Hunter and Gibbs 2007). Self-sustaining populations are healthy, robust populations capable of withstanding environmental change and accommodating random demographic processes (Reed et al. 2003). A self-sustaining population is the goal for the recovery strategy of woodland caribou (EC 2012) and other species at risk targeted for conservation (e.g., AESRD 2012; EC 2014). Protection of ecological effectiveness is aimed at preserving a species role in an ecosystem because interactions with other species are important for maintaining ecosystem function (Soulé et al. 2003; Sabo 2011; Säterberg et al. 2013). Local and Traditional Knowledge also pointed out the importance of caribou interaction with other species in the ecosystem, including Aboriginal people (Section 5 of the DAR). Self-sustaining and ecologically effective populations is still an appropriate management/recovery goal (assessment endpoint) even for species such as woodland caribou where over half of the local populations across Canada are currently not self-sustaining or as likely as not self-sustaining (EC 2012). Thus, the assessment endpoint used in the DAR addresses both protection of caribou populations and their interaction with other species (including people) and is an ecologically appropriate assessment endpoint for barren-ground caribou and other wildlife VCs.

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DOMINION DIAMOND

Information Request Number:	DAR-MVEIRB-12
Source:	MVEIRB Jay Project Adequacy Review Item 8.5
Subject:	Barren-Ground Caribou - Monitoring
DAR Section(s):	12.7 and 17.12

Preamble (MVEIRB):

The TOR requires considerable detail on monitoring programs. But the DAR does not clearly present a monitoring framework for proposed monitoring programs or amendments to existing programs and plans to guide Dominion's evaluation of and adaptive management for impacts to caribou. While there is some mention of methods (satellite collars) there is no mention of monitoring objectives, sampling design or thresholds and changes in monitoring relative to detected effects. Sample size is a limitation for the use of the collars especially at the annual scale to measure the Zone of Influence. The DAR only lists tracking migratory movements using satellite radio-collars and aerial reconnaissance surveys for caribou approaching the roads, and road surveys as monitoring for cumulative effects.

TOR Section 7.5	DAR
What parameters (measurement endpoints) will be monitored for changes and how this is related to detection of a significant adverse impact to a valued component	Measurement endpoints not mentioned: instead assessment endpoint (=self-sustaining and ecologically effective population) and measurement indicators
How monitoring data will be used to determine if action is required such as definition of any methodologies used, critical valued, and threshold conditions;	No details presented
How Dominion's proposed mitigation fits into adaptive management plans, including how project management will be adapted	No details presented but mentions the Ekati Mine WEMP which is consistent with GNWT's wildlife and wildlife habitat monitoring guidelines (GNWT-ENR 2013).
Unexpected deviation from environmental assessment predictions for any substance of concern that may impact the valued component	No details presented
A summary table listing all biophysical environmental monitoring and management systems, where they are described in the *Developer's Assessment Report*, the length of time the monitoring is proposed for, and rationale for each timeline	Missing for caribou
A framework for new plans, or for amendments to existing wildlife related plans	Missing for caribou

Request (MVEIRB):

Please provide a detailed monitoring framework with objectives, sampling design and how results will lead to adaptive management to mitigate incremental and cumulative effects and detect unpredicted effects.

Response:

The existing Wildlife Effects Monitoring Program (WEMP) (ERM Rescan 2014) for the Ekati Diamond Mine (Ekati Mine) site will be amended to include monitoring of the Jay Project. The Jay Project includes the same types of infrastructure that are currently monitored at the Ekati Mine (e.g., all-season mine roads, open pits, processing plant, Misery Road) through the existing WEMP. The Ekati Mine WEMP programs will be amended to include sites located at the Jay Project. The existing WEMP outlines details of how caribou and other wildlife are monitored at the Ekati Mine including monitoring objectives, designs and how results will support adaptive management of mine operations

Monitoring data (measurement indicators) that are collected for caribou at the Ekati Mine include the following:

- loss of caribou (and other wildlife) habitat;
- interaction of caribou (and other wildlife) with the mine site;
- mine-related caribou (and other wildlife) mortalities;
- changes to caribou behaviour and distribution; and,
- caribou behaviour in relation to roads.

This information will also be collected for the Jay Project in a manner that is consistent with current WEMP study designs. For example, camera monitoring of caribou behaviour near mine roads will be expanded to record observations of caribou along the Jay Project access road. The specific monitoring that is presented in the DAR in regards to monitoring satellite collar data, aerial reconnaissance surveys near the roads, and road surveys will provide advanced information on approaching caribou so Dominion Diamond staff can plan to refine or implement new mitigation (adaptive management) along the Misery and Jay roads (e.g., modifying or suspending traffic) as necessary.

In addition to mine-related effects monitoring programs, Dominion Diamond has participated or contributed to regional wildlife monitoring initiatives intended for conservation and management including the GNWT’s Barren-ground Caribou Management Strategy (GNWT-ENR 2011) and the Bathurst Range Plan Working Group. One initiative that is supported in part by Dominion Diamond is the Bathurst caribou aerial surveys used to determine herd composition, cow:calf ratios, and population estimates. Dominion Diamond also actively participates as a member of the Caribou Zone of Influence Technical Task Group administered by the GNWT (GNWT-ENR 2014). These programs provide data to support cumulative effects assessment and management by the GNWT.

The existing Environmental Management Framework (EMF) for the Ekati Mine, including the description of all management plans and adaptive management is provided in Section 1.2.3.1 of the DAR. Examples of adaptive management that has taken place at the Ekati Mine, including for caribou, are provided in the

DAR (Section 1.2.3.2.12; Table 1.2-1). There are a total of 25 different management plans and 10 monitoring programs that comprise the EMF. Other existing management plans that are related to caribou and other wildlife include:

- Air Quality Management and Monitoring Plan;
- Interim Closure and Reclamation Plan;
- Waste Rock and Ore Storage Management Plan;
- Waste Management Plan; and,
- Wastewater and Processed Kimberlite Management Plan.

Adaptive management is a structured process of decision making to deal with uncertainty. The objective of adaptive management is to reduce uncertainty through monitoring, or 'learning by doing' (WLWB 2010). In the case of wildlife monitoring, the 'doing' is the environmental monitoring, and the 'learning' is continual improvements to environmental management and the monitoring programs. This requires the monitoring program to be adaptive and flexible. The monitoring program must be flexible enough to incorporate comments, suggestions, and information based both on science and local and Traditional Knowledge. There are no regulator established guidelines for wildlife critical values, threshold conditions, or action levels. If changes to the receiving environment are determined to be greater than the predictions in the DAR, then the most suitable course of action will be determined by Dominion Diamond, in discussion with communities and regulatory agencies. This type of process has been used successfully in the past (e.g., Marshall 2009; Handley 2010).

Monitoring programs in the WEMP have and will continue to be adaptively managed. Changes to the WEMP will occur as monitoring results are analyzed and assessed over time. If negative effects are detected, the actions available to Dominion Diamond include the following:

- increase monitoring effort;
- implement special studies to further understand the effects; or,
- implement additional mitigation to reduce the effects.

Dominion Diamond has and will continue to actively seek input from regulatory authorities and communities through annual reports. These reports will be an opportunity for Dominion Diamond to present the findings of the monitoring program, and for communities and regulatory agencies to provide feedback and direction. Input will also be solicited during other engagement activities such as meetings and site visits.

References:

ERM Rescan. 2014. Ekati Diamond Mine: 2013 Wildlife Effects Monitoring Program. Prepared for Dominion Diamond Ekati Corporation by ERM Rescan. Yellowknife, NWT, Canada.

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DOMINION DIAMOND

Information Request Number:	DAR-MVEIRB-14
Source:	MVEIRB Jay Project Adequacy Review Item 8.7
Subject:	Barren-Ground Caribou - Effects of 2014 Fires on Caribou Winter Range
DAR Section(s):	12.4.2.1

Preamble (MVEIRB):

Describing the quantity of existing caribou habitat, this section recognizes that caribou may avoid recent burns, but does not include burn areas from 2014 (par.3, p12-76). Similarly, the winter range resource selection function values on p.12-86 were only updated to 2013, and excluded the burns of 2014. On p.12-132, the DAR notes that severe fires on winter range may decrease forage availability and lead to declines in caribou recruitment.

The very large scale of the fires of 2014 is well beyond what is shown in table 12.4-8, and may be relevant to the DAR's evaluation of the winter range land cover layer. This may matter to the quality and abundance of winter habitat, the Bathurst herd's condition, energy budget and fecundity, and the vulnerability of the herd.

Request (MVEIRB):

Please revise your description of caribou habitat to include the results of the fires of 2014, and incorporate into the DAR any changes this makes to your description of baseline conditions and related potential effects (including energetics) of the Project to the Bathurst caribou herd.

Response:

At the time that the habitat modelling was completed (i.e., through spring/summer 2014), spatial data on the extent of the 2014 fires in the Northwest Territories were not available and could not be included explicitly as part of the cumulative effects assessment on caribou habitat. However, the effects of fire on caribou habitat and caribou populations was discussed in context of prediction confidence and uncertainty in Section 12.5 and in the determination of significance in Section 12.6.2.

Data on 2014 fires in the Northwest Territories became available in December and have been acquired from U.S. Department of Agriculture, Forest Service (USDAFS), Remote Sensing Applications Center. These data represent fire detections and are provided as the centroids derived from Moderate Resolution Imaging Spectroradiometer (MODIS) satellites with a resolution of 1,000 metres (m). Prior to analysis, locations of fire detections were buffered by 2 kilometres (km) and overlapping buffers were merged and dissolved. Dissolved areas were then buffered in to 757 m (removing 1,243 m from the outer boundary). This is the same processing approach used by the governments of the Northwest Territories and Yukon to develop burn maps from MODIS data. The resulting map was consistent with 2014 fire detections mapped by the USDAFS. To determine cumulative changes to the abundance of different quality caribou habitats, the 2014 fire data were applied to caribou seasonal ranges in conjunction with cumulative development disturbance from the Project and previous, existing, and reasonably foreseeable developments (i.e., RFD Case). As described in the DAR Section 12.4.2.2.1, seasonal caribou habitat values were based on resource selection functions described by Johnson et al. (2004, 2005) for non-winter seasonal ranges and those developed for the winter range for the NICO Project (Fortune 2011). It was assumed that areas affected by 2014 fires would be reduced to poor quality habitat.

Similar to the methods used in the DAR, the cumulative changes and incremental changes from 2014 fire results on caribou habitat were estimated by calculating the relative difference or net change in that map unit between the RFD Case with 2014 fire results and the reference condition as follows:

- 100 × (RFD Case with 2014 fire area – reference condition area) / reference condition area.

In addition to cumulative changes, the incremental changes to seasonal quality habitats associated with the application of the 2014 fire data are shown relative to the RFD Case without 2014 fire data.

The extent of fires during 2014 indicate that 1,932,465 hectares (ha) (6.3%) of the annual range of the Bathurst herd was burned. Preliminary review of the distribution of 2014 fire data indicated that the spring, autumn, and winter seasonal ranges were influenced (Map 14-1). The incremental reduction of preferred (high and good) habitats on the spring range from 2014 fires is predicted to be 0.2% (Table 14-1). Inclusion of the 2014 fire data to the RFD Case predicted that the cumulative reduction to preferred caribou spring habitats will be 1.9%. The incremental reduction of preferred habitats on the autumn range from 2014 fires is predicted to be 0.1% (Table 14-2). Cumulative reduction to preferred autumn habitats from the RFD Case and 2014 burns is predicted to be 12.5%. The incremental reduction of preferred habitats on the winter range from 2014 fires is predicted to be 11.5% (Table 14-3). Cumulative reduction to preferred winter habitats from the RFD Case and 2014 fires is predicted to be 17.4%.

Table 14-1 Relative Changes in Amount of Different Quality Habitats on the Spring Range of the Bathurst Caribou Herd from Reference Conditions to Reasonably Foreseeable Development Case, Including 2014 Fires

Habitat Quality	Reference Condition (ha)	Without 2014 Fires[a]		With 2014 Fires		Change (%) from 2014 Fires
		RFD Case (ha)	Change (%) from Reference to RFD Case	RFD Case (ha)	Change (%) from Reference to RFD Case	
High	7,463,463	6,634,088	-11.1	6,621,244	-11.3	-0.2
Good	420,038	1,112,794	164.9	1,112,488	164.9	0.0
Low	3,060,619	2,881,981	-5.8	2,780,225	-9.2	-3.4
Poor	3,554,138	3,869,394	8.9	3,984,300	12.1	3.2
Nil (Water)	5,508,038	0.0	0.0	0.0	0.0	0.0
Total	20,006,294	NA	NA	NA	NA	NA
Preferred[b]	**7,883,500**	**7,746,881**	**-1.7**	**7,733,731**	**-1.9**	**-0.2**

a) Values reported in the DAR Sable Addendum.
b) Preferred habitat = High quality + Good quality.
NA = not applicable; RFD = reasonably foreseeable development; ha = hectare; % = percent.

Table 14-2 Relative Changes in Amount of Different Quality Habitats on the Autumn Range of the Bathurst Caribou Herd from Reference Conditions to Reasonably Foreseeable Development Case, Including 2014 Fires

Habitat Quality	Reference Condition (ha)	Without 2014 Fires[a]		With 2014 Fires		Change (%) from 2014 Fires
		RFD Case (ha)	Change (%) from Reference to RFD Case	RFD Case (ha)	Change (%) from Reference to RFD Case	
High	6,771,713	5,932,894	-12.4	5,922,250	-12.5	-0.1
Good	0.0	0.0	0.0	0.0	0.0	0.0
Low	1,485,850	2,078,394	39.9	1,864,869	25.5	-14.4
Poor	2,214,506	2,460,781	11.1	2,684,950	21.2	10.1
Nil (Water)	3,433,356	0.0	0.0	0.0	0.0	0
Total	13,905,425	NA	NA	NA	NA	NA
Preferred[b]	**6,771,713**	**5,932,894**	**-12.4**	**5,922,250**	**-12.5**	**-0.1**

a) Values reported in the DAR Sable Addendum.

b) Preferred habitat = High quality + Good quality.

NA = not applicable; RFD = reasonably foreseeable development; ha = hectare; % = percent.

Table 14-3 Relative Changes in Amount of Different Quality Habitats on the Winter Range of the Bathurst Caribou Herd from Reference Conditions to Reasonably Foreseeable Development Case, Including 2014 Fires

Habitat Quality	Reference Condition (ha)	Without 2014 Fires[a]		With 2014 Fires		Change (%) from 2014 Fires
		RFD Case (ha)	Change (%) from Reference to RFD Case	RFD Case (ha)	Change (%) from Reference to RFD Case	
High	3,998,276	3,756,718	-6	3,435,243	-14.1	-8.1
Good	3,932,512	3,704,519	-5.8	3,114,612	-20.8	-15.0
Low	3,968,879	4,059,156	2.3	3,404,858	-14.2	-16.5
Poor	4,058,469	4,437,743	9.3	6,003,423	47.9	38.6
Nil (Water)	0.0	0.0	0.0	0.0	0.0	0.0
Total	15,958,136	NA	NA	NA	NA	NA
Preferred[b]	**7,930,788**	**7,461,237**	**-5.9**	**6,549,855**	**-17.4**	**-11.5**

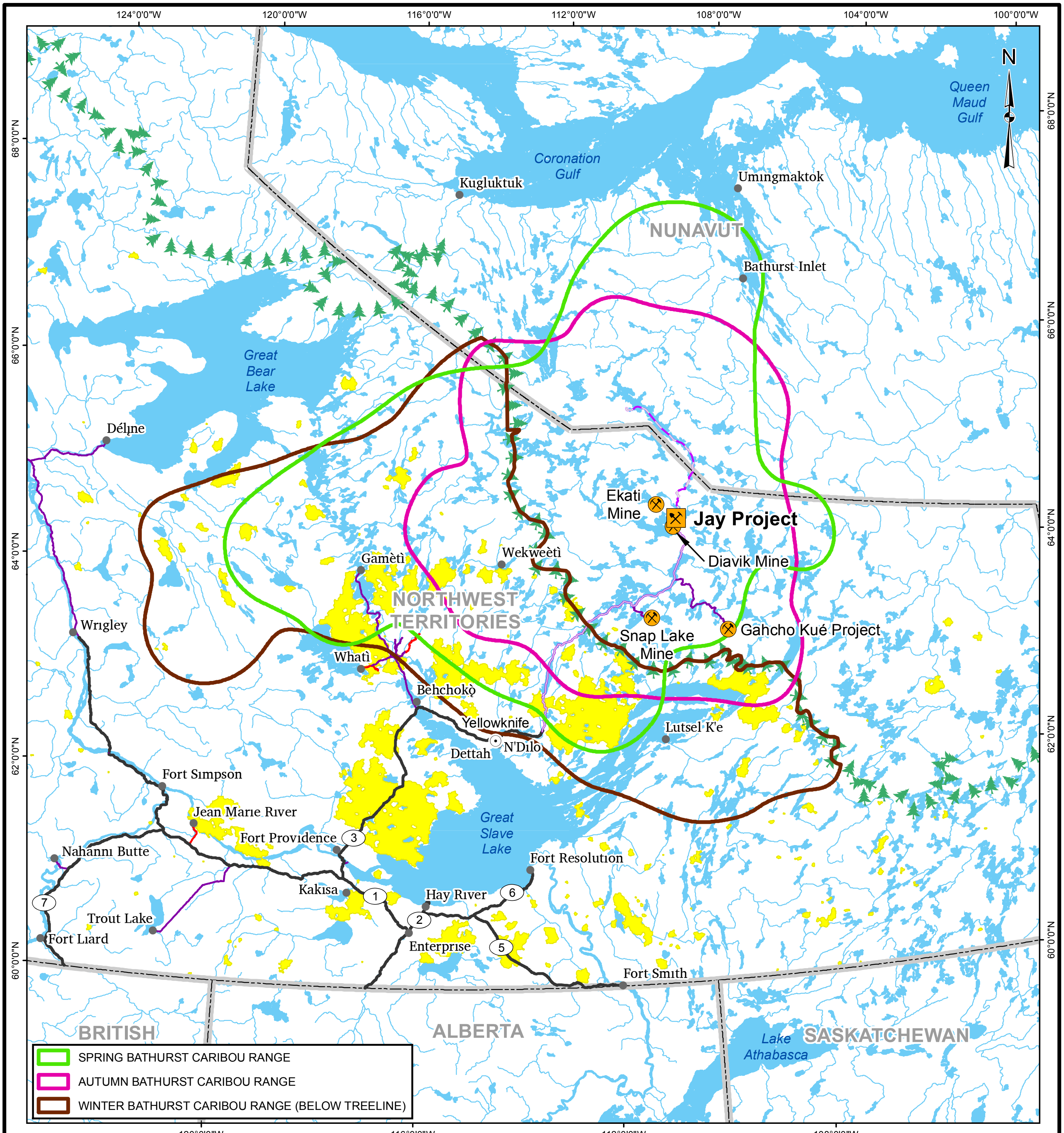
a) Values reported in the DAR.

b) Preferred habitat = High quality + Good quality.

NA = not applicable; RFD = reasonably foreseeable development; ha = hectare; % = percent.

As discussed in Section 12.6.2 of the DAR, the winter range of the Bathurst caribou herd is more likely than other seasonal ranges to be directly affected by large fires. Fires reduce the abundance of lichens, especially late-succession fruticose lichens that are the primary forage for caribou (Joly et al. 2007, 2009). The removal of lichens can last for decades (Holt et al. 2008; Jandt et al. 2008), and is thought to be the main reason why caribou avoid burned areas for long periods of time (up to 55 years) (WKSS 2001a; Joly et al. 2007). The number, frequency, size, and severity of fires is unpredictable and is likely to increase with climate change (Barrier and Johnson 2012; Gustine et al. 2014). As such, changes to the amount and quality of habitat in the winter range of the Bathurst caribou herd are difficult to predict. Adding to the unpredictability of effects is the knowledge that caribou have behavioural plasticity to shift seasonal ranges to adapt to changes in range conditions (Messier et al. 1988; Ferguson and Messier 2000; WKSS 2001a,b; Tyler 2010; Gustine et al. 2014). This may explain partially the annual variation in the location and extent of winter ranges and the inclusion of barren-ground wintering areas observed in satellite-collared Bathurst cows since 1996 (see response to IR-MVEIRB-9).

Forest fires occur annually and are part of the natural environment in which forest wintering barren-ground caribou have evolved. Although long-term data on forest fires in the Northwest Territories began to be collected in the 1960s, the ability of caribou to recover from historical population lows described by Traditional Knowledge (Zalatan et al. 2006; Adamcewski et al. 2009) and observed by population monitoring during the late 1970s (Section 12.2.2.3) provides support that caribou populations are likely resilient to the effects from forest fires. The limiting effect of forest fire on population demography (e.g., energetics, survival, and fecundity) is likely stronger and more prevalent when caribou numbers are high and near the carrying capacity of preferred wintering habitats. The amount of direct habitat loss from human development on the winter range is small (<1%) and the Jay Project does not influence the winter range. The residual impact classification of cumulative changes to habitat quality (which includes quantity) from human development and fire on the abundance and distribution of the Bathurst herd is predicted to remain moderate, and is not expected to change the determination of significance provided in the DAR. The predicted response of caribou to cumulative effects on the winter range, including the 2014 forest fires, are conservative and unlikely to have reduced the carrying capacity to the point where the current population is forced to use low quality habitats because higher quality habitats are unavailable or saturated.



LEGEND

- JAY PROJECT
- EXISTING MINE OR PROJECT
- TERRITORIAL CAPITAL
- POPULATED PLACE
- HIGHWAY
- ALL-SEASON ROAD
- WINTER ROAD
- TIBBITT TO CONTWOYTO WINTER ROAD
- NORTHERN PORTION OF TIBBITT TO CONTWOYTO WINTER ROAD
- TERRITORIAL/PROVINCIAL BOUNDARY
- TREELINE
- WATERCOURSE
- WATERBODY
- MODIS FIRE DETECTION IN NWT, 2014

150 0 150

SCALE 1:6,000,000 KILOMETRES

REFERENCE

FIRE DATA DERIVED FROM MODIS POINT DATA, USDA FOREST SERVICE, REMOTE SENSING APPLICATIONS CENTRE, 2014
WATER OBTAINED FROM ATLAS OF CANADA
NATURAL RESOURCES CANADA, CENTRE FOR TOPOGRAPHIC INFORMATION, 2012
PROJECTION: CANADA LAMBERT CONFORMAL CONIC

DOCUMENT

POST-DAR CARIBOU IR

PROJECT

DOMINION DIAMOND

JAY PROJECT
NORTHWEST TERRITORIES, CANADA

TITLE

LOCATION OF THE NWT MODIS FIRE DETECTION, 2014

Golder Associates

PROJECT		13-1328-0041	FILE No. POSTDAR_IR_Wild_004_GIS	
DESIGN	DC	31/12/14	SCALE AS SHOWN	REV. 0
GIS	ANK	15/01/15		
CHECK	DC	15/01/15	MAP 14-1	
REVIEW	JV	15/01/15		

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DOMINION DIAMOND

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DOMINION DIAMOND

Information Request Number:	DAR-MVEIRB-16
Source:	MVEIRB Jay Project Adequacy Review Item 8.9
Subject:	Barren-Ground Caribou
DAR Section(s):	12.4.1.2

Preamble (MVEIRB):

Section 12.4.1.2 of the DAR states that the base case used for the assessment includes cumulative effects from previous and existing developments. Using this as a frame of reference risks minimizing the Project's contribution to cumulative effects because the total cumulative effects (with the project) are not compared to the baseline situation (pre-Ekati). For reviewers to understand the combined effect of the Project and all other human activities on factors such as rates of migratory caribou encountering development, exposure to sensory disturbance and caribou energetics, the baseline (pre-Ekati) needs to be separated from the background (existing situation). Further discussion of this issue in an aquatic context is provided for item 9.1 below.

Request (MVEIRB):

Please provide an assessment of the cumulative effects of the Project by comparing the pre-Ekati caribou baseline with:

a) The existing conditions resulting from the Ekati and Diavik operations,
b) The predicted effects of the Project
c) The effects of reasonably foreseeable future developments.

Response:

To meet the Terms of Reference for the Project (MVEIRB 2014), the assessment included a reference condition (i.e., pre-development) in the Base Case, which is first described in Section 6.5.2.2 of the DAR. The Base Case also includes effects due to all previous and existing developments prior the Project (i.e., 2014 baseline condition). Thus, the Base Case is used to complete an analysis of cumulative effects from the reference condition to the 2014 baseline condition. The analysis is quantitative where possible and qualitative where necessary. An analysis is then completed by adding the Project to the 2014 baseline condition, termed the Application Case, and then by adding reasonably foreseeable developments to the Application Case (i.e., Reasonably Foreseeable Development Case).

For caribou, details of the assessment approach are provided in Section 12.4.1 (Table 12.4-1). For example, Table 12.4-16 (Section 12.4.2.2.2 of the DAR) shows the changes in habitat quality (direct and sensory disturbance effects) on the Bathurst caribou spring range from reference conditions (no projects) to the 2014 baseline conditions (previous and existing developments, such as Ekati and Diavik operations, without the Jay Project), incremental changes from the Jay Project (2014 baseline conditions to Application Case), and cumulative changes from the Jay Project and previous and existing developments (i.e., reference conditions to Application Case). Table 12.4-20 shows cumulative changes from reference conditions due to all previous, existing and future developments (Reasonably Foreseeable Development Case). Maps 12A-1 through 12A-4 (Appendix 12A) illustrate habitat quality conditions on the spring range at reference conditions, 2014 baseline conditions, Application Case conditions, and Reasonably Foreseeable Development Case conditions. This assessment approach was also applied to the analyses of habitat loss and fragmentation (Section 12.4.2.1.2; Table 12.4-8), and encounter rates and energetics (Section 12.4.2.3.2; Table 12.4-27).

References:

MVEIRB (Mackenzie Valley Environmental Impact Review Board). 2014. Revised Terms of Reference (EA1314-01) Jay Project, Dominion Diamond Ekati Corporation. July 17, 2014. Yellowknife, NWT, Canada.

Information Request Number:	DAR-MVEIRB-17
Source:	MVEIRB Jay Project Adequacy Review Item 9.1
Subject:	Water and Aquatic Life - Inadequate Cumulative Effects Baseline
DAR Section(s):	Volume 6, Section 6.5-2

Preamble (MVEIRB):

Section 7.2 of the ToR states:

"Pursuant to paragraph 117(2) (a) of the MVRMA, the Review Board considers cumulative effects in its determination. Cumulative effects are the combined effects of the development in combination with other past, present, or reasonably foreseeable future developments and human activities. The Jay Project site would sit in an area that has been impacted by past development. In addressing cumulative effects, the developer is encouraged to refer to the Review Board's Environmental Impact Assessment Guidelines."

Section 5 of the ToR states:

"The data presentation will consider baseline/background conditions, the natural variability of background conditions, and to the extent possible differentiate between natural background conditions, current environmental conditions, and effects from past development activities, such as exploration, the existing Ekati mine operation, or the existing Diavik mine operation."

Section 4.1 of the ToR states:

"compare the predicted impacts to pre-development conditions or to conditions without the Project as appropriate"

Volume 6, Section 6.5-2 p. 6-20 of the DAR states that "Base Case conditions include the cumulative effects from all previous and existing developments and activities that are approved to take place within the effects study area of a VC. For example, environmental and social effects from the construction and operation of Ekati, Diavik, and Snap Lake mines and the Tibbitt to Contwoyto Winter Road (TCWR) are considered to be part of the existing conditions in the Base Case, if applicable to the VC effects study area. Approved but not yet completed developments, such as the Lynx (Dominion Diamond 2013), Gahcho Kué (De Beers 2010), NICO (Fortune 2011), and Nechalacho (Avalon 2014) projects are also identified for inclusion in the Base Case."

Volume 6, Section 6.5-2 p. 6-19 of the DAR references the ToR and states that

"Environmental conditions on the landscape prior to human development (e.g., mining, mineral exploration, outfitting, and transportation), which represent reference conditions, were considered independently within the Base Case, where possible (Appendix 1A, Section 4.1).

The decision to "…include the cumulative effects from all previous and existing developments." in the base case for the cumulative effects assessment does not represent the true baseline for the project as it does not “differentiate between natural background conditions, current environmental conditions, and effects from past development activities, such as exploration, the existing Ekati mine operation, or the existing Diavik mine operation”, does not “compare the predicted impacts to pre-development conditions”,

and does not provide a rationale for comparison to “conditions without the Project as appropriate.”

The proposed cumulative effects assessment therefore starts with any existing effects from the Ekati and Diavik mines and uses this as the baseline upon which any effects of the Jay project will be assessed. This represents a “creeping baseline” as the assessment is based on current conditions with no explicit consideration of the changes that have already occurred over the past 15 years of mining. In this case, there are adequate predevelopment data that can be obtained from the original Ekati EA and the Diavik EA that would describe the environment prior to any significant industrial activity and would provide a better description of the baseline for cumulative effects assessment.

As it is, the absence of a true baseline does not permit a cumulative effects assessment. This is particularly important regarding potential impacts to caribou and to cumulative discharges to Lac de Gras from a) Jay project on Lac de Sauvage, b) Diavik project and c) an additional ten years of discharge via the Slipper Lake drainage from the main Ekati site that will be facilitated via the Jay project.

Request (MVEIRB):

Please provide an assessment of the cumulative effects of the Project by comparing the pre-Ekati water quality baseline with:

a) The existing conditions resulting from the Ekati and Diavik operations,
b) The predicted effects of the Project
c) The effects of reasonably foreseeable future developments.

Response:

To meet the Terms of Reference for the Project (MVEIRB 2014), a cumulative effects assessment was completed for water quality in Section 8 of the DAR. The approach for cumulative effects and the assessment cases are first described in Section 6.5.2 of the DAR. The purpose of this response is to provide clarity on the assessment cases used in the DAR, to direct the readers to where the information can be found in the DAR, to further clarify the cumulative effects analysis to the Reference Condition, and to provide updates to the summary prediction tables and time series figures for Lac de Gras.

The assessment cases used in the DAR to describe the Jay Project and cumulative effects analysis for the water quality assessment (Section 8.5.1.2) as follows:

- Base Case
  - Reference Condition (pre-2000): no mine discharge – this is the environmental condition prior to any discharge from the Long Lake Containment Facility and change to water quality within Lac de Gras.
  - 2014 Baseline Condition (2010 to 2014): conditions from all previous and existing developments before the Project – this is the environmental condition with the existing Ekati and Diavik mines.

- Application Case (2015 to 2060): Base Case plus the Project – this is the environmental condition with existing developments (i.e., Ekati and Diavik mines), plus the Jay Project.
- Reasonably Foreseeable Development (RFD) Case: Application Case plus reasonably foreseeable developments – this is the altered environmental condition due to existing developments, the Project, plus other future projects and activities (i.e., the Sable Pit development).

Cumulative effects of the Project were considered in the Application and Reasonably Foreseeable Development cases, and considered relative to the Reference Condition and 2014 Baseline Condition.

The Ekati Mine Sable Project is the only reasonably foreseeable development that would affect the assessment of water quality for the Jay Project. The assessment of the Sable Project in the RFD Case is included in Section 4.1.3 of the Sable Addendum to the DAR (Dominion Diamond 2014). The incremental and cumulative effects from the Project and previous, existing, and future developments, with the inclusion of the Sable Project to the RFD Case, are expected to remain the same, that is, not result in a significant adverse effect on water quality.

Water quality conditions in Lac du Sauvage, Lac de Gras, and other waterbodies in the study area under the Base Case (both Reference Condition and 2014 Baseline Condition) were presented in the DAR (Section 8.2.5.2), and in more detail in the baseline water quality and sediment quality report (Annex XI, Appendix A, Sections A3.1 and A3.2).

For Lac du Sauvage, there is only one Base Case condition, as the Reference Condition is the same as the 2014 Baseline Condition; there are no measurable changes as a result of development (i.e., cumulative) effects to Lac du Sauvage between the Reference Condition and the 2014 Baseline Condition. This conclusion was based on the findings of the annual Aquatic Effects Monitoring Program (AEMP) conducted in Lac du Sauvage for the Ekati Mine (Rescan 2012a; ERM Rescan 2013), which stated that there has been no discernible change in water or sediment quality in Lac du Sauvage over time as a result of mining activities. Therefore, for Lac du Sauvage, data collected between 2006 and 2013 were used to describe the Reference Condition.

For Lac de Gras, there is a discernible Reference Condition and 2014 Baseline Condition for water quality under the Base Case. Based on the annual AEMP studies conducted in Lac de Gras for the Ekati Mine (ERM Rescan 2014) and the Diavik Mine (DDMI 2014a), there is evidence of change in water quality in Lac de Gras from the Reference Condition as a result of mining activities. For Lac de Gras, water quality data collected prior to 2000 (DDMI 2001) were used to describe the Reference Condition (i.e., pre-Ekati discharge and pre-Diavik Mine), while data collected from 2010 to 2012 (DDMI 2011, 2012, 2013; ERM Rescan 2013; Rescan 2011, 2012a) were used to describe the 2014 Baseline Condition. Although data are available prior to 2010, the most recent data were used to reduce the variability in analytical detection limits in the dataset that changed over time. Even with this approach, detection limits still varied and for some metal constituents, most reported data were less than the detection limit. A high number of non-detectable values can influence the interpretation of results.

Modelled changes to water quality due to the Project were presented for Lac du Sauvage and Lac de Gras (Section 8.5.4.1.2). Graphical representations of the modelling predictions for each water quality constituent were segregated into snapshots or temporal boundaries that were aligned to the assessment cases (Table 17-1).

Table 17-1 Assessment Cases, Snapshot Periods, and Temporal Boundaries in the Water Quality Assessment

Assessment Case	Snapshot	Temporal Boundary
Base Case	Existing Conditions	2010 to 2015
Application Case	Construction Phase	2016 to 2019
	Early Operations Phase	2019 to 2024
	Late Operations Phase	2024 to 2029
	Closure Phase	2030 to 2033
	Post-closure Period	2034 to 2060

Water quality predictions under the Base Case included the existing Ekati and Diavik mines and their influence on water quality in Lac de Gras (there has been no influence in Lac du Sauvage as described above). Predictions for the Application Case included the existing Ekati and Diavik mines and the Jay Project, and their combined effects on water quality. Therefore, results for the Application Case include cumulative effects of existing developments and the Project.

Maximum modelled concentrations for each water quality constituent in Lac du Sauvage and Lac de Gras, for each snapshot, were compared to screening values (i.e., guidelines, objectives, and existing measured data representing the Base Case) (Table 8.5-13). For Lac du Sauvage, comparisons to existing data also represented a comparison to Reference Conditions. For Lac de Gras, comparisons to existing data included screening against available data representing the Reference Condition (Table 8.2-50) and the 2014 Baseline Condition (Table 8.5-13). Data for the Reference Condition in Lac de Gras were limited in terms of number of constituents and detection limits, so it was not possible to compare all predicted water quality constituents to the Reference Condition. The water quality prediction results show Project related changes from the Reference Condition in Lac du Sauvage (Section 8.5.4.2, pages 8-351 to 8-362, Table 8.5-24 and Figures 8.5-81 to 8.5-89, in the DAR) and cumulative changes from the 2014 Baseline Condition in Lac de Gras (Section 8.5.4.2, pages 8-363 to 8-378, Table 8.5-24 and Figures 8.5-90 to 8.5-98, in the DAR). Within the text, cumulative changes from the Reference Condition in Lac de Gras are described.

Since the submission of the DAR, the water quality modelling for Lac de Gras has been updated to incorporate updated or corrected source terms (Golder 2015). The results of the updated water quality predictions are presented in Tables 17-2 to 17-7 provided at the end of this response. These results provide modelled depth-averaged maximum constituent concentrations for each assessment node (six in Lac de Gras), for each of the Project phases (early operations to post-closure), and for the under-ice and open-water conditions within each phase. This is consistent with the approach used in the DAR. The updated modelling does not change the conclusions of the DAR with respect to the water quality assessment of the Project for Lac de Gras.

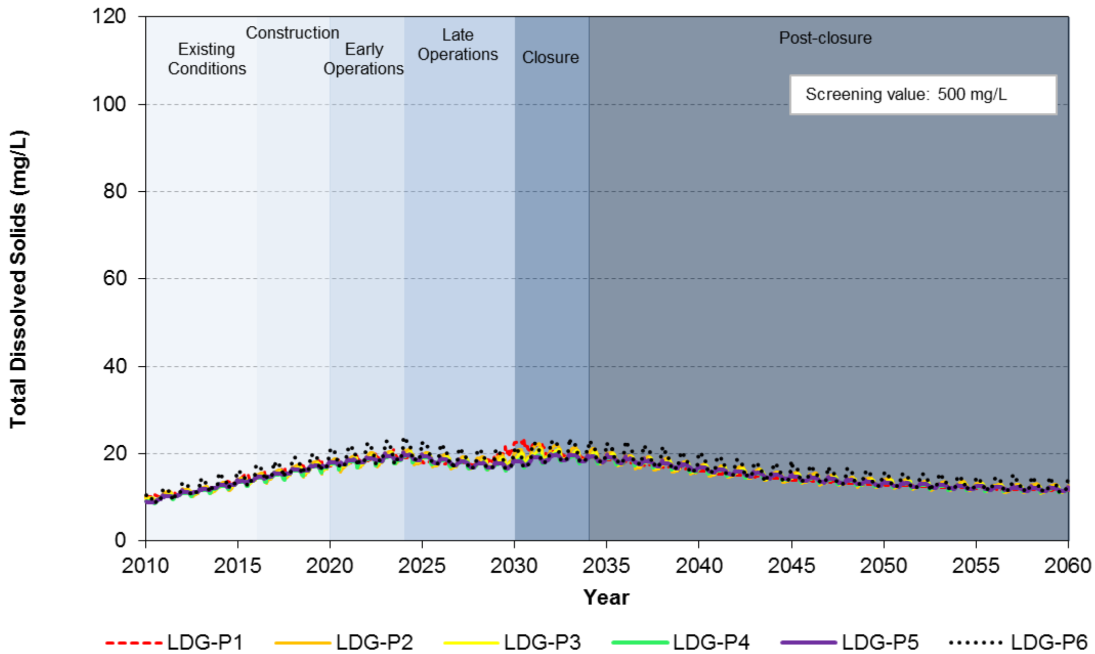
As a result of the updated water quality modelling for Lac de Gras, additional assessment text is provided below for those constituents that have Reference Condition data for comparison. The response below is organized by the same sub-headings used in the DAR, to provide clarity on the analysis of cumulative effects, particularly with respect to comparison to the Reference Condition in Lac de Gras, and interpretation of results.

Conventional Constituents and Major Ions

Consistent with the DAR findings, all concentrations of conventional constituents and major ions in Lac de Gras, at all assessment nodes, and through the Application Case, are predicted to be less than applicable water quality guidelines and site-specific water quality objective screening values (guideline and objective screening values) (Tables 17-2 to 17-7). Where constituent concentrations are predicted to be higher than measured 2014 Baseline Condition data, a superscript of "O" (open-water) or "U" (under-ice) is provided (Tables 17-2 to 17-7). The highest predicted TSS concentration under the Application Case is 2.0 milligrams per litre (mg/L; LDG-P6, pre-operations, under-ice) and the 75th percentile from the Reference Condition is 3 mg/L. Therefore, TSS concentrations under the Application Case are expected to remain similar to the Reference Condition.

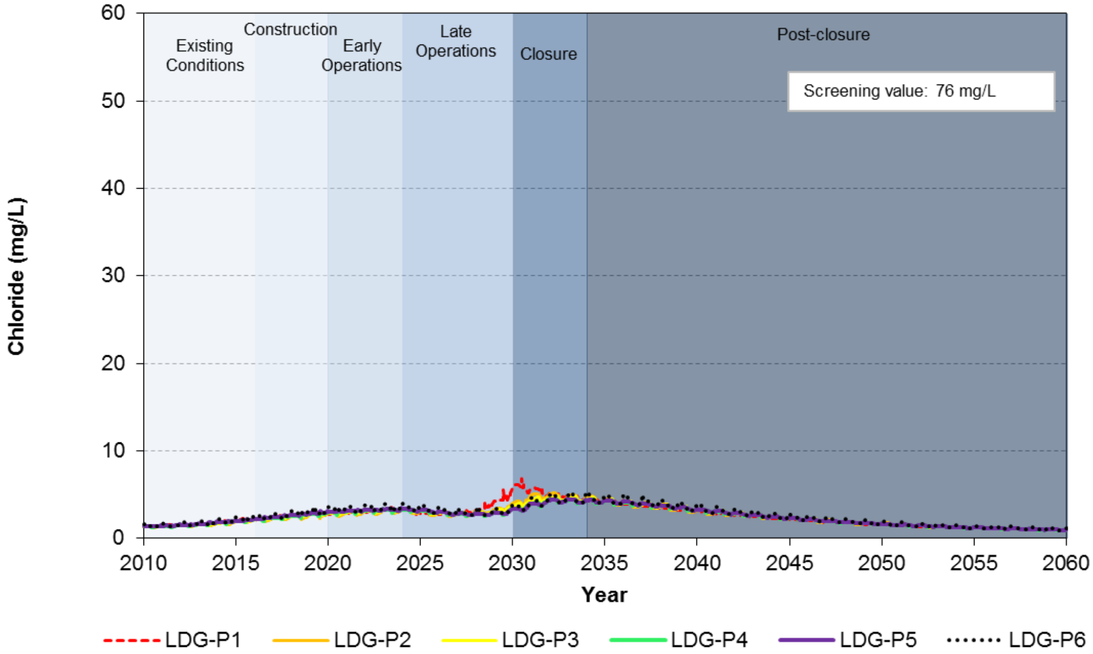
The general spatial and temporal trends for each modelled conventional water quality constituent, including major ions, in the updated predictions are similar to those presented in the DAR. Figures for total dissolved solids (TDS) (Figure 17-1) and chloride (Figure 17-2) in Lac de Gras, developed from the revised predictions, are provided to illustrate the spatial and temporal trends of conventional constituents and major ions in Lac de Gras under existing conditions (2014 Baseline Conditions) and the Application Case. Figures for these same constituents were included in the DAR.

Figure 17-1 Predicted Total Dissolved Solids Concentrations in Lac de Gras



mg/L = milligrams per litre.
Screening value from Health Canada (2012).

Figure 17-2 Predicted Chloride Concentrations in Lac de Gras



mg/L = milligrams per litre.

Screening value from Site-Specific Water Quality Objective equation (Elphick et al. 2011) and assumed maximum hardness of 11 mg/L.

Nutrients and Dissolved Oxygen

Consistent with the DAR findings, all updated modelled nutrients concentrations in Lac de Gras, at all assessment nodes, are predicted to be less than applicable guideline and objective screening values; concentrations of dissolved oxygen are predicted to remain higher than the lower CCME (1999) dissolved oxygen guideline (Tables 17-2 to 17-7). Where concentrations are predicted to be higher than measured 2014 Baseline Condition (existing) data, a superscript of “O” (open-water) or “U” (under-ice) is provided.

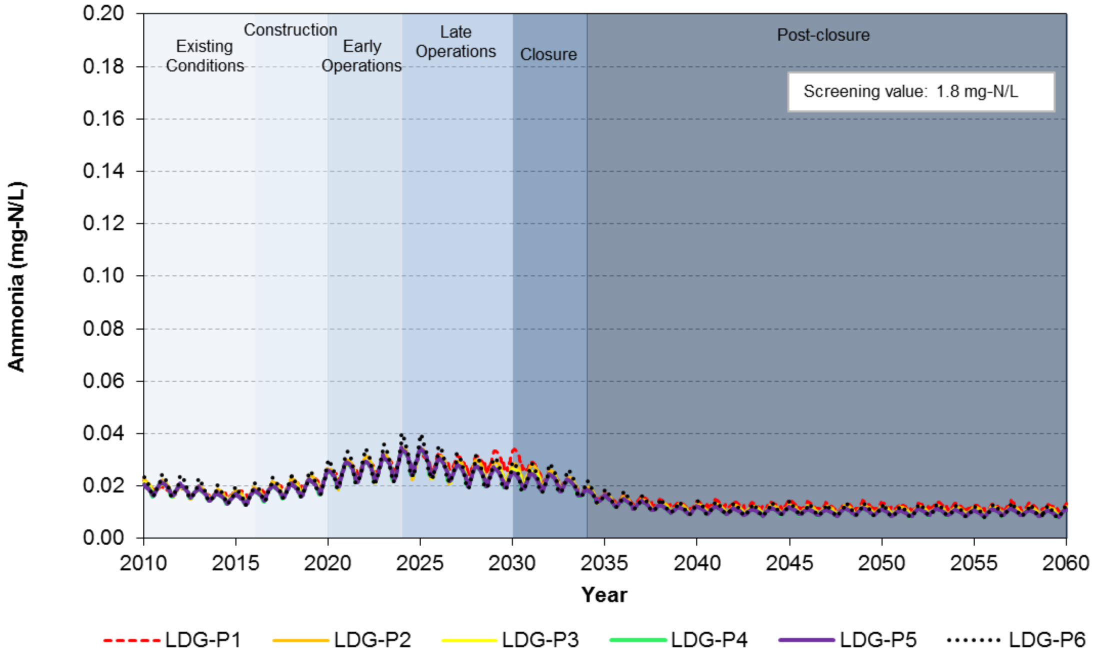
Reference condition ammonia data ranged from 0.005 to 0.010 milligrams of nitrogen per litre (mg-N/L) (25^{th} and 75^{th} percentiles, respectively). Median and maximum predicted ammonia concentrations under the Application Case during Project construction through closure range from 0.0094 to 0.031 mg-N/L and 0.015 to 0.035 mg-N/L, respectively, across all assessment nodes, and are higher than the Reference Condition. In the post-closure period, median and maximum predicted ammonia concentrations range from 0.0094 to 0.012 mg-N/L and 0.011 to 0.019 mg-N/L, respectively, showing an overall improvement in ammonia concentrations over time, but concentrations within the modelled timeframe are still predicted to be higher than the Reference Condition. Conservative assumptions were used in the model for the nitrogen source terms (e.g., blasting residual input assumptions associated with the Project), so it is expected that the modelled results are overestimated compared to reasonable expectations.

Maximum modelled TP concentrations in Lac de Gras under the Application Case range from 0.0028 to 0.0036 milligrams of phosphorus per litre (mg-P/L), which is less than the 75^{th} percentile (0.0042 mg-P/L)

Reference Condition concentration but higher than the median (0.003 mg-P/L) Reference Condition concentration. Total phosphorus concentrations during the Application Case are expected to remain within the measured range of the Reference Condition concentrations across all assessment nodes during all Project phases in the Application Case.

The general spatial and temporal trends for each modelled nutrient constituent in the updated assessment are similar to those presented in the DAR. Updated figures for ammonia (Figure 17-3), nitrate (Figure 17-4), and TP (Figure 17-5) in Lac de Gras are provided to illustrate the spatial and temporal trends of selected nutrients.

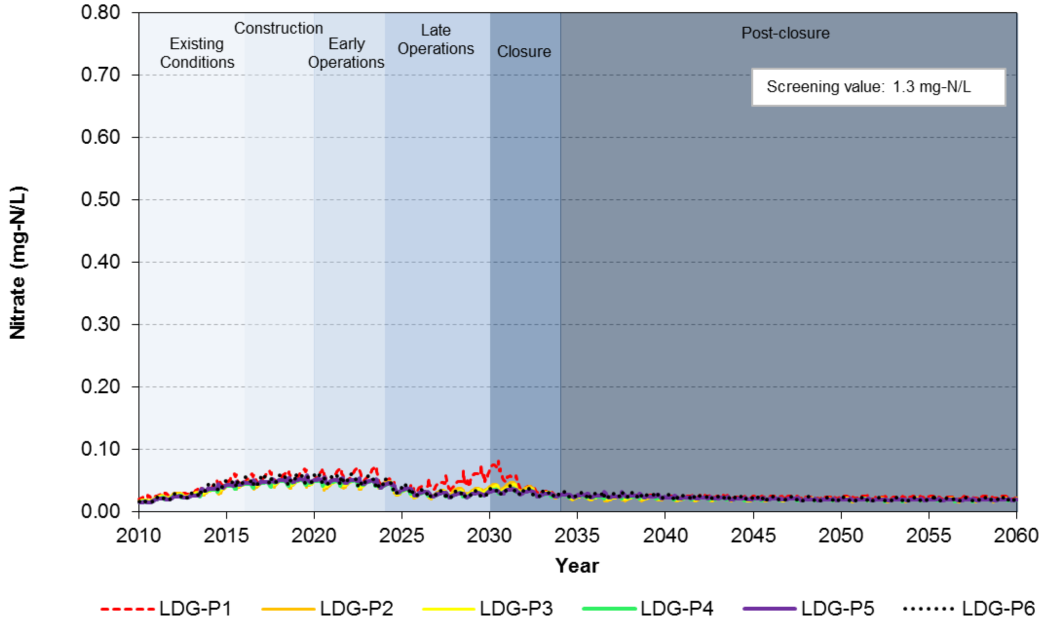
Figure 17-3 Predicted Ammonia Concentrations in Lac de Gras



mg N/L = milligrams nitrogen per litre.

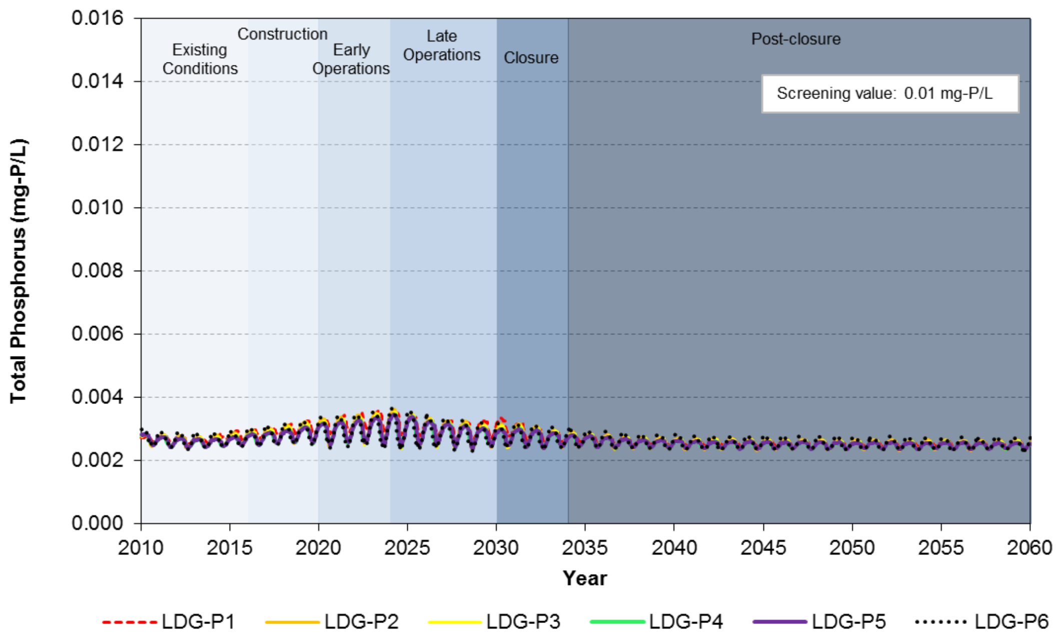
Screening value developed from Canadian water quality guideline equation (CCME 1999) with pH of 7.6 (maximum measured) and water temperature of 12°C (median summer temperature).

Figure 17-4 Predicted Nitrate Concentrations in Lac de Gras



mg N/L = milligrams nitrogen per litre.
Screening value from Site-Specific Water Quality Objective equation (Rescan 2012b) and assumed maximum hardness of 11 mg/L.

Figure 17-5 Predicted Total Phosphorus Concentrations in Lac de Gras



mg-P/L = milligrams phosphorus per litre.
Screening value from Canadian water quality guideline total phosphorus trigger value for oligotrophic to mesotrophic status (CCME 1999).

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Metals

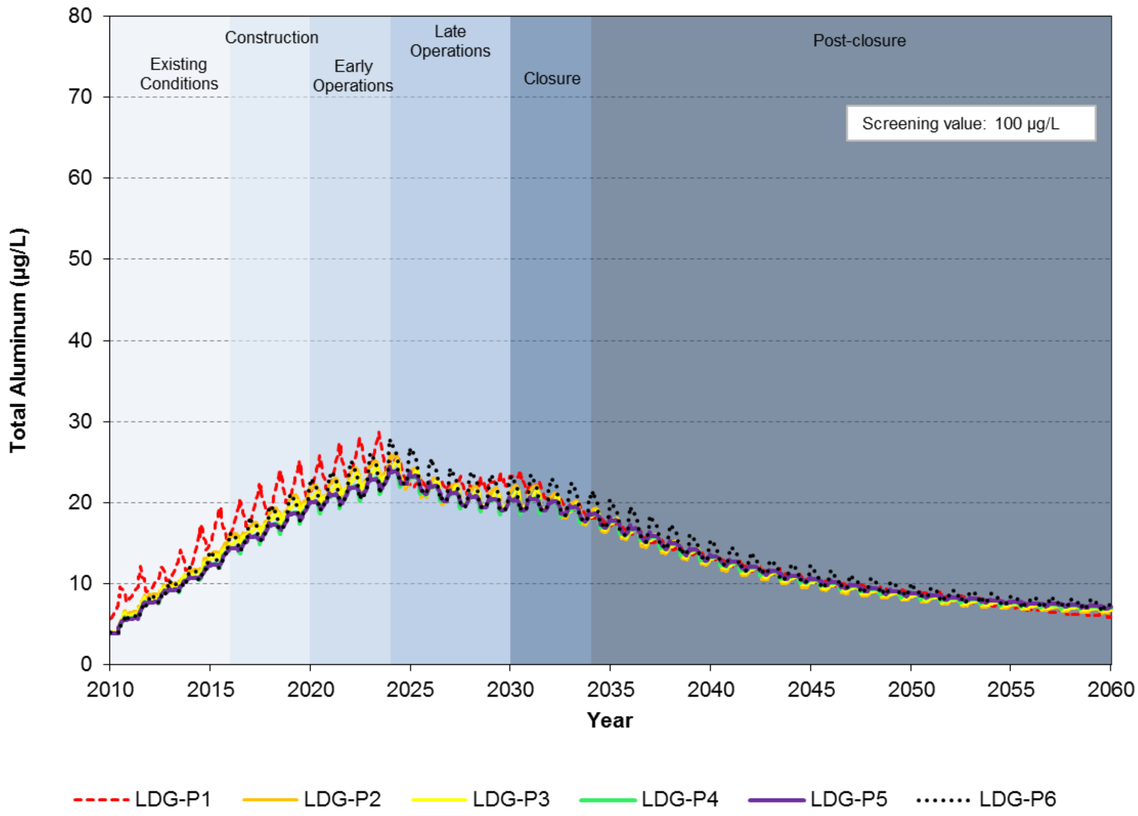
Consistent with the DAR findings, all updated modelled concentrations of metals, at all assessment nodes, are predicted to be less than applicable guideline and objective screening values (Tables 17-2 to 17-7). Metals concentrations predicted to be higher than measured 2014 Baseline Condition (existing) data are denoted with a superscript of “O” (open-water) or “U” (under-ice).

Under the Application Case, modelled metals concentrations were generally within the range of the Reference Condition for each the assessment phase, with the exception of aluminum and arsenic. Predicted concentrations of aluminum were consistently higher than the Reference Condition, but were within the range measured from the Coppermine River at Desteffany Lake (INAC 1998).

Modelled median open-water arsenic concentrations in the post-closure period are less than the Reference Condition concentration at LDG-P2, LDG-P3, LDG-P4, LDG-P5, and LDG-P6. In all other phases of the Application Case, modelled arsenic concentrations are more than the 75th percentile Reference Condition concentration (0.21 µg/L) at all assessment nodes. Arsenic concentrations are predicted to be higher than the 2014 Baseline Condition at all assessment nodes at varied times over the assessment period. Arsenic concentrations under the 2014 Baseline Condition are higher than measured in the Reference Condition in the east bay of Lac de Gras, but within the measured concentration range for the Reference Condition in the west bay of Lac de Gras and Slipper Bay (Tables 17-2 to 17-7).

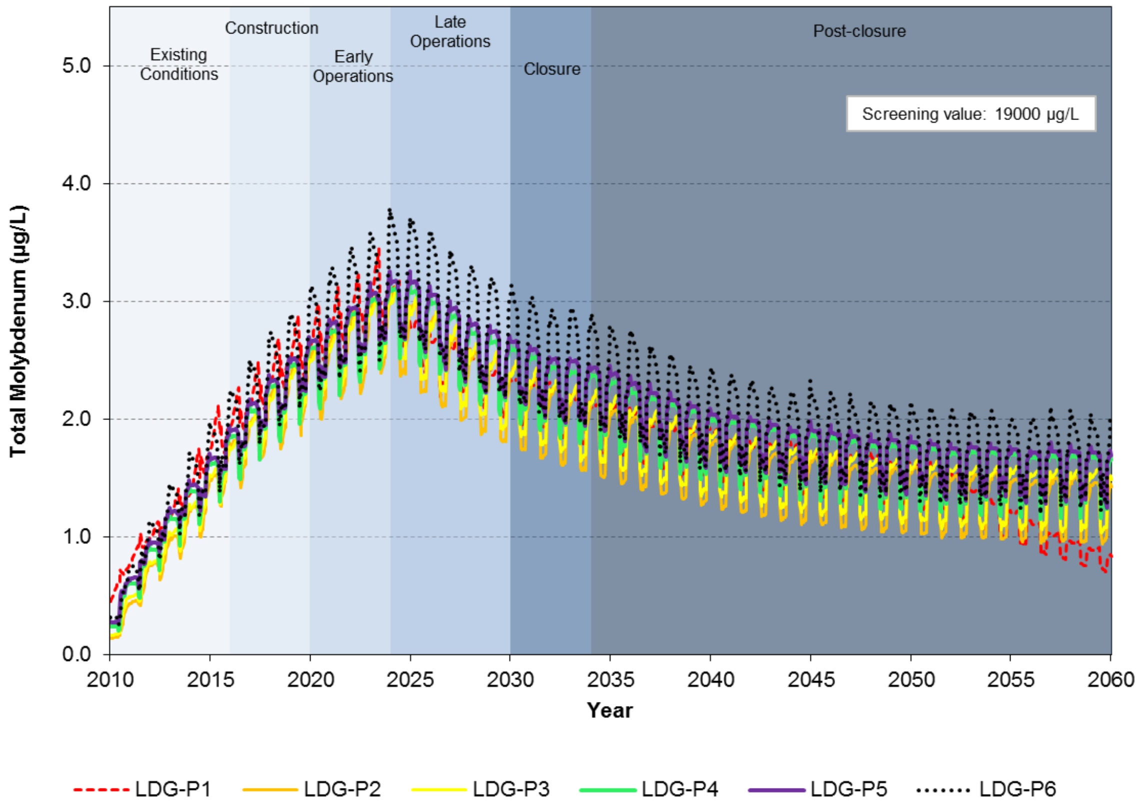
The general spatial and temporal trends for each modelled metal constituent in the updated assessment are similar to those presented in the DAR. Updated figures for aluminum (Figure 17-6), molybdenum (Figure 17-7), strontium (Figure 17-8), and uranium (Figure 17-9) in Lac de Gras are provided to illustrate the spatial and temporal trends of select metals.

Figure 17-6 Predicted Aluminum Concentrations in Lac de Gras



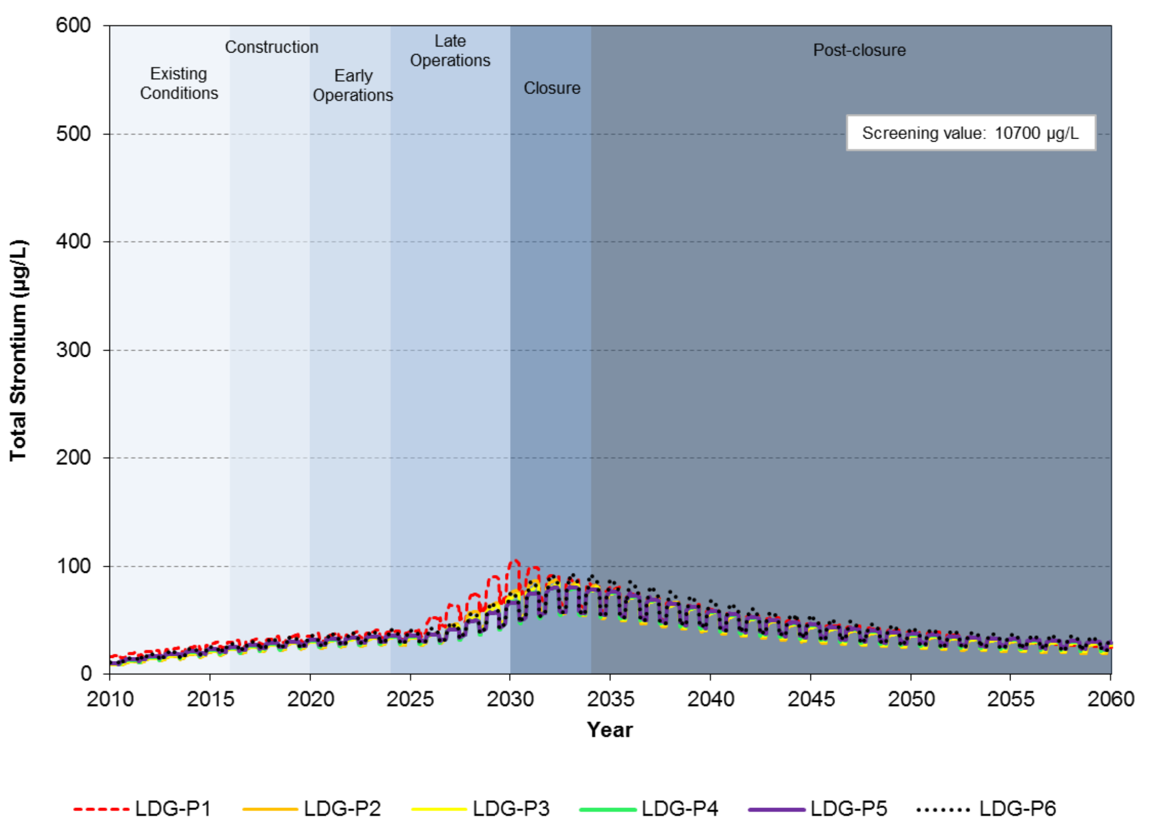
µg/L = micrograms per litre.
Screening value (CCME 1999) assumed a pH of 7.0 (median from existing condition data).

Figure 17-7 Predicted Molybdenum Concentrations in Lac de Gras



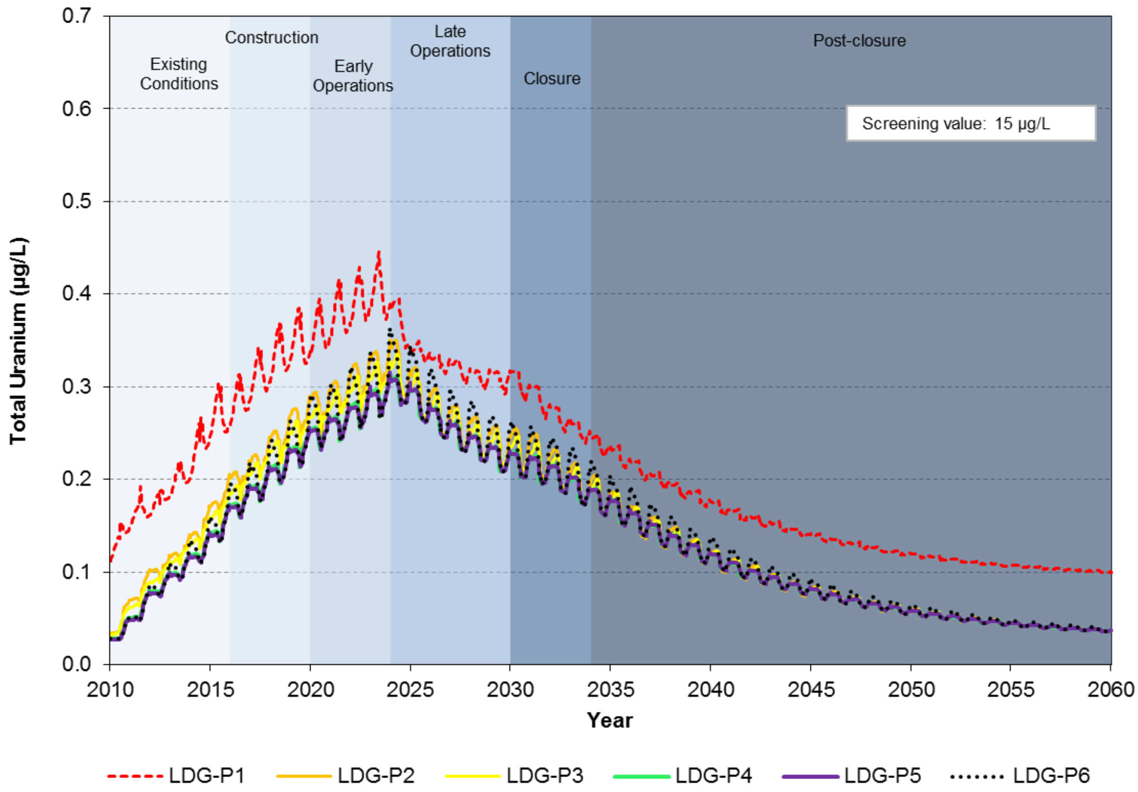
µg/L = micrograms per litre.
Screening value from site-specific water quality objective (Rescan 2012c).

Figure 17-8 Predicted Strontium Concentrations in Lac de Gras



µg/L = micrograms per litre.
Screening value from McPherson et al (2014).

Figure 17-9 Predicted Uranium Concentrations in Lac de Gras



µg/L = micrograms per litre.
Screening value from Canadian water quality guidelines (CCME 1999).

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Rescan. 2012c. EKATI Diamond Mine: Site Specific Water Quality Objective for Molybdenum, 2011. Prepared for BHP Billiton Canada Inc. Yellowknife, NWT, Canada.

Table 17-2 Predicted Water Quality (Depth-Averaged Maximum) in Lac de Gras (LDG-P1) by Operations, Closure, and Post-Closure

Part A

		Lac de Gras (whole lake) - Reference Condition				Lac de Gras (FF2) - 2014 Baseline Condition								LDG-P1 - Application Case Early Operations (2019 - 2023)					
		Open-Water and Under-Ice				Under-Ice (2010 to 2012)				Open-Water (2010 to 2012)				Under-Ice			Open-Water		
Parameter Name	**Unit**	**Count**	**Median**	**Range (25th to 75th %ile)**	**Percent of Samples Less than the Analytical Detection Limit**	**Count**	**Minimum**	**Median**	**Maximum**	**Count**	**Minimum**	**Median**	**Maximum**	**Minimum**	**Median**	**Maximum**	**Minimum**	**Median**	**Maximum**
Field Measured																			
Temperature	°C	-	-	-	-	-	-	-	-	-	-	-	-	0.2	0.7	4.6	0.9	7.2	11
Dissolved oxygen	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	10	13	14	9.7	11	13
Conventional Parameters																			
Hardness	mg/L	-	-	-	-	10	6.6	7.2	14	36	6.3	6.9	<10	7.9	8.4	9.2	**7.9**$^{(O)}$	**8.3**$^{(O)}$	**9.0**$^{(O)}$
Total dissolved solids	mg/L	-	-	-	-	10	14	17	22	36	7	14	28	17	18	21	17	18	20
Total suspended solids	mg/L	433	2	1.0 to 3.0	75	5	<3.0	<3.0	3	21	<1.0	<3.0	<3.0	1.5	1.6	1.7	**1.5**$^{(O)}$	**1.6**$^{(O)}$	**1.7**$^{(O)}$
Major Ions																			
Calcium	mg/L	-	-	-	-	10	1.3	1.4	3.9	36	1.2	1.3	1.5	1.6	1.7	1.8	**1.6**$^{(O)}$	**1.7**$^{(O)}$	**1.8**$^{(O)}$
Chloride	mg/L	-	-	-	-	10	<0.5	1.2	2.5	36	1.6	1.9	2.6	**2.6**$^{(U)}$	**3.0**$^{(U)}$	**3.5**$^{(U)}$	**2.6**$^{(O)}$	**3.0**$^{(O)}$	**3.4**$^{(O)}$
Fluoride	mg/L	-	-	-	-	10	0.02	0.03	<0.05	36	0.02	0.03	<0.05	0.013	0.012	0.014	0.012	0.013	0.014
Magnesium	mg/L	-	-	-	-	10	0.83	0.92	1.3	36	0.79	0.88	0.93	0.97	1.0	1.1	**0.97**$^{(O)}$	**1.0**$^{(O)}$	**1.1**$^{(O)}$
Potassium	mg/L	-	-	-	-	10	0.64	0.79	1.2	36	0.51	0.75	0.95	0.95	1.0	1.2	0.95	**1.0**$^{(O)}$	**1.1**$^{(O)}$
Sodium	mg/L	-	-	-	-	10	1.3	1.5	1.8	36	1.2	1.4	1.6	1.8	**1.9**$^{(U)}$	**2.2**$^{(U)}$	**1.8**$^{(O)}$	**2.0**$^{(O)}$	**2.1**$^{(O)}$
Sulphate	mg/L	-	-	-	-	10	0.49	1.1	3.4	36	1.7	2.5	3.1	3.3	**3.8**$^{(U)}$	**4.5**$^{(U)}$	**3.3**$^{(O)}$	**3.8**$^{(O)}$	**4.2**$^{(O)}$
Nutrients																			
Nitrate	mg N/L	-	-	-	-	10	0.02	0.049	0.19	36	<0.002	0.018	0.03	0.044	0.057	0.073	**0.044**$^{(O)}$	**0.06**$^{(O)}$	**0.072**$^{(O)}$
Total ammonia	mg N/L	433	0.007	0.005 to 0.010	59	10	0.0091	0.012	0.049	36	<0.005	0.01	0.042	0.022	0.028	0.034	0.019	0.024	0.027
Total phosphorus	mg P/L	448	0.003	0.002 to 0.0042	25	10	0.0018	0.0025	<0.005	36	<0.001	0.0045	0.01	**0.0028**$^{(U)}$	**0.0033**$^{(U)}$	**0.0037**$^{(U)}$	0.0029	0.0031	0.0035
Dissolved orthophosphate	mg P/L	-	-	-	-	10	<0.001	<0.003	<0.005	36	<0.001	<0.001	<0.005	0.0014	0.0019	0.0023	0.0015	0.0017	0.0021
Reactive silica	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	0.12	0.12	0.13	0.12	0.12	0.13
Chlorophyll *a*	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	0.14	0.35	2.0	0.15	1.1	2.2
Total Metals																			
Aluminum	µg/L	458	7.95	3.2 to 18.75	7	10	2.8	3.6	12	36	4.1	5.6	7.7	**21**$^{(U)}$	**24**$^{(U)}$	**29**$^{(U)}$	**21**$^{(O)}$	**25**$^{(O)}$	**28**$^{(O)}$
Arsenic	µg/L	411	0.2	0.18 to 0.21	23	10	0.21	0.23	0.39	36	0.19	0.24	0.29	0.35	0.37	**0.41**$^{(U)}$	**0.34**$^{(O)}$	**0.36**$^{(O)}$	**0.39**$^{(O)}$
Barium	µg/L	-	-	-	-	10	2.6	2.8	3.6	36	2.3	2.8	3.1	**6.6**$^{(U)}$	**7.1**$^{(U)}$	**7.9**$^{(U)}$	**5.6**$^{(O)}$	**6.2**$^{(O)}$	**6.7**$^{(O)}$
Beryllium	µg/L	-	-	-	-	10	<0.01	<0.11	<0.2	36	<0.01	<0.01	<0.2	**0.12**$^{(U)}$	**0.12**$^{(U)}$	**0.12**$^{(U)}$	**0.12**$^{(O)}$	**0.12**$^{(O)}$	**0.12**$^{(O)}$
Bismuth	µg/L	-	-	-	-	5	<0.005	<0.005	<0.005	21	<0.005	<0.005	<0.005	**0.0086**$^{(U)}$	**0.011**$^{(U)}$	**0.013**$^{(U)}$	**0.0086**$^{(O)}$	**0.01**$^{(O)}$	**0.012**$^{(O)}$
Cadmium	µg/L	465	**0.05** $^{(DL>C)}$	**0.05** $^{(DL>C)}$ to **0.2** $^{(DL>C)}$	95	10	<0.005	0.008	<0.05$^{(DL>C)}$	36	<0.005	<0.005	<0.05$^{(DL>C)}$	**0.033**$^{(U)}$	**0.034**$^{(U)}$	**0.037**$^{(U)}$	**0.033**$^{(O)}$	**0.033**$^{(O)}$	**0.035**$^{(O)}$
Chromium	µg/L	459	0.33	0.185 to **1.2** $^{(C)}$	37	10	<0.06	<0.08	0.2	36	<0.05	<0.1	0.28	0.088	0.097	0.11	0.085	0.096	0.11
Cobalt	µg/L	-	-	-	-	10	0.006	0.016	<0.1	36	0.012	0.018	<0.1	**0.067**$^{(U)}$	**0.07**$^{(U)}$	**0.075**$^{(U)}$	**0.069**$^{(O)}$	**0.075**$^{(O)}$	**0.078**$^{(O)}$
Copper	µg/L	459	0.7	0.6 to 1.0	51	10	0.57	<0.6	0.97	36	0.5	<0.6	0.75	0.38	0.4	0.42	0.37	0.39	0.4
Iron	µg/L	-	-	-	-	10	1	<5.0	10	36	<5.0	6.5	24	**25**$^{(U)}$	**30**$^{(U)}$	**37**$^{(U)}$	**28**$^{(O)}$	**33**$^{(O)}$	**38**$^{(O)}$
Lead	µg/L	388	0.05	0.05 to 0.07	85	10	0.007	0.19	0.38	36	<0.005	0.0055	0.051	0.034	0.035	0.038	0.033	0.035	0.038
Manganese	µg/L	-	-	-	-	10	0.82	1	1.2	36	1.5	1.9	4	**2.9**$^{(U)}$	**3.3**$^{(U)}$	**3.8**$^{(U)}$	**5.0**$^{(O)}$	**5.4**$^{(O)}$	**5.7**$^{(O)}$
Mercury	µg/L	-	-	-	-	5	<0.02	<0.02	<0.02	31	<0.01	<0.02	<0.02	**0.011**$^{(U)}$	**0.012**$^{(U)}$	**0.012**$^{(U)}$	**0.011**$^{(O)}$	**0.013**$^{(O)}$	**0.012**$^{(O)}$
Molybdenum	µg/L	-	-	-	-	10	0.31	0.45	0.49	36	0.38	0.47	0.59	**2.5**$^{(U)}$	**2.9**$^{(U)}$	**3.4**$^{(U)}$	**2.3**$^{(O)}$	**2.7**$^{(O)}$	**3.0**$^{(O)}$
Nickel	µg/L	459	0.69	0.5 to 1.40	16	10	0.59	0.67	0.82	36	0.52	0.6	0.77	**1.1**$^{(U)}$	**1.2**$^{(U)}$	**1.2**$^{(U)}$	**0.96**$^{(O)}$	**1.0**$^{(O)}$	**1.1**$^{(O)}$
Selenium	µg/L	-	-	-	-	10	<0.04	<0.07	<0.1	36	<0.04	<0.04	<0.1	**0.12**$^{(U)}$	**0.13**$^{(U)}$	**0.15**$^{(U)}$	**0.12**$^{(O)}$	**0.13**$^{(O)}$	**0.14**$^{(O)}$

Table 17-2 Predicted Water Quality (Depth-Averaged Maximum) in Lac de Gras (LDG-P1) by Operations, Closure, and Post-Closure

Part A

														LDG-P1 - Application Case					
		Lac de Gras (whole lake) - Reference Condition				Lac de Gras (FF2) - 2014 Baseline Condition								Early Operations (2019 - 2023)					
		Open-Water and Under-Ice				Under-Ice (2010 to 2012)				Open-Water (2010 to 2012)				Under-Ice			Open-Water		
Parameter Name	**Unit**	**Count**	**Median**	**Range (25th to 75th %ile)**	**Percent of Samples Less than the Analytical Detection Limit**	**Count**	**Minimum**	**Median**	**Maximum**	**Count**	**Minimum**	**Median**	**Maximum**	**Minimum**	**Median**	**Maximum**	**Minimum**	**Median**	**Maximum**
Silver	µg/L	-	-	-	-	10	<0.005	<0.053	<0.1	36	<0.005	<0.005	<0.1	**0.057(U)**	**0.059(U)**	**0.061(U)**	**0.058(O)**	**0.06(O)**	**0.061(O)**
Strontium	µg/L	-	-	-	-	10	12	13	18	36	14	15	16	**34(U)**	**37(U)**	**42(U)**	**29(O)**	**32(O)**	**35(O)**
Uranium	µg/L	-	-	-	-	10	0.052	0.088	0.12	36	0.058	0.069	0.096	**0.33(U)**	**0.38(U)**	**0.45(U)**	**0.33(O)**	**0.38(O)**	**0.43(O)**
Vanadium	µg/L	-	-	-	-	10	<0.05	<0.13	<0.2	36	<0.05	<0.1	<0.2	**0.43(U)**	**0.51(U)**	**0.62(U)**	**0.42(O)**	**0.51(O)**	**0.58(O)**
Zinc	µg/L	369	1	0.8 to 6.5	46	10	0.86	1.3	4.1	36	0.2	<0.8	4.4	0.56	0.58	0.63	0.54	0.57	0.6

Source:

DDMI 2001 for data from 1994 to 2000; Stations included: Lac de Gras Mid-field Stations (LDG40, LDG41, LDG42, LDG43, LDG44, LDG45, LDG49), and Lac de Gras Far-field Stations (LDG46, LDG48, BHP-S); see DDMI 2001 for station locations within Lac de Gras.

DDMI 2011, 2012, 2013 (FF2-1M, FF2-2B, FF2-2M, FF2-2, FF2-3M, FF2-4M, FF2-5B, FF2-5M, and FF2-5T sampled in 2010, 2011, and 2012).

Note:

Bolded concentrations are higher than relevant water quality guidelines.

CWQG = Canadian Council of Ministers of the Environment (CCME) water quality guidelines for the protection of aquatic life (CCME 1999); CDWQG = Canadian Drinking Water Quality Guidelines (Health Canada 2012)

FF = far-field.

(C) = concentration higher than the relevant chronic CWQG or beyond the recommended pH or DO concentration range.

(D) = concentration higher than the relevant CDWQG or beyond the recommended pH or DO concentration range.

(DL>C) = analytical detection limit was higher than the relevant chronic CWQG.

(U) = concentration higher than the relevant under ice or beyond the recommended pH or DO concentration range.

(O) = concentration higher than the relevant open water or beyond the recommended pH or DO concentration range.

<= less than; >= greater than; - = no guideline or no data; DO = dissolved oxygen.

Water quality data and guidelines shown in this table were rounded to reflect laboratory or field instrument precision after comparisons to guidelines. Therefore, values slightly above guidelines may be displayed as being equal to the guidelines and identified as exceedances. Measured concentrations equal to the guideline values were not identified as exceedances.

pH set to 6.7 (median of the 2010-2014 dataset) for the purpose of pH-dependent guidelines.

Table 17-2 Predicted Water Quality (Depth-Averaged Maximum) in Lac de Gras (LDG-P1) by Operations, Closure, and Post-Closure

Part B

Parameter Name	Unit	LDG-P1 - Application Case																	
		Operations (2024 - 2029)						Closure - Pit Back-Flooding Period (2030 - 2033)						Post-Closure (2034 - 2060)					
		Under-Ice			Open-Water			Under-Ice			Open-Water			Under-Ice			Open-Water		
		Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum
Field Measured																			
Temperature	°C	0.2	0.7	2.8	1.0	6.8	11	0.2	0.7	3.8	0.9	6.8	11	0.2	0.7	4.9	0.9	7.5	11
Dissolved oxygen	mg/L	10	12	14	9.6	11	13	10	13	14	9.7	11	13	10	13	14	9.6	11	13
Conventional Parameters																			
Hardness	mg/L	7.3	7.8	11	**7.3**(O)	**7.6**(O)	**10**(O)	8.4	9.3	11	**8.5**(O)	**9.1**(O)	**11**(O)	4.6	5.7	8.7	4.6	**5.6**(O)	**8.5**(O)
Total dissolved solids	mg/L	17	18	**23**(U)	17	18	22	19	20	**23**(U)	19	20	24	11	14	19	11	13	19
Total suspended solids	mg/L	1.4	1.5	1.6	1.4	1.5	**1.6**(O)	1.4	1.4	1.5	1.4	1.4	1.5	1.3	1.3	1.5	1.3	1.3	1.4
Major Ions																			
Calcium	mg/L	1.5	1.6	2.6	**1.5**(O)	**1.6**(O)	**2.5**(O)	2.1	2.4	2.8	**2.1**(O)	**2.3**(O)	**3.0**(O)	0.92	1.3	2.2	0.92	1.2	**2.2**(O)
Chloride	mg/L	**2.7**(U)	**3.0**(U)	**5.8**(U)	**2.7**(O)	**2.9**(O)	**5.5**(O)	**4.4**(U)	**5.1**(U)	**6.2**(U)	**4.4**(O)	**5.0**(O)	**6.9**(O)	0.92	1.9	**4.5**(U)	0.91	1.9	**4.4**(O)
Fluoride	mg/L	0.011	0.011	0.013	0.011	0.012	0.013	0.01	0.011	0.011	0.011	0.011	0.012	0.0088	0.0093	0.011	0.0088	0.0092	0.01
Magnesium	mg/L	0.85	0.92	1.0	0.85	0.89	**1.0**(O)	0.76	0.83	0.9	0.77	0.81	0.89	0.55	0.62	0.79	0.55	0.6	0.77
Potassium	mg/L	0.82	0.94	1.1	0.82	0.91	**1.0**(O)	0.72	0.78	0.85	0.73	0.77	0.84	0.54	0.61	0.74	0.53	0.59	0.72
Sodium	mg/L	1.7	**1.8**(U)	**2.3**(U)	**1.7**(O)	**1.8**(O)	**2.2**(O)	**1.8**(U)	**2.0**(U)	**2.4**(U)	**1.8**(O)	**2.0**(O)	**2.5**(O)	0.73	1.0	**1.9**(U)	0.72	1.0	**1.8**(O)
Sulphate	mg/L	2.7	3.3	**4.0**(U)	2.8	**3.2**(O)	**3.9**(O)	2.3	2.5	2.8	2.3	2.5	2.8	1.3	1.6	2.3	1.3	1.6	2.2
Nutrients																			
Nitrate	mg N/L	0.031	0.046	0.068	**0.031**(O)	**0.043**(O)	**0.077**(O)	0.025	0.041	0.075	0.025	**0.039**(O)	**0.082**(O)	0.021	0.025	0.028	0.02	0.023	0.028
Total ammonia	mg N/L	0.027	0.031	0.033	0.023	0.026	0.029	0.018	0.025	0.034	0.017	0.021	0.03	0.011	0.014	0.019	0.011	0.011	0.015
Total phosphorus	mg P/L	**0.0028**(U)	**0.0033**(U)	**0.0035**(U)	0.0027	0.0029	0.0034	**0.0027**(U)	**0.003**(U)	**0.0033**(U)	0.0026	0.0027	0.0033	0.0025	**0.0026**(U)	**0.0028**(U)	0.0025	0.0025	0.0027
Dissolved orthophosphate	mg P/L	0.0014	0.0019	0.0021	0.0013	0.0015	0.002	0.0013	0.0016	0.0019	0.0012	0.0013	0.0019	0.0011	0.0012	0.0014	0.0011	0.0011	0.0013
Reactive silica	mg/L	0.12	0.12	0.14	0.12	0.12	0.13	0.13	0.13	0.14	0.13	0.13	0.13	0.12	0.12	0.13	0.12	0.12	0.13
Chlorophyll *a*	µg/L	0.29	0.49	1.9	0.37	1.6	2.1	0.17	0.44	1.3	0.16	0.92	1.7	0.054	0.14	0.61	0.056	0.34	0.67
Total Metals																			
Aluminum	µg/L	**21**(U)	**22**(U)	**25**(U)	**22**(O)	**23**(O)	**25**(O)	**18**(U)	**20**(U)	**23**(U)	**19**(O)	**21**(O)	**24**(O)	5.8	9.6	**18**(U)	6.8	**9.9**(O)	**18**(O)
Arsenic	µg/L	0.33	0.35	0.39	**0.31**(O)	**0.33**(O)	**0.37**(O)	0.31	0.32	0.33	**0.29**(O)	**0.3**(O)	**0.31**(O)	0.25	0.27	0.31	0.24	0.26	0.29
Barium	µg/L	**6.2**(U)	**6.6**(U)	**7.4**(U)	**5.2**(O)	**5.5**(O)	**6.3**(O)	**5.8**(U)	**6.0**(U)	**6.3**(U)	**4.7**(O)	**4.9**(O)	**5.2**(O)	**4.3**(U)	**4.9**(U)	**5.8**(U)	**3.3**(O)	**3.8**(O)	**4.6**(O)
Beryllium	µg/L	**0.11**(U)	**0.11**(U)	**0.12**(U)	**0.11**(O)	**0.12**(O)	**0.12**(O)	**0.11**(U)	**0.11**(U)	**0.11**(U)	**0.11**(O)	**0.11**(O)	**0.11**(O)	**0.1**(U)	**0.1**(U)	**0.11**(U)	**0.1**(O)	**0.11**(O)	**0.11**(O)
Bismuth	µg/L	**0.006**(U)	**0.0077**(U)	**0.011**(U)	**0.006**(O)	**0.0074**(O)	**0.011**(O)	**0.0043**(U)	**0.0052**(U)	**0.0063**(U)	**0.0041**(O)	**0.0051**(O)	**0.006**(O)	0.00036	0.0011	**0.0043**(U)	0.00035	0.0011	**0.0039**(O)
Cadmium	µg/L	**0.031**(U)	**0.032**(U)	**0.034**(U)	**0.03**(O)	**0.032**(O)	**0.034**(O)	**0.031**(U)	**0.032**(U)	**0.031**(U)	**0.029**(O)	**0.03**(O)	**0.031**(O)	**0.026**(U)	**0.028**(U)	**0.031**(U)	**0.025**(O)	**0.028**(O)	**0.03**(O)
Chromium	µg/L	0.084	0.09	0.1	0.079	0.084	0.098	0.074	0.079	0.087	0.069	0.074	0.082	0.038	0.053	0.074	0.037	0.048	0.067
Cobalt	µg/L	**0.068**(U)	**0.074**(U)	**0.087**(U)	**0.072**(O)	**0.076**(O)	**0.088**(O)	**0.076**(U)	**0.08**(U)	**0.088**(U)	**0.078**(O)	**0.081**(O)	**0.09**(O)	**0.052**(U)	**0.057**(U)	**0.077**(U)	**0.057**(O)	**0.061**(O)	**0.077**(O)
Copper	µg/L	0.39	0.4	0.41	0.38	0.38	0.39	0.39	0.39	0.4	0.37	0.37	0.38	0.32	0.36	0.39	0.31	0.34	0.36
Iron	µg/L	**21**(U)	**25**(U)	**32**(U)	23	**26**(O)	**33**(O)	**16**(U)	**19**(U)	**22**(U)	18	21	24	3.8	6.9	**16**(U)	6.5	9.2	18
Lead	µg/L	0.034	0.035	0.036	0.034	0.034	0.035	0.032	0.034	0.036	0.032	0.032	0.034	0.025	0.027	0.032	0.025	0.028	0.031

Table 17-2 Predicted Water Quality (Depth-Averaged Maximum) in Lac de Gras (LDG-P1) by Operations, Closure, and Post-Closure

Part B

Parameter Name	Unit	LDG-P1 - Application Case																	
		Operations (2024 - 2029)						Closure - Pit Back-Flooding Period (2030 - 2033)						Post-Closure (2034 - 2060)					
		Under-Ice			Open-Water			Under-Ice			Open-Water			Under-Ice			Open-Water		
		Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum
Manganese	µg/L	**3.1(U)**	**3.2(U)**	**3.5(U)**	**5.1(O)**	**5.2(O)**	**5.4(O)**	**2.8(U)**	**3.1(U)**	**3.5(U)**	**4.8(O)**	**5.0(O)**	**5.4(O)**	**1.3(U)**	**1.8(U)**	**2.8(U)**	3.5	3.8	**4.7(O)**
Mercury	µg/L	**0.012(U)**	**0.011(U)**	**0.012(U)**	**0.012(O)**	**0.011(O)**	**0.012(O)**	**0.011(U)**	**0.012(U)**	**0.012(U)**	**0.012(O)**	**0.011(O)**	**0.012(O)**	**0.01(U)**	**0.011(U)**	**0.011(U)**	**0.01(O)**	**0.01(O)**	**0.011(O)**
Molybdenum	µg/L	**2.3(U)**	**2.6(U)**	**3.2(U)**	**2.0(O)**	**2.3(O)**	**2.8(O)**	**2.1(U)**	**2.3(U)**	**2.4(U)**	**1.8(O)**	**1.9(O)**	**2.0(O)**	**0.84(U)**	**1.7(U)**	**2.2(U)**	**0.71(O)**	**1.3(O)**	**1.7(O)**
Nickel	µg/L	**1.1(U)**	**1.1(U)**	**1.2(U)**	**0.92(O)**	**0.94(O)**	**1.0(O)**	**1.0(U)**	**1.1(U)**	**1.1(U)**	**0.87(O)**	**0.9(O)**	**0.92(O)**	**0.88(U)**	**0.95(U)**	**1.0(U)**	0.73	**0.78(O)**	**0.87(O)**
Selenium	µg/L	**0.097(U)**	**0.11(U)**	**0.14(U)**	**0.096(O)**	**0.11(O)**	**0.13(O)**	**0.085(U)**	**0.091(U)**	**0.098(U)**	**0.083(O)**	**0.088(O)**	**0.095(O)**	**0.055(U)**	**0.066(U)**	**0.086(U)**	**0.054(O)**	**0.063(O)**	**0.081(O)**
Silver	µg/L	**0.054(U)**	**0.057(U)**	**0.06(U)**	**0.054(O)**	**0.056(O)**	**0.059(O)**	**0.054(U)**	**0.055(U)**	**0.055(U)**	**0.053(O)**	**0.054(O)**	**0.054(O)**	**0.051(U)**	**0.051(U)**	**0.054(U)**	**0.05(O)**	**0.051(O)**	**0.053(O)**
Strontium	µg/L	**38(U)**	**63(U)**	**101(U)**	**32(O)**	**49(O)**	**76(O)**	**81(U)**	**91(U)**	**105(U)**	**60(O)**	**66(O)**	**82(O)**	**24(U)**	**44(U)**	**83(U)**	**19(O)**	**32(O)**	**60(O)**
Uranium	µg/L	**0.3(U)**	**0.33(U)**	**0.39(U)**	**0.29(O)**	**0.32(O)**	**0.38(O)**	**0.25(U)**	**0.28(U)**	**0.32(U)**	**0.24(O)**	**0.27(O)**	**0.3(O)**	**0.1**	**0.13(U)**	**0.25(U)**	**0.10(O)**	**0.13(O)**	**0.23(O)**
Vanadium	µg/L	**0.31(U)**	**0.4(U)**	**0.54(U)**	**0.3(O)**	**0.37(O)**	**0.51(O)**	**0.24(U)**	**0.27(U)**	**0.31(U)**	**0.22(O)**	**0.26(O)**	**0.29(O)**	0.056	**0.12(U)**	**0.24(U)**	0.052	**0.1(O)**	**0.21(O)**
Zinc	µg/L	0.57	0.58	0.6	0.55	0.55	0.58	0.55	0.57	0.59	0.52	0.54	0.56	0.43	0.49	0.56	0.42	0.46	0.52

Source:

DDMI 2001 for data from 1994 to 2000; Stations included: Lac de Gras Mid-field Stations (LDG40, LDG41, LDG42, LDG43, LDG44, LDG45, LDG49), and Lac de Gras Far-field Stations (LDG46, LDG48, BHP-S); see DDMI 2001 for station locations within Lac de Gras.

DDMI 2011, 2012, 2013 (FF2-1M, FF2-2B, FF2-2M, FF2-2, FF2-3M, FF2-4M, FF2-5B, FF2-5M, and FF2-5T sampled in 2010, 2011, and 2012).

Note:

Bolded concentrations are higher than relevant water quality guidelines.

CWQG = Canadian Council of Ministers of the Environment (CCME) water quality guidelines for the protection of aquatic life (CCME 1999); CDWQG = Canadian Drinking Water Quality Guidelines (Health Canada 2012)

FF = far-field.

(C) = concentration higher than the relevant chronic CWQG or beyond the recommended pH or DO concentration range.

(D) = concentration higher than the relevant CDWQG or beyond the recommended pH or DO concentration range.

(DL>C) = analytical detection limit was higher than the relevant chronic CWQG.

(U) = concentration higher than the relevant under ice or beyond the recommended pH or DO concentration range.

(O) = concentration higher than the relevant open water or beyond the recommended pH or DO concentration range.

<= less than; >= greater than; - = no guideline or no data; DO = dissolved oxygen.

Water quality data and guidelines shown in this table were rounded to reflect laboratory or field instrument precision after comparisons to guidelines. Therefore, values slightly above guidelines may be displayed as being equal to the guidelines and identified as exceedances. Measured concentrations equal to the guideline values were not identified as exceedances.

pH set to 6.7 (median of the 2010-2014 dataset) for the purpose of pH-dependent guidelines.

DOMINION DIAMOND

Table 17-3 Predicted Water Quality (Depth-Averaged Maximum) in Lac de Gras (LDG-P2) by Operations, Closure, and Post-Closure

Part A

Parameter Name	Unit	Lac de Gras (whole lake) - Reference Condition				Lac de Gras (FFA) - 2014 Baseline Condition								LDG-P2 - Application Case Early Operations (2019 - 2023)					
		Open-Water and Under-Ice				Under-Ice (2010 to 2012)				Open-Water (2010 to 2012)				Under-Ice			Open-Water		
		Count	Median	Range (25th to 75th %ile)	Percent of Samples Less than the Analytical Detection Limit	Count	Minimum	Median	Maximum	Count	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum
Field Measured																			
Temperature	°C	-	-	-	-	-	-	-	-	-	-	-	-	0.2	0.6	2.8	0.9	7.4	11
Dissolved oxygen	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	9.8	13	14	9.2	11	14
Conventional Parameters																			
Hardness	mg/L	-	-	-	-	10	5.9	6.4	7.1	30	4.7	5.5	<10	**7.8**(U)	**8.8**(U)	**9.2**(U)	**7.4**(O)	**7.9**(O)	**8.8**(O)
Total dissolved solids	mg/L	-	-	-	-	10	9	12	21	30	<5.0	13	30	17	19	21	15	17	19
Total suspended solids	mg/L	433	2	1.0 to 3.0	75	5	<3.0	<3.0	<3.0	15	<3.0	<3.0	3	**1.5**(U)	**1.7**(U)	**1.8**(U)	1.4	1.5	1.7
Major Ions																			
Calcium	mg/L	-	-	-	-	10	1.1	1.2	1.3	30	0.89	1.1	1.1	**1.6**(U)	**1.8**(U)	**1.8**(U)	**1.5**(O)	**1.6**(O)	**1.7**(O)
Chloride	mg/L	-	-	-	-	10	0.8	0.93	1.2	30	0.81	1	1.7	**2.6**(U)	**3.0**(U)	**3.4**(U)	**2.3**(O)	**2.7**(O)	**3.1**(O)
Fluoride	mg/L	-	-	-	-	10	0.02	0.03	<0.05	30	0.01	0.03	<0.05	0.013	0.014	0.014	0.012	0.012	0.013
Magnesium	mg/L	-	-	-	-	10	0.75	0.8	0.92	30	0.61	0.71	0.76	**0.96**(U)	**1.1**(U)	**1.1**(U)	**0.91**(O)	**0.96**(O)	**1.1**(O)
Potassium	mg/L	-	-	-	-	10	0.61	0.64	0.75	30	0.35	0.59	0.7	**0.94**(U)	**1.1**(U)	**1.2**(U)	**0.87**(O)	**0.96**(O)	**1.1**(O)
Sodium	mg/L	-	-	-	-	10	0.8	0.95	<1.0	30	0.76	0.82	<1.0	**1.7**(U)	**2.0**(U)	**2.2**(U)	**1.6**(O)	**1.8**(O)	**2.0**(O)
Sulphate	mg/L	-	-	-	-	10	2.3	2.6	2.8	30	1.4	2.5	3.2	**3.3**(U)	**3.8**(U)	**4.3**(U)	3.0	**3.4**(O)	**3.9**(O)
Nutrients																			
Nitrate	mg N/L	-	-	-	-	10	<0.006	<0.013	<0.02	30	<0.006	<0.013	<0.02	**0.04**(U)	**0.049**(U)	**0.052**(U)	**0.036**(O)	**0.041**(O)	**0.048**(O)
Total ammonia	mg N/L	433	0.007	0.005 to 0.010	59	10	0.015	0.024	0.046	30	<0.005	0.0085	0.042	0.02	0.028	0.035	0.016	0.022	0.027
Total phosphorus	mg P/L	448	0.003	0.002 to 0.0042	25	10	0.002	0.0033	<0.005	30	<0.001	0.0049	<0.005	**0.0027**(U)	**0.0032**(U)	**0.0035**(U)	0.0024	**0.0027**(O)	**0.0031**(O)
Dissolved orthophosphate	mg P/L	-	-	-	-	10	<0.001	<0.003	<0.005	30	<0.001	<0.003	<0.005	0.0013	0.0018	0.0021	0.001	0.0013	0.0017
Reactive silica	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	0.12	0.13	0.14	0.12	0.12	0.13
Chlorophyll *a*	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	0.19	0.5	2.2	0.33	1.7	2.8
Total Metals																			
Aluminum	µg/L	458	7.95	3.2 to 18.75	7	10	3	3.7	4.6	30	3.2	5	7.2	**20**(U)	**23**(U)	**26**(U)	**18**(O)	**21**(O)	**24**(O)
Arsenic	µg/L	411	0.2	0.18 to 0.21	23	10	0.081	0.16	0.19	30	0.15	0.18	0.23	**0.3**(U)	**0.32**(U)	**0.34**(U)	**0.27**(O)	**0.29**(O)	**0.31**(O)
Barium	µg/L	-	-	-	-	10	1.8	2	2.3	30	1.7	1.8	2.8	**4.7**(U)	**5.1**(U)	**5.7**(U)	**4.1**(O)	**4.6**(O)	**5.0**(O)
Beryllium	µg/L	-	-	-	-	10	<0.01	<0.11	<0.2	30	<0.01	<0.11	<0.2	**0.12**(U)	**0.12**(U)	**0.12**(U)	**0.12**(O)	**0.12**(O)	**0.12**(O)
Bismuth	µg/L	-	-	-	-	5	<0.005	<0.005	<0.005	17	<0.005	<0.005	<0.2	**0.0084**(U)	**0.0097**(U)	**0.012**(U)	0.0073	0.009	0.011
Cadmium	µg/L	465	**0.05** (DL>C)	**0.05** (DL>C) to **0.2** (DL>C)	95	10	<0.005	<0.028	<0.05(DL>C)	30	<0.005	0.006	<0.05(DL>C)	**0.032**(U)	**0.033**(U)	**0.035**(U)	**0.031**(O)	**0.033**(O)	**0.033**(O)
Chromium	µg/L	459	0.33	0.185 to **1.2**(C)	37	10	<0.06	0.074	<0.1	30	<0.06	<0.1	0.21	**0.087**(U)	**0.097**(U)	**0.11**(U)	0.078	0.087	0.096
Cobalt	µg/L	-	-	-	-	10	0.006	0.02	0.19	30	0.019	0.028	<0.1	0.066	0.07	0.072	**0.067**(O)	**0.071**(O)	**0.074**(O)
Copper	µg/L	459	0.7	0.6 to 1.0	51	10	0.53	0.61	0.67	30	0.48	<0.6	1	0.38	0.4	0.42	0.36	0.38	0.39

Table 17-3 Predicted Water Quality (Depth-Averaged Maximum) in Lac de Gras (LDG-P2) by Operations, Closure, and Post-Closure

Part A

Parameter Name	Unit	Lac de Gras (whole lake) - Reference Condition				Lac de Gras (FFA) - 2014 Baseline Condition								LDG-P2 - Application Case Early Operations (2019 - 2023)					
		Open-Water and Under-Ice				Under-Ice (2010 to 2012)				Open-Water (2010 to 2012)				Under-Ice			Open-Water		
		Count	Median	Range (25th to 75th %ile)	Percent of Samples Less than the Analytical Detection Limit	Count	Minimum	Median	Maximum	Count	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum
Iron	µg/L	-	-	-	-	10	1	3	9.1	30	4	5.8	9.5	**25**(U)	**29**(U)	**34**(U)	**25**(O)	**29**(O)	**33**(O)
Lead	µg/L	388	0.05	0.05 to 0.07	85	10	<0.005	0.028	0.074	30	<0.005	0.01	0.056	0.033	0.035	0.037	0.033	0.034	0.035
Manganese	µg/L	-	-	-	-	10	0.62	1.2	1.6	30	1.8	2.5	4.2	**3.2**(U)	**3.5**(U)	**3.9**(U)	**5.0**(O)	**5.3**(O)	**5.6**(O)
Mercury	µg/L	-	-	-	-	10	<0.01	<0.015	<0.02	25	<0.01	<0.02	0.02	**0.012**(U)	**0.012**(U)	**0.012**(U)	0.012	0.012	0.012
Molybdenum	µg/L	-	-	-	-	10	0.08	0.13	0.15	30	0.073	0.12	0.73	**2.3**(U)	**2.7**(U)	**3.1**(U)	**1.9**(O)	**2.2**(O)	**2.5**(O)
Nickel	µg/L	459	0.69	0.5 to 1.40	16	10	0.92	1	1.7	30	0.79	0.94	1.3	1.3	1.3	1.4	1.2	1.3	**1.3**(O)
Selenium	µg/L	-	-	-	-	10	<0.04	<0.07	0.1	30	<0.04	<0.07	<0.1	**0.12**(U)	**0.13**(U)	**0.14**(U)	**0.11**(O)	**0.12**(O)	**0.13**(O)
Silver	µg/L	-	-	-	-	10	<0.005	<0.053	<0.1	30	<0.005	<0.053	<0.1	**0.058**(U)	**0.059**(U)	**0.06**(U)	**0.057**(O)	**0.058**(O)	**0.059**(O)
Strontium	µg/L	-	-	-	-	10	7.7	8.3	10	30	7.9	8.7	9.8	**27**(U)	**31**(U)	**34**(U)	**22**(O)	**26**(O)	**28**(O)
Uranium	µg/L	-	-	-	-	10	0.023	0.031	0.05	30	0.02	0.03	<0.05	**0.26**(U)	**0.3**(U)	**0.35**(U)	**0.23**(O)	**0.28**(O)	**0.32**(O)
Vanadium	µg/L	-	-	-	-	10	<0.05	<0.13	<0.2	30	<0.05	<0.13	<0.2	**0.43**(U)	**0.49**(U)	**0.58**(U)	**0.37**(O)	**0.44**(O)	**0.5**(O)
Zinc	µg/L	369	1	0.8 to 6.5	46	10	0.5	1.3	2.3	30	0.3	<0.8	3.3	1.4	1.4	1.4	0.73	0.75	0.77

Source:

DDMI 2001 for data from 1994 to 2000; Stations included: Lac de Gras Mid-field Stations (LDG40, LDG41, LDG42, LDG43, LDG44, LDG45, LDG49), and Lac de Gras Far-field Stations (LDG46, LDG48, BHP-S); see DDMI 2001 for station locations within Lac de Gras.

DDMI 2011 and 2012 (FFA-1, FFA-2, FFA-3, FFA-4, and FFA-5 sampled in 2010 and 2011).

Note:

Bolded concentrations are higher than relevant water quality guidelines.

CWQG = Canadian Council of Ministers of the Environment (CCME) water quality guidelines for the protection of aquatic life (CCME 1999); CDWQG = Canadian Drinking Water Quality Guidelines (Health Canada 2012).

FF = far-field.

(C) = concentration higher than the relevant chronic CWQG or beyond the recommended pH or DO concentration range.

(D) = concentration higher than the relevant CDWQG or beyond the recommended pH or DO concentration range.

(DL>C) = analytical detection limit was higher than the relevant chronic CWQG.

(U) = concentration higher than the relevant under ice or beyond the recommended pH or DO concentration range.

(O) = concentration higher than the relevant open water or beyond the recommended pH or DO concentration range.

<= less than; >= greater than; - = no guideline or no data; DO = dissolved oxygen.

Water quality data and guidelines shown in this table were rounded to reflect laboratory or field instrument precision after comparisons to guidelines. Therefore, values slightly above guidelines may be displayed as being equal to the guidelines and identified as exceedances. Measured concentrations equal to the guideline values were not identified as exceedances.

pH set to 6.7 (median of the 2010-2014 dataset) for the purpose of pH-dependent guidelines.

Table 17-3 Predicted Water Quality (Depth-Averaged Maximum) in Lac de Gras (LDG-P2) by Operations, Closure, and Post-Closure

Part B

Parameter Name	Unit	LDG-P2 - Application Case																	
		Operations (2024 - 2029)						Closure - Pit Back-Flooding Period (2030 - 2033)						Post-Closure (2034 - 2060)					
		Under-Ice			Open-Water			Under-Ice			Open-Water			Under-Ice			Open-Water		
		Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum
Field Measured																			
Temperature	°C	0.2	0.7	1.2	0.9	6.9	11	0.2	0.6	1.6	0.9	6.4	11	0.1	0.6	3.1	0.9	7.0	11
Dissolved oxygen	mg/L	9.8	12	14	8.6	11	14	9.9	13	14	9.3	11	14	9.6	13	14	8.3	11	14
Conventional Parameters																			
Hardness	mg/L	7.1	**8.3**(U)	**9.8**(U)	**6.9**(O)	**7.5**(O)	**9.0**(O)	**8.2**(U)	**9.5**(U)	**10**(U)	**7.8**(O)	**8.6**(O)	**9.6**(O)	4.6	6.1	**9.5**(U)	4.4	**5.5**(O)	**9.0**(O)
Total dissolved solids	mg/L	17	19	21	16	17	20	18	**21**(U)	**22**(U)	18	19	21	11	15	**21**(U)	11	13	20
Total suspended solids	mg/L	1.4	**1.6**(U)	**1.8**(U)	1.4	1.5	1.7	1.4	**1.6**(U)	**1.6**(U)	1.3	1.4	1.6	1.3	1.4	**1.6**(U)	1.2	1.3	1.5
Major Ions																			
Calcium	mg/L	**1.5**(U)	**1.7**(U)	**2.1**(U)	**1.4**(O)	**1.5**(O)	**1.9**(O)	**2.0**(U)	**2.3**(U)	**2.5**(U)	**1.9**(O)	**2.1**(O)	**2.4**(O)	0.92	**1.3**(U)	**2.4**(U)	0.89	**1.2**(O)	**2.2**(O)
Chloride	mg/L	**2.6**(U)	**3.1**(U)	**4.1**(U)	**2.5**(O)	**2.8**(O)	**3.7**(O)	**4.0**(U)	**4.9**(U)	**5.2**(U)	**3.7**(O)	**4.4**(O)	**5.0**(O)	0.91	**2.1**(U)	**4.9**(U)	0.9	**1.9**(O)	**4.6**(O)
Fluoride	mg/L	0.01	0.013	0.013	0.011	0.012	0.013	0.01	0.011	0.013	0.01	0.01	0.011	0.0087	0.01	0.012	0.0082	0.009	0.011
Magnesium	mg/L	0.83	**0.98**(U)	**1.1**(U)	**0.81**(O)	**0.89**(O)	**1.1**(O)	0.76	0.89	**0.96**(U)	0.76	**0.81**(O)	**0.91**(O)	0.55	0.66	0.88	0.52	0.6	**0.83**(O)
Potassium	mg/L	**0.82**(U)	**1.0**(U)	**1.2**(U)	**0.81**(O)	**0.91**(O)	**1.1**(O)	0.73	**0.85**(U)	**0.94**(U)	**0.72**(O)	**0.77**(O)	**0.89**(O)	0.53	0.65	**0.83**(U)	0.51	0.59	**0.79**(O)
Sodium	mg/L	**1.7**(U)	**1.9**(U)	**2.2**(U)	**1.6**(O)	**1.8**(O)	**2.1**(O)	**1.8**(U)	**2.1**(U)	**2.2**(U)	**1.8**(O)	**1.9**(O)	**2.1**(O)	**0.73**(U)	**1.1**(U)	**2.0**(U)	**0.71**(O)	**1.0**(O)	**1.9**(O)
Sulphate	mg/L	2.8	**3.6**(U)	**4.3**(U)	2.7	**3.2**(O)	**4.1**(O)	2.3	2.8	**3.2**(U)	2.3	2.5	3.0	1.3	1.7	2.6	1.2	1.6	2.5
Nutrients																			
Nitrate	mg N/L	**0.025**(U)	**0.035**(U)	**0.05**(U)	**0.021**(O)	**0.028**(O)	**0.044**(O)	**0.023**(U)	**0.039**(U)	**0.047**(U)	**0.023**(O)	**0.034**(O)	**0.044**(O)	**0.018**(U)	**0.022**(U)	**0.029**(U)	**0.016**(O)	**0.018**(O)	**0.027**(O)
Total ammonia	mg N/L	0.025	0.03	0.034	0.02	0.023	0.028	0.017	0.025	0.028	0.017	0.02	0.023	0.01	0.012	0.02	0.0087	0.01	0.017
Total phosphorus	mg P/L	**0.0027**(U)	**0.0031**(U)	**0.0036**(U)	0.0024	**0.0026**(O)	**0.0032**(O)	**0.0025**(U)	**0.0029**(U)	**0.0032**(U)	0.0024	**0.0026**(O)	**0.003**(O)	0.0024	**0.0026**(U)	**0.003**(U)	0.0023	0.0024	**0.0028**(O)
Dissolved orthophosphate	mg P/L	0.0013	0.0017	0.0022	0.00099	0.0012	0.0018	0.0011	0.0015	0.0018	0.00099	0.0012	0.0016	0.001	0.0012	0.0016	0.00092	0.001	0.0014
Reactive silica	mg/L	0.12	0.13	0.14	0.11	0.12	0.13	0.12	0.14	0.14	0.12	0.12	0.14	0.12	0.13	0.14	0.11	0.12	0.14
Chlorophyll *a*	µg/L	0.29	0.61	2.1	0.5	1.8	3.1	0.21	0.42	1.3	0.32	1.2	1.8	0.067	0.14	0.7	0.082	0.47	0.9
Total Metals																			
Aluminum	µg/L	**20**(U)	**22**(U)	**26**(U)	**19**(O)	**20**(O)	**25**(O)	**17**(U)	**21**(U)	**22**(U)	**17**(O)	**19**(O)	**21**(O)	**6.4**(U)	**9.3**(U)	**19**(U)	6.4	**8.8**(O)	**18**(O)
Arsenic	µg/L	**0.28**(U)	**0.31**(U)	**0.34**(U)	**0.26**(O)	**0.28**(O)	**0.32**(O)	**0.26**(U)	**0.28**(U)	**0.29**(U)	**0.24**(O)	**0.25**(O)	**0.26**(O)	**0.21**(U)	**0.22**(U)	**0.27**(U)	0.19	0.2	**0.24**(O)
Barium	µg/L	**4.3**(U)	**4.9**(U)	**5.7**(U)	**3.9**(O)	**4.3**(O)	**5.2**(O)	**3.8**(U)	**4.3**(U)	**4.6**(U)	**3.4**(O)	**3.7**(O)	**4.1**(O)	**2.6**(U)	**3.0**(U)	**4.1**(U)	2.3	2.6	**3.6**(O)
Beryllium	µg/L	**0.11**(U)	**0.12**(U)	**0.12**(U)	**0.11**(O)	**0.12**(O)	**0.12**(O)	**0.11**(U)	**0.11**(U)	**0.11**(U)	**0.11**(O)	**0.11**(O)	**0.11**(O)	**0.1**(U)	**0.1**(U)	**0.11**(U)	**0.1**(O)	**0.11**(O)	**0.11**(O)
Bismuth	µg/L	**0.0061**(U)	**0.0085**(U)	**0.011**(U)	0.0058	0.0076	0.011	**0.0043**(U)	**0.0056**(U)	**0.0069**(U)	0.0041	0.0051	0.0064	0.00036	0.0013	**0.005**(U)	0.00035	0.0012	0.0045
Cadmium	µg/L	**0.032**(U)	**0.033**(U)	**0.036**(U)	**0.031**(O)	**0.032**(O)	**0.034**(O)	**0.03**(U)	**0.032**(U)	**0.032**(U)	**0.029**(O)	**0.031**(O)	**0.031**(O)	**0.027**(U)	**0.029**(U)	**0.032**(U)	**0.027**(O)	**0.028**(O)	**0.03**(O)
Chromium	µg/L	**0.082**(U)	**0.094**(U)	**0.11**(U)	0.076	0.083	0.1	**0.074**(U)	**0.083**(U)	**0.09**(U)	0.069	0.073	0.081	0.047	**0.054**(U)	**0.08**(U)	0.04	0.047	0.071
Cobalt	µg/L	0.067	0.071	0.08	**0.07**(O)	**0.073**(O)	**0.079**(O)	0.075	0.081	0.083	**0.078**(O)	**0.08**(O)	**0.083**(O)	0.052	0.059	0.078	**0.056**(O)	**0.061**(O)	**0.08**(O)
Copper	µg/L	0.39	0.4	0.42	0.37	0.38	0.39	0.39	0.4	0.41	0.36	0.37	0.38	0.35	0.36	0.4	0.33	0.34	0.37
Iron	µg/L	**20**(U)	**26**(U)	**34**(U)	**22**(O)	**26**(O)	**35**(O)	**16**(U)	**20**(U)	**23**(U)	**18**(O)	**21**(O)	**24**(O)	4.3	7.3	**18**(U)	6.7	9.2	**19**(O)
Lead	µg/L	0.034	0.035	0.037	0.032	0.033	0.036	0.032	0.034	0.035	0.031	0.033	0.033	0.027	0.028	0.033	0.026	0.028	0.031
Manganese	µg/L	**3.3**(U)	**3.6**(U)	**3.9**(U)	**5.1**(O)	**5.2**(O)	**5.7**(O)	**3.1**(U)	**3.5**(U)	**3.7**(U)	**4.9**(O)	**5.1**(O)	**5.4**(O)	**1.8**(U)	**2.2**(U)	**3.4**(U)	3.7	4.0	**5.0**(O)
Mercury	µg/L	**0.012**(U)	**0.011**(U)	**0.012**(U)	0.011	0.012	0.013	**0.011**(U)	**0.012**(U)	**0.012**(U)	0.012	0.012	0.011	**0.01**(U)	**0.01**(U)	**0.011**(U)	0.011	0.011	0.011
Molybdenum	µg/L	**2.2**(U)	**2.6**(U)	**3.1**(U)	**1.8**(O)	**2.1**(O)	**2.7**(O)	**1.9**(U)	**2.2**(U)	**2.5**(U)	**1.6**(O)	**1.7**(O)	**2.0**(O)	**1.3**(U)	**1.6**(U)	**2.2**(U)	**0.94**(O)	**1.1**(O)	**1.7**(O)
Nickel	µg/L	1.2	1.3	1.4	1.2	1.2	**1.3**(O)	1.2	1.2	1.3	1.2	1.2	1.2	1.1	1.1	1.2	1.1	1.1	1.2
Selenium	µg/L	0.098	**0.12**(U)	**0.14**(U)	**0.094**(O)	**0.11**(O)	**0.13**(O)	0.087	0.095	**0.11**(U)	**0.083**(O)	**0.089**(O)	**0.099**(O)	0.06	0.067	0.091	**0.058**(O)	**0.063**(O)	**0.086**(O)
Silver	µg/L	**0.055**(U)	**0.057**(U)	**0.06**(U)	**0.055**(O)	**0.057**(O)	**0.06**(O)	**0.053**(U)	**0.054**(U)	**0.055**(U)	**0.054**(O)	**0.055**(O)	**0.056**(O)	**0.05**(U)	**0.051**(U)	**0.054**(U)	**0.05**(O)	**0.05**(O)	**0.053**(O)

Table 17-3 Predicted Water Quality (Depth-Averaged Maximum) in Lac de Gras (LDG-P2) by Operations, Closure, and Post-Closure

Part B

Parameter Name	Unit	LDG-P2 - Application Case																	
		Operations (2024 - 2029)						Closure - Pit Back-Flooding Period (2030 - 2033)						Post-Closure (2034 - 2060)					
		Under-Ice			Open-Water			Under-Ice			Open-Water			Under-Ice			Open-Water		
		Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum
Strontium	µg/L	**30**(U)	**45**(U)	**74**(U)	**26**(O)	**35**(O)	**52**(O)	**73**(U)	**83**(U)	**87**(U)	**52**(O)	**56**(O)	**62**(O)	**25**(U)	**39**(U)	**82**(U)	**19**(O)	**28**(O)	**58**(O)
Uranium	µg/L	**0.23**(U)	**0.28**(U)	**0.35**(U)	**0.22**(O)	**0.25**(O)	**0.33**(O)	**0.18**(U)	**0.23**(U)	**0.26**(U)	**0.17**(O)	**0.2**(O)	**0.24**(O)	0.037	**0.075**(U)	**0.21**(U)	**0.037**(O)	**0.067**(O)	**0.19**(O)
Vanadium	µg/L	**0.31**(U)	**0.44**(U)	**0.58**(U)	**0.3**(O)	**0.39**(O)	**0.53**(O)	**0.24**(U)	**0.3**(U)	**0.36**(U)	**0.22**(O)	**0.26**(O)	**0.32**(O)	0.085	**0.13**(U)	**0.27**(U)	0.07	**0.1**(O)	**0.24**(O)
Zinc	µg/L	1.4	1.4	1.4	0.73	0.75	0.78	1.4	1.4	1.4	0.72	0.74	0.75	1.3	1.3	1.4	0.64	0.66	0.73

Source:

DDMI 2001 for data from 1994 to 2000; Stations included: Lac de Gras Mid-field Stations (LDG40, LDG41, LDG42, LDG43, LDG44, LDG45, LDG49), and Lac de Gras Far-field Stations (LDG46, LDG48, BHP-S); see DDMI 2001 for station locations within Lac de Gras.

DDMI 2011 and 2012 (FFA-1, FFA-2, FFA-3, FFA-4, and FFA-5 sampled in 2010 and 2011).

Note:

Bolded concentrations are higher than relevant water quality guidelines.

CWQG = Canadian Council of Ministers of the Environment (CCME) water quality guidelines for the protection of aquatic life (CCME 1999); CDWQG = Canadian Drinking Water Quality Guidelines (Health Canada 2012).

FF = far-field.

(C) = concentration higher than the relevant chronic CWQG or beyond the recommended pH or DO concentration range.

(D) = concentration higher than the relevant CDWQG or beyond the recommended pH or DO concentration range.

(DL>C) = analytical detection limit was higher than the relevant chronic CWQG.

(U) = concentration higher than the relevant under ice 2014 Baseline Condition or beyond the recommended DO concentration range.

(O) = concentration higher than the relevant open water 2014 Baseline Condition or beyond the recommended DO concentration range.

<= less than; >= greater than; - = no guideline or no data; DO = dissolved oxygen.

Water quality data and guidelines shown in this table were rounded to reflect laboratory or field instrument precision after comparisons to guidelines. Therefore, values slightly above guidelines may be displayed as being equal to the guidelines and identified as exceedances. Measured concentrations equal to the guideline values were not identified as exceedances.

pH set to 6.7 (median of the 2010-2014 dataset) for the purpose of pH-dependent guidelines.

Table 17-4 Predicted Water Quality (Depth-Averaged Maximum) in Lac de Gras (LDG-P3) by Operations, Closure, and Post-Closure

Part A

Parameter Name	Unit	Lac de Gras (whole lake) - - Reference Condition				Lac de Gras (FFA) - 2014 Baseline Condition								LDG-P3 - Application Case Early Operations (2019 - 2023)					
		Open-Water and Under-Ice				Under-Ice (2010 to 2012)				Open-Water (2010 to 2012)				Under-Ice			Open-Water		
		Count	Median	Range (25th to 75th %ile)	Percent of Samples Less than the Analytical Detection Limit	Count	Minimum	Median	Maximum	Count	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum
Field Measured																			
Temperature	°C	-	-	-	-		-	-	-	-	-	-	-	-	0.7	2.1	1.1	7.8	13
Dissolved oxygen	mg/L	-	-	-	-		-	-	-	-	-	-	-	-	13	14	10	11	14
Conventional Parameters																			
Hardness	mg/L	-	-	-	-	10	5.9	6.4	7.1	30	4.7	5.5	<10	**7.9**$^{(U)}$	**8.5**$^{(U)}$	**9.0**$^{(U)}$	**7.7**$^{(O)}$	**8.0**$^{(O)}$	**8.6**$^{(O)}$
Total dissolved solids	mg/L	-	-	-	-	10	9	12	21	30	<5.0	13	30	17	18	20	16	18	19
Total suspended solids	mg/L	433	2	1.0 to 3.0	75	5	<3.0	<3.0	<3.0	15	<3.0	<3.0	3	**1.5**$^{(U)}$	**1.6**$^{(U)}$	**1.7**$^{(U)}$	1.5	1.5	1.6
Major Ions																			
Calcium	mg/L	-	-	-	-	10	1.1	1.2	1.3	30	0.89	1.1	1.1	**1.6**$^{(U)}$	**1.7**$^{(U)}$	**1.8**$^{(U)}$	**1.5**$^{(O)}$	**1.6**$^{(O)}$	**1.7**$^{(O)}$
Chloride	mg/L	-	-	-	-	10	0.8	0.93	1.2	30	0.81	1	1.7	**2.7**$^{(U)}$	**3.0**$^{(U)}$	**3.4**$^{(U)}$	**2.5**$^{(O)}$	**2.9**$^{(O)}$	**3.1**$^{(O)}$
Fluoride	mg/L	-	-	-	-	10	0.02	0.03	<0.05	30	0.01	0.03	<0.05	0.013	0.013	0.014	0.011	0.013	0.013
Magnesium	mg/L	-	-	-	-	10	0.75	0.8	0.92	30	0.61	0.71	0.76	**0.96**$^{(U)}$	**1.0**$^{(U)}$	**1.1**$^{(U)}$	**0.94**$^{(O)}$	**0.98**$^{(O)}$	**1.0**$^{(O)}$
Potassium	mg/L	-	-	-	-	10	0.61	0.64	0.75	30	0.35	0.59	0.7	**0.94**$^{(U)}$	**1.0**$^{(U)}$	**1.1**$^{(U)}$	**0.91**$^{(O)}$	**0.98**$^{(O)}$	**1.1**$^{(O)}$
Sodium	mg/L	-	-	-	-	10	0.8	0.95	<1.0	30	0.76	0.82	<1.0	**1.8**$^{(U)}$	**2.0**$^{(U)}$	**2.2**$^{(U)}$	**1.7**$^{(O)}$	**1.9**$^{(O)}$	**2.0**$^{(O)}$
Sulphate	mg/L	-	-	-	-	10	2.3	2.6	2.8	30	1.4	2.5	3.2	**3.3**$^{(U)}$	**3.7**$^{(U)}$	**4.1**$^{(U)}$	3.1	**3.5**$^{(O)}$	**3.8**$^{(O)}$
Nutrients																			
Nitrate	mg N/L	-	-	-	-	10	<0.006	<0.013	<0.02	30	<0.006	<0.013	<0.02	**0.039**$^{(U)}$	**0.049**$^{(U)}$	**0.052**$^{(U)}$	**0.037**$^{(O)}$	**0.043**$^{(O)}$	**0.047**$^{(O)}$
Total ammonia	mg N/L	433	0.007	0.005 to 0.010	59	10	0.015	0.024	0.046	30	<0.005	0.0085	0.042	0.02	0.028	0.034	0.018	0.022	0.027
Total phosphorus	mg P/L	448	0.003	0.002 to 0.0042	25	10	0.002	0.0033	<0.005	30	<0.001	0.0049	<0.005	**0.0027**$^{(U)}$	**0.0032**$^{(U)}$	**0.0035**$^{(U)}$	0.0025	**0.0027**$^{(O)}$	**0.003**$^{(O)}$
Dissolved orthophosphate	mg P/L	-	-	-	-	10	<0.001	<0.003	<0.005	30	<0.001	<0.003	<0.005	0.0013	0.0018	0.0021	0.0011	0.0013	0.0016
Reactive silica	mg/L	-	-	-	-		-	-	-	-	-	-	-	-	0.13	0.14	0.12	0.12	0.13
Chlorophyll *a*	µg/L	-	-	-	-		-	-	-	-	-	-	-	-	0.44	2.3	0.59	1.7	3.1
Total Metals																			
Aluminum	µg/L	458	7.95	3.2 to 18.75	7	10	3	3.7	4.6	30	3.2	5	7.2	**19**$^{(U)}$	**22**$^{(U)}$	**25**$^{(U)}$	**19**$^{(O)}$	**21**$^{(O)}$	**23**$^{(O)}$
Arsenic	µg/L	411	0.2	0.18 to 0.21	23	10	0.081	0.16	0.19	30	0.15	0.18	0.23	**0.3**$^{(U)}$	**0.32**$^{(U)}$	**0.34**$^{(U)}$	**0.27**$^{(O)}$	**0.29**$^{(O)}$	**0.31**$^{(O)}$
Barium	µg/L	-	-	-	-	10	1.8	2	2.3	30	1.7	1.8	2.8	**4.6**$^{(U)}$	**5.0**$^{(U)}$	**5.5**$^{(U)}$	**4.2**$^{(O)}$	**4.6**$^{(O)}$	**4.9**$^{(O)}$
Beryllium	µg/L	-	-	-	-	10	<0.01	<0.11	<0.2	30	<0.01	<0.11	<0.2	**0.11**$^{(U)}$	**0.12**$^{(U)}$	**0.12**$^{(U)}$	**0.12**$^{(O)}$	**0.12**$^{(O)}$	**0.12**$^{(O)}$
Bismuth	µg/L	-	-	-	-	5	<0.005	<0.005	<0.005	17	<0.005	<0.005	<0.2	**0.0079**$^{(U)}$	**0.0094**$^{(U)}$	**0.011**$^{(U)}$	0.0075	0.009	0.01
Cadmium	µg/L	465	**0.05** $^{(DL>C)}$	**0.05** $^{(DL>C)}$ to **0.2** $^{(DL>C)}$	95	10	<0.005	<0.028	<0.05$^{(DL>C)}$	30	<0.005	0.006	<0.05$^{(DL>C)}$	**0.032**$^{(U)}$	**0.034**$^{(U)}$	**0.034**$^{(U)}$	**0.032**$^{(O)}$	**0.033**$^{(O)}$	**0.033**$^{(O)}$
Chromium	µg/L	459	0.33	0.185 to **1.2** $^{(C)}$	37	10	<0.06	0.074	<0.1	30	<0.06	<0.1	0.21	**0.086**$^{(U)}$	**0.095**$^{(U)}$	**0.1**$^{(U)}$	0.08	0.088	0.095
Cobalt	µg/L	-	-	-	-	10	0.006	0.02	0.19	30	0.019	0.028	<0.1	0.065	0.068	0.07	**0.069**$^{(O)}$	**0.072**$^{(O)}$	**0.073**$^{(O)}$
Copper	µg/L	459	0.7	0.6 to 1.0	51	10	0.53	0.61	0.67	30	0.48	<0.6	1	0.39	0.4	0.41	0.37	0.38	0.39

Table 17-4 Predicted Water Quality (Depth-Averaged Maximum) in Lac de Gras (LDG-P3) by Operations, Closure, and Post-Closure

Part A

Parameter Name	Unit	Lac de Gras (whole lake) - - Reference Condition				Lac de Gras (FFA) - 2014 Baseline Condition								LDG-P3 - Application Case					
														Early Operations (2019 - 2023)					
		Open-Water and Under-Ice				Under-Ice (2010 to 2012)				Open-Water (2010 to 2012)				Under-Ice			Open-Water		
		Count	Median	Range (25th to 75th %ile)	Percent of Samples Less than the Analytical Detection Limit	Count	Minimum	Median	Maximum	Count	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum
Iron	µg/L	-	-	-	-	10	1	3	9.1	30	4	5.8	9.5	**24$^{(U)}$**	**28$^{(U)}$**	**32$^{(U)}$**	**26$^{(O)}$**	**29$^{(O)}$**	**32$^{(O)}$**
Lead	µg/L	388	0.05	0.05 to 0.07	85	10	<0.005	0.028	0.074	30	<0.005	0.01	0.056	0.034	0.035	0.036	0.033	0.034	0.035
Manganese	µg/L	-	-	-	-	10	0.62	1.2	1.6	30	1.8	2.5	4.2	**3.2$^{(U)}$**	**3.5$^{(U)}$**	**3.8$^{(U)}$**	**5.1$^{(O)}$**	**5.3$^{(O)}$**	**5.5$^{(O)}$**
Mercury	µg/L	-	-	-	-	10	<0.01	<0.015	<0.02	25	<0.01	<0.02	0.02	**0.011$^{(U)}$**	**0.012$^{(U)}$**	**0.011$^{(U)}$**	0.011	0.011	0.012
Molybdenum	µg/L	-	-	-	-	10	0.08	0.13	0.15	30	0.073	0.12	0.73	**2.3$^{(U)}$**	**2.7$^{(U)}$**	**3.1$^{(U)}$**	**2.0$^{(O)}$**	**2.3$^{(O)}$**	**2.6$^{(O)}$**
Nickel	µg/L	459	0.69	0.5 to 1.40	16	10	0.92	1	1.7	30	0.79	0.94	1.3	1.3	1.3	1.4	1.2	1.3	**1.3$^{(O)}$**
Selenium	µg/L	-	-	-	-	10	<0.04	<0.07	0.1	30	<0.04	<0.07	<0.1	**0.11$^{(U)}$**	**0.13$^{(U)}$**	**0.14$^{(U)}$**	**0.11$^{(O)}$**	**0.12$^{(O)}$**	**0.13$^{(O)}$**
Silver	µg/L	-	-	-	-	10	<0.005	<0.053	<0.1	30	<0.005	<0.053	<0.1	**0.057$^{(U)}$**	**0.058$^{(U)}$**	**0.06$^{(U)}$**	**0.057$^{(O)}$**	**0.058$^{(O)}$**	**0.059$^{(O)}$**
Strontium	µg/L	-	-	-	-	10	7.7	8.3	10	30	7.9	8.7	9.8	**28$^{(U)}$**	**31$^{(U)}$**	**34$^{(U)}$**	**24$^{(O)}$**	**26$^{(O)}$**	**28$^{(O)}$**
Uranium	µg/L	-	-	-	-	10	0.023	0.031	0.05	30	0.02	0.03	<0.05	**0.25$^{(U)}$**	**0.29$^{(U)}$**	**0.33$^{(U)}$**	**0.24$^{(O)}$**	**0.28$^{(O)}$**	**0.31$^{(O)}$**
Vanadium	µg/L	-	-	-	-	10	<0.05	<0.13	<0.2	30	<0.05	<0.13	<0.2	**0.41$^{(U)}$**	**0.48$^{(U)}$**	**0.54$^{(U)}$**	**0.38$^{(O)}$**	**0.45$^{(O)}$**	**0.49$^{(O)}$**
Zinc	µg/L	369	1	0.8 to 6.5	46	10	0.5	1.3	2.3	30	0.3	<0.8	3.3	1.4	1.4	1.4	0.73	0.75	0.77

Source:
DDMI 2001 for data from 1994 to 2000; Stations included: Lac de Gras Mid-field Stations (LDG40, LDG41, LDG42, LDG43, LDG44, LDG45, LDG49), and Lac de Gras Far-field Stations (LDG46, LDG48, BHP-S); see DDMI 2001 for station locations within Lac de Gras.
DDMI 2011 and 2012 (FFA-1, FFA-2, FFA-3, FFA-4, and FFA-5 sampled in 2010 and 2011).

Note:
Bolded concentrations are higher than relevant water quality guidelines.
CWQG = Canadian Council of Ministers of the Environment (CCME) water quality guidelines for the protection of aquatic life (CCME 1999); CDWQG = Canadian Drinking Water Quality Guidelines (Health Canada 2012).
FF = far-field.
(C) = concentration higher than the relevant chronic CWQG or beyond the recommended pH or DO concentration range.
(D) = concentration higher than the relevant CDWQG or beyond the recommended pH or DO concentration range.
(DL>C) = analytical detection limit was higher than the relevant chronic CWQG.
(U) = concentration higher than the relevant under ice 2014 Baseline Condition or beyond the recommended DO concentration range.
(O) = concentration higher than the relevant open water 2014 Baseline Condition or beyond the recommended DO concentration range.
<= less than; >= greater than; - = no guideline or no data; DO = dissolved oxygen.
Water quality data and guidelines shown in this table were rounded to reflect laboratory or field instrument precision after comparisons to guidelines. Therefore, values slightly above guidelines may be displayed as being equal to the guidelines and identified as exceedances. Measured concentrations equal to the guideline values were not identified as exceedances.
pH set to 6.7 (median of the 2010-2014 dataset) for the purpose of pH-dependent guidelines.

Table 17-4 Predicted Water Quality (Depth-Averaged Maximum) in Lac de Gras (LDG-P3) by Operations, Closure, and Post-Closure

Part B

Parameter Name	Unit	LDG-P3 - Application Case																	
		Operations (2024 - 2029)						Closure - Pit Back-Flooding Period (2030 - 2033)						Post-Closure (2034 - 2060)					
		Under-Ice			Open-Water			Under-Ice			Open-Water			Under-Ice			Open-Water		
		Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum
Field Measured																			
Temperature	°C	0.2	0.7	1.4	1.2	7.3	14	0.2	0.7	2.6	1.1	6.8	14	0.2	0.7	3.1	1.1	7.2	14
Dissolved oxygen	mg/L	10	12	14	10	11	14	10	13	14	10	11	14	10	13	14	9.8	11	14
Conventional Parameters																			
Hardness	mg/L	**7.1(U)**	**8.1(U)**	**9.3(U)**	**7.0(O)**	**7.5(O)**	**8.7(O)**	**7.9(U)**	**9.0(U)**	**9.6(U)**	**7.7(O)**	**8.5(O)**	**9.2(O)**	4.6	5.9	**9.2(U)**	4.5	**5.6(O)**	**8.6(O)**
Total dissolved solids	mg/L	17	19	20	17	17	19	18	20	**21(U)**	18	19	20	11	14	20	11	13	19
Total suspended solids	mg/L	1.4	**1.6(U)**	**1.7(U)**	1.4	1.5	1.6	1.4	1.5	**1.6(U)**	1.3	1.4	1.5	1.3	1.4	**1.5(U)**	1.3	1.3	1.4
Major Ions																			
Calcium	mg/L	**1.5(U)**	**1.6(U)**	**1.9(U)**	**1.4(O)**	**1.5(O)**	**1.8(O)**	**1.9(U)**	**2.2(U)**	**2.3(U)**	**1.8(O)**	**2.1(O)**	**2.2(O)**	0.92	**1.3(U)**	**2.3(U)**	0.91	**1.2(O)**	**2.1(O)**
Chloride	mg/L	**2.7(U)**	**3.0(U)**	**3.8(U)**	**2.6(O)**	**2.8(O)**	**3.4(O)**	**3.7(U)**	**4.5(U)**	**4.9(U)**	**3.6(O)**	**4.3(O)**	**4.6(O)**	0.92	**2.0(U)**	**4.7(U)**	0.92	**1.9(O)**	**4.3(O)**
Fluoride	mg/L	0.01	0.012	0.013	0.01	0.012	0.013	0.011	0.011	0.012	0.0099	0.01	0.011	0.0088	0.0097	0.011	0.0086	0.0092	0.011
Magnesium	mg/L	0.83	**0.96(U)**	**1.1(U)**	**0.82(O)**	**0.89(O)**	**1.0(O)**	0.77	0.86	**0.92(U)**	0.76	**0.81(O)**	**0.88(O)**	0.55	0.64	0.85	0.54	0.61	**0.8(O)**
Potassium	mg/L	**0.83(U)**	**0.99(U)**	**1.1(U)**	**0.83(O)**	**0.92(O)**	**1.1(O)**	0.73	**0.83(U)**	**0.92(U)**	**0.72(O)**	**0.78(O)**	**0.87(O)**	0.54	0.64	**0.81(U)**	0.53	0.6	**0.76(O)**
Sodium	mg/L	**1.7(U)**	**1.9(U)**	**2.2(U)**	**1.7(O)**	**1.8(O)**	**2.0(O)**	**1.8(U)**	**2.0(U)**	**2.1(U)**	**1.8(O)**	**1.9(O)**	**2.0(O)**	**0.73(U)**	**1.1(U)**	**2.0(U)**	**0.72(O)**	**1.0(O)**	**1.8(O)**
Sulphate	mg/L	2.8	**3.6(U)**	**4.2(U)**	2.8	**3.3(O)**	**3.9(O)**	2.3	2.7	**3.1(U)**	2.3	2.5	2.9	1.3	1.7	2.5	1.3	1.6	2.4
Nutrients																			
Nitrate	mg N/L	**0.026(U)**	**0.033(U)**	**0.047(U)**	**0.023(O)**	**0.027(O)**	**0.038(O)**	**0.024(U)**	**0.036(U)**	**0.044(U)**	**0.023(O)**	**0.031(O)**	**0.039(O)**	**0.018(U)**	**0.021(U)**	**0.029(U)**	**0.018(O)**	**0.02(O)**	**0.025(O)**
Total ammonia	mg N/L	0.024	0.028	0.033	0.02	0.023	0.029	0.017	0.024	0.026	0.016	0.02	0.023	0.0095	0.011	0.018	0.0086	0.0098	0.015
Total phosphorus	mg P/L	**0.0026(U)**	**0.0031(U)**	**0.0035(U)**	0.0024	**0.0026(O)**	**0.0029(O)**	**0.0025(U)**	**0.0029(U)**	**0.0031(U)**	0.0024	**0.0025(O)**	**0.0028(O)**	0.0025	**0.0026(U)**	**0.0029(U)**	0.0023	0.0025	**0.0027(O)**
Dissolved orthophosphate	mg P/L	0.0012	0.0017	0.0021	0.00095	0.0012	0.0015	0.0011	0.0015	0.0017	0.00099	0.0011	0.0014	0.0011	0.0012	0.0015	0.00097	0.0011	0.0013
Reactive silica	mg/L	0.12	0.13	0.13	0.12	0.12	0.13	0.12	0.13	0.14	0.12	0.12	0.13	0.12	0.13	0.14	0.12	0.12	0.13
Chlorophyll *a*	µg/L	0.28	0.55	2.2	0.88	1.8	3.3	0.19	0.38	1.3	0.6	1.2	1.9	0.055	0.13	0.68	0.21	0.44	0.88
Total Metals																			
Aluminum	µg/L	**20(U)**	**22(U)**	**25(U)**	**19(O)**	**20(O)**	**24(O)**	**18(U)**	**20(U)**	**22(U)**	**17(O)**	**19(O)**	**20(O)**	**6.6(U)**	**9.4(U)**	**19(U)**	6.5	**9.0(O)**	**18(O)**
Arsenic	µg/L	**0.28(U)**	**0.31(U)**	**0.34(U)**	**0.26(O)**	**0.28(O)**	**0.31(O)**	**0.26(U)**	**0.28(U)**	**0.29(U)**	**0.24(O)**	**0.25(O)**	**0.26(O)**	**0.21(U)**	**0.23(U)**	**0.27(U)**	0.19	0.2	**0.24(O)**
Barium	µg/L	**4.3(U)**	**4.9(U)**	**5.6(U)**	**3.9(O)**	**4.4(O)**	**5.0(O)**	**3.9(U)**	**4.2(U)**	**4.6(U)**	**3.5(O)**	**3.7(O)**	**4.0(O)**	**2.7(U)**	**3.0(U)**	**4.1(U)**	2.3	2.6	**3.5(O)**
Beryllium	µg/L	**0.11(U)**	**0.11(U)**	**0.12(U)**	**0.11(O)**	**0.12(O)**	**0.12(O)**	**0.11(U)**	**0.11(U)**	**0.11(U)**	**0.11(O)**	**0.11(O)**	**0.11(O)**	**0.1(U)**	**0.1(U)**	**0.11(U)**	**0.1(O)**	**0.11(O)**	**0.11(O)**
Bismuth	µg/L	**0.006(U)**	**0.0085(U)**	**0.011(U)**	0.006	0.0076	0.01	0.0043	**0.0056(U)**	**0.0067(U)**	0.0043	0.005	0.0061	0.00036	0.0014	**0.0049(U)**	0.00036	0.0011	0.0043
Cadmium	µg/L	**0.032(U)**	**0.034(U)**	**0.035(U)**	**0.031(O)**	**0.032(O)**	**0.034(O)**	**0.03(U)**	**0.031(U)**	**0.033(U)**	**0.029(O)**	**0.03(O)**	**0.03(O)**	**0.027(U)**	**0.028(U)**	**0.032(U)**	**0.027(O)**	**0.028(O)**	**0.03(O)**
Chromium	µg/L	**0.084(U)**	**0.093(U)**	**0.11(U)**	0.077	0.083	0.096	**0.075(U)**	**0.083(U)**	**0.088(U)**	0.07	0.075	0.079	0.048	**0.055(U)**	**0.08(U)**	0.042	0.048	0.07
Cobalt	µg/L	0.067	0.07	0.078	**0.071(O)**	**0.073(O)**	**0.078(O)**	0.075	0.079	0.082	**0.077(O)**	**0.079(O)**	**0.082(O)**	0.052	0.057	0.078	**0.057(O)**	**0.062(O)**	**0.078(O)**
Copper	µg/L	0.4	0.4	0.42	0.37	0.38	0.39	0.39	0.4	0.41	0.37	0.37	0.38	0.35	0.37	0.4	0.33	0.34	0.37
Iron	µg/L	**20(U)**	**26(U)**	**32(U)**	**23(O)**	**26(O)**	**33(O)**	**16(U)**	**20(U)**	**22(U)**	**18(O)**	**21(O)**	**23(O)**	4.4	7.3	**18(U)**	6.8	9.3	**18(O)**
Lead	µg/L	0.033	0.035	0.037	0.032	0.034	0.035	0.032	0.034	0.035	0.032	0.033	0.033	0.027	0.028	0.034	0.025	0.028	0.032
Manganese	µg/L	**3.3(U)**	**3.5(U)**	**3.8(U)**	**5.1(O)**	**5.2(O)**	**5.6(O)**	**3.1(U)**	**3.4(U)**	**3.6(U)**	**5.0(O)**	**5.1(O)**	**5.2(O)**	**1.8(U)**	**2.2(U)**	**3.3(U)**	3.7	4.0	**5.0(O)**
Mercury	µg/L	**0.012(U)**	**0.012(U)**	**0.012(U)**	0.011	0.012	0.012	**0.011(U)**	**0.011(U)**	**0.011(U)**	0.012	0.012	0.012	**0.011(U)**	**0.011(U)**	**0.012(U)**	0.01	0.011	0.012
Molybdenum	µg/L	**2.3(U)**	**2.7(U)**	**3.1(U)**	**1.9(O)**	**2.2(O)**	**2.6(O)**	**2.0(U)**	**2.3(U)**	**2.5(U)**	**1.6(O)**	**1.8(O)**	**2.0(O)**	**1.4(U)**	**1.6(U)**	**2.2(U)**	**1.0(O)**	**1.2(O)**	**1.7(O)**
Nickel	µg/L	1.2	1.3	1.4	1.2	1.3	**1.3(O)**	1.2	1.2	1.3	1.2	1.2	1.2	1.1	1.1	1.2	1.1	1.1	1.2
Selenium	µg/L	0.1	**0.12(U)**	**0.14(U)**	**0.096(O)**	**0.11(O)**	**0.13(O)**	0.088	0.096	**0.1(U)**	**0.083(O)**	**0.09(O)**	**0.098(O)**	0.062	0.067	0.091	**0.057(O)**	**0.063(O)**	**0.085(O)**
Silver	µg/L	**0.055(U)**	**0.057(U)**	**0.06(U)**	**0.055(O)**	**0.057(O)**	**0.059(O)**	**0.054(U)**	**0.055(U)**	**0.055(U)**	**0.053(O)**	**0.055(O)**	**0.055(O)**	**0.051(U)**	**0.05(U)**	**0.053(U)**	**0.051(O)**	**0.05(O)**	**0.053(O)**

Table 17-4 Predicted Water Quality (Depth-Averaged Maximum) in Lac de Gras (LDG-P3) by Operations, Closure, and Post-Closure

Part B

Parameter Name	Unit	LDG-P3 - Application Case																	
		Operations (2024 - 2029)						Closure - Pit Back-Flooding Period (2030 - 2033)						Post-Closure (2034 - 2060)					
		Under-Ice			Open-Water			Under-Ice			Open-Water			Under-Ice			Open-Water		
		Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum
Strontium	µg/L	**32**(U)	**42**(U)	**71**(U)	**27**(O)	**33**(O)	**50**(O)	**70**(U)	**78**(U)	**84**(U)	**51**(O)	**56**(O)	**59**(O)	**26**(U)	**40**(U)	**81**(U)	**20**(O)	**29**(O)	**55**(O)
Uranium	µg/L	**0.23**(U)	**0.27**(U)	**0.34**(U)	**0.22**(O)	**0.25**(O)	**0.31**(O)	**0.18**(U)	**0.22**(U)	**0.25**(U)	**0.18**(O)	**0.2**(O)	**0.23**(O)	0.039	**0.074**(U)	**0.2**(U)	**0.037**(O)	**0.068**(O)	**0.18**(O)
Vanadium	µg/L	**0.32**(U)	**0.44**(U)	**0.56**(U)	**0.31**(O)	**0.39**(O)	**0.5**(O)	**0.25**(U)	**0.3**(U)	**0.35**(U)	**0.23**(O)	**0.27**(O)	**0.31**(O)	0.092	**0.13**(U)	**0.27**(U)	0.075	**0.11**(O)	**0.23**(O)
Zinc	µg/L	1.4	1.4	1.4	0.74	0.75	0.77	1.4	1.4	1.4	0.73	0.74	0.75	1.3	1.3	1.4	0.65	0.67	0.73

Source:

DDMI 2001 for data from 1994 to 2000; Stations included: Lac de Gras Mid-field Stations (LDG40, LDG41, LDG42, LDG43, LDG44, LDG45, LDG49), and Lac de Gras Far-field Stations (LDG46, LDG48, BHP-S); see DDMI 2001 for station locations within Lac de Gras.

DDMI 2011 and 2012 (FFA-1, FFA-2, FFA-3, FFA-4, and FFA-5 sampled in 2010 and 2011).

Note:

Bolded concentrations are higher than relevant water quality guidelines.

CWQG = Canadian Council of Ministers of the Environment (CCME) water quality guidelines for the protection of aquatic life (CCME 1999); CDWQG = Canadian Drinking Water Quality Guidelines (Health Canada 2012).

FF = far-field.

(C) = concentration higher than the relevant chronic CWQG or beyond the recommended pH or DO concentration range.

(D) = concentration higher than the relevant CDWQG or beyond the recommended pH or DO concentration range.

(DL>C) = analytical detection limit was higher than the relevant chronic CWQG.

(U) = concentration higher than the relevant under ice 2014 Baseline Condition or beyond the recommended DO concentration range.

(O) = concentration higher than the relevant open water 2014 Baseline Condition or beyond the recommended DO concentration range.

<= less than; >= greater than; - = no guideline or no data; DO = dissolved oxygen.

Water quality data and guidelines shown in this table were rounded to reflect laboratory or field instrument precision after comparisons to guidelines. Therefore, values slightly above guidelines may be displayed as being equal to the guidelines and identified as exceedances. Measured concentrations equal to the guideline values were not identified as exceedances.

pH set to 6.7 (median of the 2010-2014 dataset) for the purpose of pH-dependent guidelines.

Table 17-5 Predicted Water Quality (Depth-Averaged Maximum) in Lac de Gras (LDG-P4) by Operations, Closure, and Post-Closure

Part A

Parameter Name	Unit	Lac de Gras (whole lake) - Reference Condition				Lac de Gras (FFA) - 2014 Baseline Condition								LDG-P4 - Application Case Early Operations (2019 - 2023)					
		Open-Water and Under-Ice				Under-Ice (2010 to 2012)				Open-Water (2010 to 2012)				Under-Ice			Open-Water		
		Count	Median	Range (25th to 75th %ile)	Percent of Samples Less than the Analytical Detection Limit	Count	Minimum	Median	Maximum	Count	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum
Field Measured																			
Temperature	°C	-	-	-	-	-	-	-	-	-	-	-	-	0.3	0.8	3.3	1.1	8.0	13
Dissolved oxygen	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	9.4	12	14	9.0	11	13
Conventional Parameters																			
Hardness	mg/L	-	-	-	-	10	5.9	6.4	7.1	30	4.7	5.5	<10	**8.0(U)**	**8.4(U)**	**8.8(U)**	**7.6(O)**	**8.1(O)**	**8.2(O)**
Total dissolved solids	mg/L	-	-	-	-	10	9	12	21	30	<5.0	13	30	17	18	20	16	18	19
Total suspended solids	mg/L	433	2	1.0 to 3.0	75	5	<3.0	<3.0	<3.0	15	<3.0	<3.0	3	1.5	**1.6(U)**	**1.6(U)**	1.4	1.5	1.5
Major Ions																			
Calcium	mg/L	-	-	-	-	10	1.1	1.2	1.3	30	0.89	1.1	1.1	**1.6(U)**	**1.7(U)**	**1.8(U)**	**1.5(O)**	**1.6(O)**	**1.7(O)**
Chloride	mg/L	-	-	-	-	10	0.8	0.93	1.2	30	0.81	1	1.7	**2.8(U)**	**3.1(U)**	**3.4(U)**	**2.5(O)**	**3.0(O)**	**3.2(O)**
Fluoride	mg/L	-	-	-	-	10	0.02	0.03	<0.05	30	0.01	0.03	<0.05	0.012	0.013	0.014	0.012	0.012	0.012
Magnesium	mg/L	-	-	-	-	10	0.75	0.8	0.92	30	0.61	0.71	0.76	**0.96(U)**	**1.0(U)**	**1.1(U)**	**0.91(O)**	**0.97(O)**	**0.99(O)**
Potassium	mg/L	-	-	-	-	10	0.61	0.64	0.75	30	0.35	0.59	0.7	**0.96(U)**	**1.0(U)**	**1.1(U)**	**0.89(O)**	**0.99(O)**	**1.0(O)**
Sodium	mg/L	-	-	-	-	10	0.8	0.95	<1.0	30	0.76	0.82	<1.0	**1.8(U)**	**2.0(U)**	**2.2(U)**	**1.7(O)**	**2.0(O)**	**2.1(O)**
Sulphate	mg/L	-	-	-	-	10	2.3	2.6	2.8	30	1.4	2.5	3.2	**3.2(U)**	**3.6(U)**	**4.0(U)**	2.9	**3.4(O)**	**3.8(O)**
Nutrients																			
Nitrate	mg N/L	-	-	-	-	10	<0.006	<0.013	<0.02	30	<0.006	<0.013	<0.02	**0.04(U)**	**0.05(U)**	**0.051(U)**	**0.039(O)**	**0.046(O)**	**0.052(O)**
Total ammonia	mg N/L	433	0.007	0.005 to 0.010	59	10	0.015	0.024	0.046	30	<0.005	0.0085	0.042	0.019	0.028	0.034	0.017	0.023	0.028
Total phosphorus	mg P/L	448	0.003	0.002 to 0.0042	25	10	0.002	0.0033	<0.005	30	<0.001	0.0049	<0.005	**0.0027(U)**	**0.0031(U)**	**0.0034(U)**	0.0025	**0.0027(O)**	**0.0029(O)**
Dissolved orthophosphate	mg P/L	-	-	-	-	10	<0.001	<0.003	<0.005	30	<0.001	<0.003	<0.005	0.0013	0.0017	0.002	0.0011	0.0013	0.0015
Reactive silica	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	0.12	0.12	0.13	0.12	0.12	0.12
Chlorophyll *a*	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	0.17	0.44	2.4	0.55	1.7	3.0
Total Metals																			
Aluminum	µg/L	458	7.95	3.2 to 18.75	7	10	3	3.7	4.6	30	3.2	5	7.2	**19(U)**	**21(U)**	**24(U)**	**17(O)**	**20(O)**	**23(O)**
Arsenic	µg/L	411	0.2	0.18 to 0.21	23	10	0.081	0.16	0.19	30	0.15	0.18	0.23	**0.29(U)**	**0.31(U)**	**0.33(U)**	**0.27(O)**	**0.29(O)**	**0.3(O)**
Barium	µg/L	-	-	-	-	10	1.8	2	2.3	30	1.7	1.8	2.8	**4.5(U)**	**4.9(U)**	**5.4(U)**	**4.0(O)**	**4.5(O)**	**4.9(O)**
Beryllium	µg/L	-	-	-	-	10	<0.01	<0.11	<0.2	30	<0.01	<0.11	<0.2	**0.11(U)**	**0.12(U)**	**0.12(U)**	**0.12(O)**	**0.12(O)**	**0.12(O)**
Bismuth	µg/L	-	-	-	-	5	<0.005	<0.005	<0.005	17	<0.005	<0.005	<0.2	**0.0074(U)**	**0.0085(U)**	**0.01(U)**	**0.0067**	**0.008**	**0.0094**
Cadmium	µg/L	465	**0.05** (DL>C)	**0.05** (DL>C) to **0.2** (DL>C)	95	10	<0.005	<0.028	<0.05(DL>C)	30	<0.005	0.006	<0.05(DL>C)	**0.033(U)**	**0.034(U)**	**0.035(U)**	**0.03(O)**	**0.033(O)**	**0.034(O)**
Chromium	µg/L	459	0.33	0.185 to **1.2**(C)	37	10	<0.06	0.074	<0.1	30	<0.06	<0.1	0.21	**0.085(U)**	**0.094(U)**	**0.1(U)**	0.075	0.086	0.093
Cobalt	µg/L	-	-	-	-	10	0.006	0.02	0.19	30	0.019	0.028	<0.1	**0.064**	**0.067**	**0.069**	**0.068(O)**	**0.071(O)**	**0.074(O)**
Copper	µg/L	459	0.7	0.6 to 1.0	51	10	0.53	0.61	0.67	30	0.48	<0.6	1	0.39	0.4	0.42	0.37	0.38	0.39

Table 17-5 Predicted Water Quality (Depth-Averaged Maximum) in Lac de Gras (LDG-P4) by Operations, Closure, and Post-Closure

Part A

Parameter Name	Unit	Lac de Gras (whole lake) - Reference Condition				Lac de Gras (FFA) - 2014 Baseline Condition								LDG-P4 - Application Case Early Operations (2019 - 2023)					
		Open-Water and Under-Ice				Under-Ice (2010 to 2012)				Open-Water (2010 to 2012)				Under-Ice			Open-Water		
		Count	Median	Range (25^{th} to 75^{th} %ile)	Percent of Samples Less than the Analytical Detection Limit	Count	Minimum	Median	Maximum	Count	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum
Iron	µg/L	-	-	-	-	10	1	3	9.1	30	4	5.8	9.5	**23**$^{(U)}$	**26**$^{(U)}$	**31**$^{(U)}$	**23**$^{(O)}$	**27**$^{(O)}$	**31**$^{(O)}$
Lead	µg/L	388	0.05	0.05 to 0.07	85	10	<0.005	0.028	0.074	30	<0.005	0.01	0.056	0.033	0.035	0.036	0.032	0.034	0.034
Manganese	µg/L	-	-	-	-	10	0.62	1.2	1.6	30	1.8	2.5	4.2	**3.1**$^{(U)}$	**3.4**$^{(U)}$	**3.7**$^{(U)}$	**4.9**$^{(O)}$	**5.2**$^{(O)}$	**5.4**$^{(O)}$
Mercury	µg/L	-	-	-	-	10	<0.01	<0.015	<0.02	25	<0.01	<0.02	0.02	**0.011**$^{(U)}$	**0.012**$^{(U)}$	**0.011**$^{(U)}$	**0.012**	**0.012**	**0.013**
Molybdenum	µg/L	-	-	-	-	10	0.08	0.13	0.15	30	0.073	0.12	0.73	**2.4**$^{(U)}$	**2.8**$^{(U)}$	**3.2**$^{(U)}$	**2.0**$^{(O)}$	**2.4**$^{(O)}$	**2.7**$^{(O)}$
Nickel	µg/L	459	0.69	0.5 to 1.40	16	10	0.92	1	1.7	30	0.79	0.94	1.3	1.3	1.3	1.3	1.2	1.3	1.3
Selenium	µg/L	-	-	-	-	10	<0.04	<0.07	0.1	30	<0.04	<0.07	<0.1	**0.11**$^{(U)}$	**0.12**$^{(U)}$	**0.13**$^{(U)}$	**0.1**$^{(O)}$	**0.11**$^{(O)}$	**0.12**$^{(O)}$
Silver	µg/L	-	-	-	-	10	<0.005	<0.053	<0.1	30	<0.005	<0.053	<0.1	**0.057**$^{(U)}$	**0.058**$^{(U)}$	**0.06**$^{(U)}$	**0.055**$^{(O)}$	**0.057**$^{(O)}$	**0.058**$^{(O)}$
Strontium	µg/L	-	-	-	-	10	7.7	8.3	10	30	7.9	8.7	9.8	**29**$^{(U)}$	**32**$^{(U)}$	**36**$^{(U)}$	**24**$^{(O)}$	**28**$^{(O)}$	**30**$^{(O)}$
Uranium	µg/L	-	-	-	-	10	0.023	0.031	0.05	30	0.02	0.03	<0.05	**0.23**$^{(U)}$	**0.27**$^{(U)}$	**0.32**$^{(U)}$	**0.21**$^{(O)}$	**0.25**$^{(O)}$	**0.29**$^{(O)}$
Vanadium	µg/L	-	-	-	-	10	<0.05	<0.13	<0.2	30	<0.05	<0.13	<0.2	**0.39**$^{(U)}$	**0.45**$^{(U)}$	**0.53**$^{(U)}$	**0.35**$^{(O)}$	**0.41**$^{(O)}$	**0.47**$^{(O)}$
Zinc	µg/L	369	1	0.8 to 6.5	46	10	0.5	1.3	2.3	30	0.3	<0.8	3.3	1.4	1.4	1.4	0.73	0.75	0.77

Source:
DDMI 2001 for data from 1994 to 2000; Stations included: Lac de Gras Mid-field Stations (LDG40, LDG41, LDG42, LDG43, LDG44, LDG45, LDG49), and Lac de Gras Far-field Stations (LDG46, LDG48, BHP-S); see DDMI 2001 for station locations within Lac de Gras.
DDMI 2011 and 2012 (FFA-1, FFA-2, FFA-3, FFA-4, and FFA-5 sampled in 2010 and 2011).

Note:
Bolded concentrations are higher than relevant water quality guidelines.
CWQG = Canadian Council of Ministers of the Environment (CCME) water quality guidelines for the protection of aquatic life (CCME 1999); CDWQG = Canadian Drinking Water Quality Guidelines (Health Canada 2012).
FF = far-field.
(C) = concentration higher than the relevant chronic CWQG or beyond the recommended pH or DO concentration range.
(D) = concentration higher than the relevant CDWQG or beyond the recommended pH or DO concentration range.
(DL>C) = analytical detection limit was higher than the relevant chronic CWQG.
(U) = concentration higher than the relevant under ice 2014 Baseline Condition or beyond the recommended DO concentration range.
(O) = concentration higher than the relevant open water 2014 Baseline Condition or beyond the recommended DO concentration range.
<= less than; >= greater than; - = no guideline or no data; DO = dissolved oxygen.
Water quality data and guidelines shown in this table were rounded to reflect laboratory or field instrument precision after comparisons to guidelines. Therefore, values slightly above guidelines may be displayed as being equal to the guidelines and identified as exceedances. Measured concentrations equal to the guideline values were not identified as exceedances.
pH set to 6.7 (median of the 2010-2014 dataset) for the purpose of pH-dependent guidelines.

DOMINION DIAMOND

Table 17-5 Predicted Water Quality (Depth-Averaged Maximum) in Lac de Gras (LDG-P4) by Operations, Closure, and Post-Closure

Part B

Parameter Name	Unit	LDG-P4 - Application Case																	
		Operations (2024 - 2029)						Closure - Pit Back-Flooding Period (2030 - 2033)						Post-Closure (2034 - 2060)					
		Under-Ice			Open-Water			Under-Ice			Open-Water			Under-Ice			Open-Water		
		Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum
Field Measured																			
Temperature	°C	0.3	0.8	1.8	1.2	7.1	12	0.3	0.8	2.5	1.1	7.3	12	0.3	0.8	3.8	1.1	7.4	13
Dissolved oxygen	mg/L	9.3	12	14	8.9	11	13	9.4	12	14	8.9	11	13	9.3	12	14	8.8	11	14
Conventional Parameters																			
Hardness	mg/L	7.1	**7.9**$^{(U)}$	**8.8**$^{(U)}$	**6.9**$^{(O)}$	**7.4**$^{(O)}$	**8.1**$^{(O)}$	**7.5**$^{(U)}$	**8.6**$^{(U)}$	**9.0**$^{(U)}$	**7.2**$^{(O)}$	**8.2**$^{(O)}$	**8.5**$^{(O)}$	4.6	5.8	**8.7**$^{(U)}$	4.5	**5.5**$^{(O)}$	**8.1**$^{(O)}$
Total dissolved solids	mg/L	17	18	20	16	17	19	18	19	20	17	18	19	11	14	19	11	13	18
Total suspended solids	mg/L	1.4	**1.6**$^{(U)}$	**1.6**$^{(U)}$	1.4	1.5	1.5	1.4	1.5	**1.5**$^{(U)}$	1.4	1.4	1.4	1.3	1.4	1.5	1.2	1.3	1.4
Major Ions																			
Calcium	mg/L	**1.5**$^{(U)}$	**1.6**$^{(U)}$	**1.8**$^{(U)}$	**1.4**$^{(O)}$	**1.5**$^{(O)}$	**1.6**$^{(O)}$	**1.8**$^{(U)}$	**2.1**$^{(U)}$	**2.2**$^{(U)}$	**1.6**$^{(O)}$	**2.0**$^{(O)}$	**2.0**$^{(O)}$	0.92	1.3	**2.2**$^{(U)}$	0.91	**1.2**$^{(O)}$	**2.0**$^{(O)}$
Chloride	mg/L	**2.7**$^{(U)}$	**2.9**$^{(U)}$	**3.4**$^{(U)}$	**2.5**$^{(O)}$	**2.8**$^{(O)}$	**3.2**$^{(O)}$	**3.4**$^{(U)}$	**4.3**$^{(U)}$	**4.5**$^{(U)}$	**3.1**$^{(O)}$	**4.1**$^{(O)}$	**4.2**$^{(O)}$	0.93	**2.0**$^{(U)}$	**4.4**$^{(U)}$	0.93	**1.9**$^{(O)}$	**4.1**$^{(O)}$
Fluoride	mg/L	0.01	0.012	0.013	0.01	0.012	0.012	0.01	0.011	0.011	0.01	0.01	0.01	0.0086	0.0094	0.01	0.0085	0.009	0.011
Magnesium	mg/L	0.82	**0.95**$^{(U)}$	**1.1**$^{(U)}$	**0.81**$^{(O)}$	**0.88**$^{(O)}$	**0.98**$^{(O)}$	0.76	0.84	0.88	0.76	**0.79**$^{(O)}$	**0.81**$^{(O)}$	0.55	0.63	0.81	0.54	0.6	0.76
Potassium	mg/L	**0.83**$^{(U)}$	**0.99**$^{(U)}$	**1.1**$^{(U)}$	**0.82**$^{(O)}$	**0.91**$^{(O)}$	**1.0**$^{(O)}$	0.74	**0.82**$^{(U)}$	**0.88**$^{(U)}$	**0.73**$^{(O)}$	**0.77**$^{(O)}$	**0.82**$^{(O)}$	0.55	0.64	**0.78**$^{(U)}$	0.54	0.61	**0.74**$^{(O)}$
Sodium	mg/L	**1.7**$^{(U)}$	**1.9**$^{(U)}$	**2.1**$^{(U)}$	**1.6**$^{(O)}$	**1.7**$^{(O)}$	**2.1**$^{(O)}$	**1.8**$^{(U)}$	**1.9**$^{(U)}$	**2.0**$^{(U)}$	**1.7**$^{(O)}$	**1.8**$^{(O)}$	**1.8**$^{(O)}$	**0.74**$^{(U)}$	**1.1**$^{(U)}$	**1.9**$^{(U)}$	**0.73**$^{(O)}$	**1.0**$^{(O)}$	**1.8**$^{(O)}$
Sulphate	mg/L	**2.8**$^{(U)}$	**3.5**$^{(U)}$	**4.0**$^{(U)}$	2.8	**3.2**$^{(O)}$	**3.8**$^{(O)}$	2.3	2.7	**3.0**$^{(U)}$	2.3	2.5	2.7	1.3	1.7	2.5	1.3	1.6	2.3
Nutrients																			
Nitrate	mg N/L	**0.026**$^{(U)}$	**0.03**$^{(U)}$	**0.045**$^{(U)}$	**0.024**$^{(O)}$	**0.026**$^{(O)}$	**0.042**$^{(O)}$	**0.024**$^{(U)}$	**0.034**$^{(U)}$	**0.038**$^{(U)}$	**0.024**$^{(O)}$	**0.029**$^{(O)}$	**0.034**$^{(O)}$	**0.018**$^{(U)}$	**0.02**$^{(U)}$	**0.028**$^{(U)}$	**0.018**$^{(O)}$	**0.021**$^{(O)}$	**0.029**$^{(O)}$
Total ammonia	mg N/L	0.022	0.027	0.034	0.02	0.022	0.028	0.017	0.023	0.025	0.017	0.018	0.021	0.0089	0.01	0.018	0.0081	0.0094	0.014
Total phosphorus	mg P/L	**0.0026**$^{(U)}$	**0.0031**$^{(U)}$	**0.0035**$^{(U)}$	0.0024	**0.0025**$^{(O)}$	**0.0029**$^{(O)}$	**0.0026**$^{(U)}$	**0.0029**$^{(U)}$	**0.003**$^{(U)}$	0.0024	**0.0026**$^{(O)}$	**0.0027**$^{(O)}$	0.0024	**0.0026**$^{(U)}$	**0.0028**$^{(U)}$	0.0023	0.0025	**0.0025**$^{(O)}$
Dissolved orthophosphate	mg P/L	0.0012	0.0017	0.0021	0.001	0.0011	0.0015	0.0012	0.0015	0.0016	0.001	0.0012	0.0013	0.001	0.0012	0.0014	0.00097	0.0011	0.0011
Reactive silica	mg/L	0.12	0.12	0.13	0.11	0.12	0.12	0.12	0.13	0.13	0.12	0.12	0.12	0.12	0.12	0.13	0.11	0.12	0.12
Chlorophyll *a*	µg/L	0.27	0.56	2.2	0.82	1.8	3.2	0.2	0.36	1.4	0.54	1.1	1.8	0.056	0.14	0.72	0.2	0.45	0.91
Total Metals																			
Aluminum	µg/L	**19**$^{(U)}$	**21**$^{(U)}$	**24**$^{(U)}$	**18**$^{(O)}$	**20**$^{(O)}$	**22**$^{(O)}$	**18**$^{(U)}$	**20**$^{(U)}$	**21**$^{(U)}$	**18**$^{(O)}$	**19**$^{(O)}$	**19**$^{(O)}$	**6.9**$^{(U)}$	**9.7**$^{(U)}$	**19**$^{(U)}$	6.8	**9.3**$^{(O)}$	**17**$^{(O)}$
Arsenic	µg/L	**0.29**$^{(U)}$	**0.31**$^{(U)}$	**0.33**$^{(U)}$	**0.26**$^{(O)}$	**0.28**$^{(O)}$	**0.3**$^{(O)}$	**0.27**$^{(U)}$	**0.28**$^{(U)}$	**0.29**$^{(U)}$	**0.24**$^{(O)}$	**0.25**$^{(O)}$	**0.26**$^{(O)}$	**0.22**$^{(U)}$	**0.23**$^{(U)}$	**0.27**$^{(U)}$	0.19	0.21	**0.24**$^{(O)}$
Barium	µg/L	**4.4**$^{(U)}$	**4.9**$^{(U)}$	**5.4**$^{(U)}$	**4.0**$^{(O)}$	**4.3**$^{(O)}$	**4.9**$^{(O)}$	**4.0**$^{(U)}$	**4.3**$^{(U)}$	**4.5**$^{(U)}$	**3.6**$^{(O)}$	**3.8**$^{(O)}$	**4.0**$^{(O)}$	**2.8**$^{(U)}$	**3.1**$^{(U)}$	**4.1**$^{(U)}$	2.4	2.7	**3.6**$^{(O)}$
Beryllium	µg/L	**0.11**$^{(U)}$	**0.11**$^{(U)}$	**0.12**$^{(U)}$	**0.11**$^{(O)}$	**0.12**$^{(O)}$	**0.12**$^{(O)}$	**0.11**$^{(U)}$	**0.11**$^{(U)}$	**0.11**$^{(U)}$	**0.11**$^{(O)}$	**0.11**$^{(O)}$	**0.12**$^{(O)}$	**0.1**$^{(U)}$	**0.1**$^{(U)}$	**0.11**$^{(U)}$	**0.11**$^{(O)}$	**0.11**$^{(O)}$	**0.11**$^{(O)}$
Bismuth	µg/L	**0.0059**$^{(U)}$	**0.0082**$^{(U)}$	**0.01**$^{(U)}$	**0.0058**	**0.0073**	**0.0092**	**0.0044**$^{(U)}$	**0.0055**$^{(U)}$	**0.0063**$^{(U)}$	**0.0042**	**0.0049**	**0.0057**	0.00038	0.0012	**0.0046**$^{(U)}$	0.00037	0.0011	**0.004**
Cadmium	µg/L	**0.033**$^{(U)}$	**0.034**$^{(U)}$	**0.034**$^{(U)}$	**0.03**$^{(O)}$	**0.032**$^{(O)}$	**0.033**$^{(O)}$	**0.031**$^{(U)}$	**0.031**$^{(U)}$	**0.033**$^{(U)}$	**0.03**$^{(O)}$	**0.03**$^{(O)}$	**0.031**$^{(O)}$	**0.027**$^{(U)}$	**0.029**$^{(U)}$	**0.031**$^{(U)}$	**0.027**$^{(O)}$	**0.027**$^{(O)}$	**0.03**$^{(O)}$
Chromium	µg/L	**0.085**$^{(U)}$	**0.095**$^{(U)}$	**0.1**$^{(U)}$	0.078	0.085	0.095	**0.078**$^{(U)}$	**0.084**$^{(U)}$	**0.087**$^{(U)}$	0.07	0.075	0.078	0.05	**0.058**$^{(U)}$	**0.081**$^{(U)}$	0.043	0.051	0.072
Cobalt	µg/L	**0.066**	**0.068**	**0.075**	**0.071**$^{(O)}$	**0.074**$^{(O)}$	**0.077**$^{(O)}$	**0.074**	**0.076**	**0.079**	**0.077**$^{(O)}$	**0.079**$^{(O)}$	**0.08**$^{(O)}$	**0.051**	**0.058**	**0.076**	**0.058**$^{(O)}$	**0.064**$^{(O)}$	**0.078**$^{(O)}$
Copper	µg/L	0.4	0.41	0.42	0.37	0.38	0.39	0.4	0.41	0.41	0.37	0.38	0.38	0.36	0.37	0.4	0.34	0.35	0.38
Iron	µg/L	**20**$^{(U)}$	**25**$^{(U)}$	**30**$^{(U)}$	**22**$^{(O)}$	**26**$^{(O)}$	**30**$^{(O)}$	**16**$^{(U)}$	**19**$^{(U)}$	**21**$^{(U)}$	**18**$^{(O)}$	**20**$^{(O)}$	**22**$^{(O)}$	4.6	7.3	**17**$^{(U)}$	6.9	9.4	**18**$^{(O)}$
Lead	µg/L	0.033	0.035	0.036	0.032	0.033	0.034	0.032	0.034	0.033	0.031	0.032	0.032	0.027	0.028	0.032	0.026	0.027	0.031
Manganese	µg/L	**3.3**$^{(U)}$	**3.4**$^{(U)}$	**3.7**$^{(U)}$	**5.0**$^{(O)}$	**5.2**$^{(O)}$	**5.4**$^{(O)}$	**3.2**$^{(U)}$	**3.4**$^{(U)}$	**3.5**$^{(U)}$	**5.0**$^{(O)}$	**5.1**$^{(O)}$	**5.1**$^{(O)}$	**1.9**$^{(U)}$	**2.2**$^{(U)}$	**3.3**$^{(U)}$	3.8	4.0	**4.9**$^{(O)}$
Mercury	µg/L	**0.011**$^{(U)}$	**0.011**$^{(U)}$	**0.012**$^{(U)}$	**0.011**	**0.011**	**0.012**	**0.012**$^{(U)}$	**0.011**$^{(U)}$	**0.011**$^{(U)}$	**0.012**	**0.012**	**0.011**	**0.011**$^{(U)}$	**0.01**$^{(U)}$	**0.011**$^{(U)}$	**0.01**	**0.011**	**0.012**
Molybdenum	µg/L	**2.5**$^{(U)}$	**2.9**$^{(U)}$	**3.2**$^{(U)}$	**2.0**$^{(O)}$	**2.4**$^{(O)}$	**2.7**$^{(O)}$	**2.3**$^{(U)}$	**2.4**$^{(U)}$	**2.6**$^{(U)}$	**1.8**$^{(O)}$	**2.0**$^{(O)}$	**2.2**$^{(O)}$	**1.5**$^{(U)}$	**1.8**$^{(U)}$	**2.4**$^{(U)}$	**1.2**$^{(O)}$	**1.4**$^{(O)}$	**2.0**$^{(O)}$
Nickel	µg/L	1.3	1.3	1.3	1.2	1.3	1.3	1.2	1.3	1.3	1.2	1.2	1.2	1.1	1.1	1.2	1.1	1.1	1.2
Selenium	µg/L	**0.1**$^{(U)}$	**0.12**$^{(U)}$	**0.13**$^{(U)}$	**0.098**$^{(O)}$	**0.11**$^{(O)}$	**0.12**$^{(O)}$	0.089	0.097	**0.1**$^{(U)}$	**0.085**$^{(O)}$	**0.09**$^{(O)}$	**0.096**$^{(O)}$	0.062	0.068	0.091	**0.059**$^{(O)}$	**0.065**$^{(O)}$	**0.085**$^{(O)}$
Silver	µg/L	**0.055**$^{(U)}$	**0.057**$^{(U)}$	**0.059**$^{(U)}$	**0.056**$^{(O)}$	**0.057**$^{(O)}$	**0.059**$^{(O)}$	**0.053**$^{(U)}$	**0.054**$^{(U)}$	**0.055**$^{(U)}$	**0.053**$^{(O)}$	**0.055**$^{(O)}$	**0.055**$^{(O)}$	**0.051**$^{(U)}$	**0.05**$^{(U)}$	**0.054**$^{(U)}$	**0.051**$^{(O)}$	**0.05**$^{(O)}$	**0.053**$^{(O)}$

Table 17-5 Predicted Water Quality (Depth-Averaged Maximum) in Lac de Gras (LDG-P4) by Operations, Closure, and Post-Closure

Part B

Parameter Name	Unit	LDG-P4 - Application Case																	
		Operations (2024 - 2029)						Closure - Pit Back-Flooding Period (2030 - 2033)						Post-Closure (2034 - 2060)					
		Under-Ice			Open-Water			Under-Ice			Open-Water			Under-Ice			Open-Water		
		Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum
Strontium	µg/L	**33**$^{(U)}$	**41**$^{(U)}$	**67**$^{(U)}$	**28**$^{(O)}$	**32**$^{(O)}$	**47**$^{(O)}$	**66**$^{(U)}$	**76**$^{(U)}$	**80**$^{(U)}$	**47**$^{(O)}$	**56**$^{(O)}$	**57**$^{(O)}$	**28**$^{(U)}$	**41**$^{(U)}$	**78**$^{(U)}$	**21**$^{(O)}$	**31**$^{(O)}$	**55**$^{(O)}$
Uranium	µg/L	**0.22**$^{(U)}$	**0.26**$^{(U)}$	**0.31**$^{(U)}$	**0.21**$^{(O)}$	**0.24**$^{(O)}$	**0.29**$^{(O)}$	**0.18**$^{(U)}$	**0.22**$^{(U)}$	**0.23**$^{(U)}$	**0.18**$^{(O)}$	**0.2**$^{(O)}$	**0.21**$^{(O)}$	**0.039**	**0.074**$^{(U)}$	**0.19**$^{(U)}$	**0.037**$^{(O)}$	**0.067**$^{(O)}$	**0.17**$^{(O)}$
Vanadium	µg/L	**0.33**$^{(U)}$	**0.44**$^{(U)}$	**0.52**$^{(U)}$	**0.32**$^{(O)}$	**0.38**$^{(O)}$	**0.47**$^{(O)}$	**0.26**$^{(U)}$	**0.3**$^{(U)}$	**0.35**$^{(U)}$	**0.24**$^{(O)}$	**0.27**$^{(O)}$	**0.31**$^{(O)}$	0.099	**0.14**$^{(U)}$	**0.27**$^{(U)}$	0.079	**0.12**$^{(O)}$	**0.23**$^{(O)}$
Zinc	µg/L	1.4	1.4	1.4	0.74	0.75	0.77	1.4	1.4	1.4	0.73	0.74	0.75	1.3	1.3	1.4	0.65	0.67	0.73

Source:

DDMI 2001 for data from 1994 to 2000; Stations included: Lac de Gras Mid-field Stations (LDG40, LDG41, LDG42, LDG43, LDG44, LDG45, LDG49), and Lac de Gras Far-field Stations (LDG46, LDG48, BHP-S); see DDMI 2001 for station locations within Lac de Gras.

DDMI 2011 and 2012 (FFA-1, FFA-2, FFA-3, FFA-4, and FFA-5 sampled in 2010 and 2011).

Note:

Bolded concentrations are higher than relevant water quality guidelines.

CWQG = Canadian Council of Ministers of the Environment (CCME) water quality guidelines for the protection of aquatic life (CCME 1999); CDWQG = Canadian Drinking Water Quality Guidelines (Health Canada 2012).

FF = far-field.

(C) = concentration higher than the relevant chronic CWQG or beyond the recommended pH or DO concentration range.

(D) = concentration higher than the relevant CDWQG or beyond the recommended pH or DO concentration range.

(DL>C) = analytical detection limit was higher than the relevant chronic CWQG.

(U) = concentration higher than the relevant under ice 2014 Baseline Condition or beyond the recommended DO concentration range.

(O) = concentration higher than the relevant open water 2014 Baseline Condition or beyond the recommended DO concentration range.

<= less than; >= greater than; - = no guideline or no data; DO = dissolved oxygen.

Water quality data and guidelines shown in this table were rounded to reflect laboratory or field instrument precision after comparisons to guidelines. Therefore, values slightly above guidelines may be displayed as being equal to the guidelines and identified as exceedances. Measured concentrations equal to the guideline values were not identified as exceedances.

pH set to 6.7 (median of the 2010-2014 dataset) for the purpose of pH-dependent guidelines.

Table 17-6 Predicted Water Quality (Depth-Averaged Maximum) in Lac de Gras (LDG-P5) by Operations, Closure, and Post-Closure

Part A

Parameter Name	Unit	Lac de Gras (whole lake) - Reference Condition				Lac de Gras (S2/S3) - 2014 Baseline Condition								LDG-P5 - Application Case					
														Early Operations (2019 - 2023)					
		Open-Water and Under-Ice				Under-Ice (2010 to 2012)				Open-Water (2010 to 2012)				Under-Ice			Open-Water		
		Count	Median	Range (25th to 75th %ile)	Percent of Samples Less than the Analytical Detection Limit	Count	Minimum	Median	Maximum	Count	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum
Field Measured																			
Temperature	°C	-	-	-	-	-	-	-	-	-	-	-	-	0.1	0.8	2.6	1.1	7.6	12
Dissolved oxygen	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	9.2	12	14	8.5	11	14
Conventional Parameters																			
Hardness	mg/L	-	-	-	-	24	6.7	7.5	14	35	6.3	8.5	11	8.0	8.5	8.9	8.0	8.1	8.3
Total dissolved solids	mg/L	-	-	-	-	24	9.7	15	30	35	13	19	25	17	19	20	17	18	19
Total suspended solids	mg/L	433	2	1.0 to 3.0	75	24	<3.0	<3.0	<3.0	35	<3.0	<3.0	3.5	1.5	**1.6**$^{(U)}$	**1.7**$^{(U)}$	1.5	1.5	1.5
Major Ions																			
Calcium	mg/L	-	-	-	-	24	1.3	1.4	2.6	35	1.2	1.6	2	1.6	1.7	1.8	1.6	1.7	1.7
Chloride	mg/L	-	-	-	-	24	0.9	1.6	5.5	35	1.4	3	4.7	2.8	3.2	3.4	2.9	3.2	3.3
Fluoride	mg/L	-	-	-	-	0	-	-	-	0	-	-	-	0.012	0.012	0.014	0.012	0.012	0.013
Magnesium	mg/L	-	-	-	-	24	0.88	0.96	1.9	35	0.81	1.1	1.5	0.96	1.0	1.1	0.95	0.98	1.0
Potassium	mg/L	-	-	-	-	24	0.69	0.81	1.7	35	0.74	1.1	1.6	0.96	1.0	1.1	0.96	1.0	1.1
Sodium	mg/L	-	-	-	-	24	0.88	1.2	3.7	35	1.1	2.1	3.1	1.9	2.1	2.2	1.9	2.1	2.2
Sulphate	mg/L	-	-	-	-	24	2.3	3.3	7.2	35	2.9	4.3	5.7	3.2	3.6	4.1	3.2	3.5	3.8
Nutrients																			
Nitrate	mg N/L	-	-	-	-	24	<0.005	0.013	0.082	35	<0.005	<0.005	<0.005	0.04	0.05	0.052	**0.039**$^{(O)}$	**0.05**$^{(O)}$	**0.059**$^{(O)}$
Total ammonia	mg N/L	433	0.007	0.005 to 0.010	59	24	0.008	0.015	0.021	35	<0.005	<0.005	0.015	0.019	**0.028**$^{(U)}$	**0.035**$^{(U)}$	**0.017**$^{(O)}$	**0.023**$^{(O)}$	**0.028**$^{(O)}$
Total phosphorus	mg P/L	448	0.003	0.002 to 0.0042	25	24	<0.002	0.0024	0.0029	35	0.0023	0.0034	0.0062	0.0027	**0.0032**$^{(U)}$	**0.0033**$^{(U)}$	0.0025	0.0027	0.0032
Dissolved orthophosphate	mg P/L	-	-	-	-	24	<0.001	<0.001	<0.001	35	<0.001	<0.001	<0.001	0.0013	0.0018	0.0019	0.0011	0.0013	0.0018
Reactive silica	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	0.12	0.12	0.13	0.12	0.12	0.12
Chlorophyll *a*	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	0.17	0.46	2.4	0.26	1.7	2.9
Total Metals																			
Aluminum	µg/L	458	7.95	3.2 to 18.75	7	24	2.7	3.5	7.7	35	5.3	6.9	26	**18**$^{(U)}$	**21**$^{(U)}$	**24**$^{(U)}$	18	20	22
Arsenic	µg/L	411	0.2	0.18 to 0.21	23	24	0.17	0.2	0.22	35	0.18	0.21	0.32	**0.29**$^{(U)}$	**0.31**$^{(U)}$	**0.34**$^{(U)}$	0.27	0.29	0.3
Barium	µg/L	-	-	-	-	24	2.2	2.4	4.2	35	2.4	3.2	4.5	**4.5**$^{(U)}$	**4.9**$^{(U)}$	**5.5**$^{(U)}$	4.1	4.5	**4.8**$^{(O)}$
Beryllium	µg/L	-	-	-	-	24	<0.01	<0.01	<0.2	35	<0.01	<0.01	<0.2	**0.11**$^{(U)}$	**0.12**$^{(U)}$	**0.12**$^{(U)}$	**0.12**$^{(U)}$	**0.12**$^{(U)}$	**0.12**$^{(U)}$
Bismuth	µg/L	-	-	-	-	0	-	-	-	0	-	-	-	0.0071	0.0085	0.011	0.0068	0.008	0.0092
Cadmium	µg/L	465	**0.05** $^{(DL>C)}$	**0.05** $^{(DL>C)}$ to **0.2** $^{(DL>C)}$	95	24	<0.01	<0.01	<0.01	35	<0.01	<0.01	0.017	**0.033**$^{(U)}$	**0.034**$^{(U)}$	**0.035**$^{(U)}$	**0.031**$^{(O)}$	**0.033**$^{(O)}$	**0.034**$^{(O)}$
Chromium	µg/L	459	0.33	0.185 to **1.2** $^{(C)}$	37	24	<0.1	<0.1	<0.2	35	<0.1	<0.1	0.49	0.085	0.094	**0.11**$^{(U)}$	0.08	0.087	0.094
Cobalt	µg/L	-	-	-	-	24	<0.1	<0.1	<0.1	35	<0.1	<0.1	<0.1	**0.064**$^{(U)}$	**0.067**$^{(U)}$	**0.07**$^{(U)}$	**0.069**$^{(U)}$	**0.072**$^{(U)}$	**0.074**$^{(U)}$
Copper	µg/L	459	0.7	0.6 to 1.0	51	24	0.61	0.68	0.75	35	0.52	0.67	1.8	0.39	0.41	0.42	0.37	0.39	0.39

Table 17-6 Predicted Water Quality (Depth-Averaged Maximum) in Lac de Gras (LDG-P5) by Operations, Closure, and Post-Closure

Part A

Parameter Name	Unit	Lac de Gras (whole lake) - Reference Condition				Lac de Gras (S2/S3) - 2014 Baseline Condition								LDG-P5 - Application Case Early Operations (2019 - 2023)					
		Open-Water and Under-Ice				Under-Ice (2010 to 2012)				Open-Water (2010 to 2012)				Under-Ice			Open-Water		
		Count	Median	Range (25th to 75th %ile)	Percent of Samples Less than the Analytical Detection Limit	Count	Minimum	Median	Maximum	Count	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum
Iron	µg/L	-	-	-	-	24	<10	<10	<10	35	<10	13	27	**22**(U)	**26**(U)	**31**(U)	24	**27**(O)	**30**(O)
Lead	µg/L	388	0.05	0.05 to 0.07	85	24	<0.01	<0.01	<0.05	35	<0.01	0.014	0.07	**0.033**(U)	**0.035**(U)	**0.037**(U)	0.032	0.033	0.034
Manganese	µg/L	-	-	-	-	24	0.65	1.3	2.9	35	2.9	4	5.1	**3.1**(U)	**3.4**(U)	**3.8**(U)	4.9	**5.2**(O)	**5.4**(O)
Mercury	µg/L	-	-	-	-	24	<0.02	<0.02	<0.02	35	<0.02	<0.02	<0.02	**0.011**(U)	**0.011**(U)	**0.012**(U)	**0.012**(U)	**0.012**(U)	**0.012**(U)
Molybdenum	µg/L	-	-	-	-	24	0.12	0.28	1.2	35	0.28	0.8	1.3	**2.5**(U)	**2.8**(U)	**3.3**(U)	**2.2**(O)	**2.5**(O)	**2.7**(O)
Nickel	µg/L	459	0.69	0.5 to 1.40	16	24	0.77	1	1.1	35	0.81	0.91	2.5	**1.3**(U)	**1.3**(U)	**1.4**(U)	1.2	1.3	1.3
Selenium	µg/L	-	-	-	-	24	<0.04	<0.04	<0.2	35	<0.04	<0.04	<0.1	**0.11**(U)	**0.12**(U)	**0.13**(U)	**0.11**(O)	**0.11**(O)	**0.12**(O)
Silver	µg/L	-	-	-	-	24	<0.01	<0.01	<0.1	35	<0.01	<0.01	<0.1	**0.056**(U)	**0.058**(U)	**0.059**(U)	**0.056**(U)	**0.057**(U)	**0.058**(U)
Strontium	µg/L	-	-	-	-	24	10	13	36	35	11	19	27	30	33	**37**(U)	26	**28**(O)	**31**(O)
Uranium	µg/L	-	-	-	-	24	0.025	0.03	0.033	35	0.024	0.029	0.037	**0.23**(U)	**0.27**(U)	**0.32**(U)	**0.22**(U)	**0.25**(U)	**0.29**(U)
Vanadium	µg/L	-	-	-	-	24	<0.05	<0.05	<0.05	35	<0.05	<0.05	<0.05	**0.39**(U)	**0.45**(U)	**0.54**(U)	**0.36**(O)	**0.42**(O)	**0.47**(O)
Zinc	µg/L	369	1	0.8 to 6.5	46	24	<1.0	<1.0	11	35	<1.0	<1.0	3.1	1.4	1.4	1.4	0.74	0.75	0.77

Source:

DDMI 2001 for data from 1994 to 2000; Stations included: Lac de Gras Mid-field Stations (LDG40, LDG41, LDG42, LDG43, LDG44, LDG45, LDG49), and Lac de Gras Far-field Stations (LDG46, LDG48, BHP-S); see DDMI 2001 for station locations within Lac de Gras.

Rescan 2011, 2012a; ERM Rescan 2013 (S2 and S3 sampled in 2010, 2011, and 2012).

Note:

Bolded concentrations are higher than relevant water quality guidelines.

CWQG = Canadian Council of Ministers of the Environment (CCME) water quality guidelines for the protection of aquatic life (CCME 1999); CDWQG = Canadian Drinking Water Quality Guidelines (Health Canada 2012).

(C) = concentration higher than the relevant chronic CWQG or beyond the recommended pH or DO concentration range.

(D) = concentration higher than the relevant CDWQG or beyond the recommended pH or DO concentration range.

(DL>C) = analytical detection limit was higher than the relevant chronic CWQG.

(U) = concentration higher than the relevant under ice 2014 Baseline Condition or beyond the recommended DO concentration range.

(O) = concentration higher than the relevant open water 2014 Baseline Condition or beyond the recommended DO concentration range.

<= less than; >= greater than; - = no guideline or no data; DO = dissolved oxygen.

Water quality data and guidelines shown in this table were rounded to reflect laboratory or field instrument precision after comparisons to guidelines. Therefore, values slightly above guidelines may be displayed as being equal to the guidelines and identified as exceedances. Measured concentrations equal to the guideline values were not identified as exceedances.

pH set to 6.7 (median of the 2010-2014 dataset) for the purpose of pH-dependent guidelines.

Table 17-6 Predicted Water Quality (Depth-Averaged Maximum) in Lac de Gras (LDG-P5) by Operations, Closure, and Post-Closure

Part B

Parameter Name	Unit	LDG-P5 - Application Case																	
		Operations (2024 - 2029)						Closure - Pit Back-Flooding Period (2030 - 2033)						Post-Closure (2034 - 2060)					
		Under-Ice			Open-Water			Under-Ice			Open-Water			Under-Ice			Open-Water		
		Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum
Field Measured																			
Temperature	°C	0.2	0.8	1.8	1.1	7.1	13	0.2	0.8	2.8	1.1	6.9	13	0.1	0.8	3.4	1.0	7.6	13
Dissolved oxygen	mg/L	9.1	12	14	8.2	11	14	9.3	12	14	8.4	11	14	9.0	12	14	8.5	11	14
Conventional Parameters																			
Hardness	mg/L	7.1	7.9	8.8	7.0	7.5	8.3	7.4	8.6	9.1	7.3	8.2	8.7	4.6	5.8	8.8	4.5	5.6	8.3
Total dissolved solids	mg/L	17	18	20	17	17	19	18	19	20	17	18	19	11	14	20	11	14	19
Total suspended solids	mg/L	1.4	**1.6**(U)	**1.7**(U)	1.4	1.5	1.6	1.4	1.5	**1.5**(U)	1.4	1.4	1.5	1.3	1.4	1.5	1.3	1.3	1.4
Major Ions																			
Calcium	mg/L	1.5	1.6	1.8	1.5	1.5	1.7	1.7	2.1	2.2	1.7	2.0	**2.1**(O)	0.92	1.3	2.2	0.91	1.2	**2.0**(O)
Chloride	mg/L	2.7	2.9	3.4	2.6	2.8	3.3	3.3	4.2	4.5	3.2	4.1	4.3	0.94	2.0	4.4	0.93	1.9	4.2
Fluoride	mg/L	0.01	0.012	0.012	0.011	0.011	0.013	0.011	0.011	0.012	0.011	0.011	0.011	0.0087	0.0095	0.011	0.0085	0.009	0.01
Magnesium	mg/L	0.82	0.95	1.1	0.82	0.9	1.0	0.76	0.84	0.87	0.76	0.8	0.84	0.55	0.63	0.82	0.55	0.61	0.77
Potassium	mg/L	0.83	0.99	1.1	0.83	0.94	1.1	0.74	0.82	0.88	0.74	0.78	0.85	0.55	0.64	0.8	0.55	0.62	0.76
Sodium	mg/L	1.7	1.9	2.2	1.7	1.8	2.1	1.8	1.9	2.0	1.7	1.8	1.9	0.74	1.1	1.9	0.74	1.1	1.9
Sulphate	mg/L	2.8	3.5	4.0	2.8	3.3	3.9	2.3	2.7	3.0	2.3	2.5	2.9	1.3	1.7	2.5	1.3	1.6	2.4
Nutrients																			
Nitrate	mg N/L	0.026	0.031	0.047	**0.023**(O)	**0.028**(O)	**0.045**(O)	0.024	0.033	0.036	**0.024**(O)	**0.028**(O)	**0.035**(O)	0.018	0.021	0.028	**0.018**(O)	**0.021**(O)	**0.032**(O)
Total ammonia	mg N/L	**0.022**(U)	**0.028**(U)	**0.035**(U)	**0.02**(O)	**0.023**(O)	**0.029**(O)	0.017	**0.022**(U)	**0.025**(U)	**0.016**(O)	**0.019**(O)	**0.022**(O)	0.0088	0.011	0.018	0.0083	0.0095	0.014
Total phosphorus	mg P/L	0.0027	**0.003**(U)	**0.0034**(U)	0.0024	0.0026	0.0032	0.0026	0.0029	**0.003**(U)	0.0024	0.0025	0.003	0.0025	0.0025	0.0028	0.0023	0.0024	0.0027
Dissolved orthophosphate	mg P/L	0.0013	0.0016	0.002	0.001	0.0012	0.0018	0.0012	0.0015	0.0016	0.001	0.0011	0.0016	0.0011	0.0011	0.0014	0.00095	0.001	0.0013
Reactive silica	mg/L	0.12	0.12	0.13	0.11	0.12	0.12	0.12	0.13	0.13	0.12	0.12	0.13	0.12	0.12	0.13	0.11	0.12	0.12
Chlorophyll *a*	µg/L	0.28	0.57	2.3	0.4	1.7	3.1	0.2	0.36	1.4	0.28	1.1	1.8	0.059	0.13	0.73	0.073	0.45	0.9
Total Metals																			
Aluminum	µg/L	**19**(U)	**21**(U)	**24**(U)	19	20	23	**18**(U)	**20**(U)	**21**(U)	18	19	20	6.9	**9.7**(U)	**19**(U)	6.8	9.5	18
Arsenic	µg/L	**0.29**(U)	**0.31**(U)	**0.33**(U)	0.26	0.29	0.31	**0.27**(U)	**0.28**(U)	**0.29**(U)	0.25	0.25	0.27	0.22	**0.23**(U)	**0.27**(U)	0.2	0.21	0.25
Barium	µg/L	**4.4**(U)	**4.9**(U)	**5.4**(U)	4.0	4.5	**4.9**(O)	4.0	**4.3**(U)	**4.5**(U)	3.6	3.8	4.1	2.8	3.1	4.1	2.4	2.7	3.6
Beryllium	µg/L	**0.11**(U)	**0.11**(U)	**0.12**(U)	**0.12**(U)	**0.12**(U)	**0.12**(U)	**0.11**(U)	**0.11**(U)	**0.11**(U)	**0.11**(U)	**0.11**(U)	**0.12**(U)	**0.1**(U)	**0.1**(U)	**0.11**(U)	**0.11**(U)	**0.11**(U)	**0.11**(U)
Bismuth	µg/L	0.006	0.0082	0.011	0.0059	0.0076	0.0095	0.0043	0.0055	0.0064	0.0043	0.0051	0.0061	0.00037	0.0013	0.0045	0.00037	0.0012	0.0043
Cadmium	µg/L	**0.032**(U)	**0.034**(U)	**0.035**(U)	**0.031**(O)	**0.032**(O)	**0.033**(O)	**0.031**(U)	**0.033**(U)	**0.032**(U)	**0.031**(O)	**0.031**(O)	**0.031**(O)	**0.028**(U)	**0.028**(U)	**0.032**(U)	**0.027**(O)	**0.028**(O)	**0.031**(O)
Chromium	µg/L	0.085	0.095	**0.1**(U)	0.08	0.087	0.095	0.078	0.085	0.088	0.072	0.076	0.08	0.051	0.057	0.081	0.045	0.052	0.073
Cobalt	µg/L	**0.066**(U)	**0.069**(U)	**0.074**(U)	**0.073**(U)	**0.073**(U)	**0.078**(U)	**0.073**(U)	**0.077**(U)	**0.079**(U)	**0.077**(U)	**0.08**(U)	**0.081**(U)	**0.051**(U)	**0.057**(U)	**0.076**(U)	**0.058**(U)	**0.064**(U)	**0.08**(U)
Copper	µg/L	0.4	0.41	0.42	0.38	0.39	0.4	0.4	0.41	0.41	0.38	0.38	0.38	0.36	0.37	0.41	0.34	0.35	0.38
Iron	µg/L	**20**(U)	**25**(U)	**30**(U)	22	26	**31**(O)	**16**(U)	**19**(U)	**21**(U)	18	21	23	4.6	**7.4**(U)	**17**(U)	6.9	9.5	18
Lead	µg/L	**0.034**(U)	**0.035**(U)	**0.035**(U)	0.033	0.033	0.035	**0.032**(U)	**0.034**(U)	**0.034**(U)	0.032	0.032	0.032	**0.027**(U)	**0.029**(U)	**0.033**(U)	0.026	0.028	0.032
Manganese	µg/L	**3.3**(U)	**3.4**(U)	**3.7**(U)	5.1	**5.2**(O)	**5.5**(O)	**3.2**(U)	**3.4**(U)	**3.5**(U)	5.0	5.1	**5.2**(O)	1.9	2.2	**3.3**(U)	3.8	4.1	5.0
Mercury	µg/L	**0.012**(U)	**0.011**(U)	**0.012**(U)	**0.011**(U)	**0.011**(U)	**0.012**(U)	**0.012**(U)	**0.011**(U)	**0.011**(U)	**0.012**(U)	**0.011**(U)	**0.012**(U)	**0.011**(U)	**0.01**(U)	**0.012**(U)	**0.01**(U)	**0.011**(U)	**0.012**(U)
Molybdenum	µg/L	**2.5**(U)	**2.9**(U)	**3.3**(U)	**2.2**(O)	**2.5**(O)	**2.8**(O)	**2.3**(U)	**2.5**(U)	**2.7**(U)	**1.9**(O)	**2.1**(O)	**2.3**(O)	**1.6**(U)	**1.8**(U)	**2.5**(U)	1.2	**1.5**(O)	**2.0**(O)
Nickel	µg/L	**1.3**(U)	**1.3**(U)	**1.3**(U)	1.2	1.3	1.3	**1.2**(U)	**1.3**(U)	**1.3**(U)	1.2	1.2	1.2	**1.1**(U)	**1.1**(U)	**1.2**(U)	1.1	1.1	1.2
Selenium	µg/L	**0.1**(U)	**0.12**(U)	**0.13**(U)	**0.098**(O)	**0.11**(O)	**0.13**(O)	0.09	0.096	**0.1**(U)	**0.086**(O)	**0.091**(O)	**0.098**(O)	0.063	0.069	0.091	**0.06**(O)	**0.065**(O)	**0.085**(O)
Silver	µg/L	**0.055**(U)	**0.058**(U)	**0.058**(U)	**0.056**(U)	**0.057**(U)	**0.059**(U)	**0.054**(U)	**0.054**(U)	**0.056**(U)	**0.054**(U)	**0.055**(U)	**0.056**(U)	**0.051**(U)	**0.05**(U)	**0.054**(U)	**0.051**(U)	**0.05**(U)	**0.053**(U)

Table 17-6 Predicted Water Quality (Depth-Averaged Maximum) in Lac de Gras (LDG-P5) by Operations, Closure, and Post-Closure

Part B

Parameter Name	Unit	LDG-P5 - Application Case																	
		Operations (2024 - 2029)						Closure - Pit Back-Flooding Period (2030 - 2033)						Post-Closure (2034 - 2060)					
		Under-Ice			Open-Water			Under-Ice			Open-Water			Under-Ice			Open-Water		
		Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum
Strontium	µg/L	35	**41$^{(U)}$**	**67$^{(U)}$**	**30$^{(O)}$**	**34$^{(O)}$**	**47$^{(O)}$**	**65$^{(U)}$**	**76$^{(U)}$**	**81$^{(U)}$**	**49$^{(O)}$**	**56$^{(O)}$**	**59$^{(O)}$**	28	**42$^{(U)}$**	**79$^{(U)}$**	22	**32$^{(O)}$**	**57$^{(O)}$**
Uranium	µg/L	**0.22$^{(U)}$**	**0.26$^{(U)}$**	**0.31$^{(U)}$**	**0.21$^{(U)}$**	**0.25$^{(U)}$**	**0.3$^{(U)}$**	**0.18$^{(U)}$**	**0.22$^{(U)}$**	**0.23$^{(U)}$**	**0.18$^{(U)}$**	**0.2$^{(U)}$**	**0.22$^{(U)}$**	**0.039$^{(U)}$**	**0.074$^{(U)}$**	**0.19$^{(U)}$**	**0.037$^{(U)}$**	**0.069$^{(U)}$**	**0.18$^{(U)}$**
Vanadium	µg/L	**0.33$^{(U)}$**	**0.44$^{(U)}$**	**0.52$^{(U)}$**	**0.32$^{(O)}$**	**0.4$^{(O)}$**	**0.49$^{(O)}$**	**0.26$^{(U)}$**	**0.3$^{(U)}$**	**0.35$^{(U)}$**	**0.24$^{(O)}$**	**0.27$^{(O)}$**	**0.32$^{(O)}$**	**0.099$^{(U)}$**	**0.14$^{(U)}$**	**0.27$^{(U)}$**	**0.083$^{(O)}$**	**0.12$^{(O)}$**	**0.24$^{(O)}$**
Zinc	µg/L	1.4	1.4	1.4	0.75	0.75	0.77	1.4	1.4	1.4	0.73	0.74	0.75	1.3	1.3	1.4	0.66	0.68	0.74

Source:

DDMI 2001 for data from 1994 to 2000; Stations included: Lac de Gras Mid-field Stations (LDG40, LDG41, LDG42, LDG43, LDG44, LDG45, LDG49), and Lac de Gras Far-field Stations (LDG46, LDG48, BHP-S); see DDMI 2001 for station locations within Lac de Gras.

Rescan 2011, 2012a; ERM Rescan 2013 (S2 and S3 sampled in 2010, 2011, and 2012).

Note:

Bolded concentrations are higher than relevant water quality guidelines.

CWQG = Canadian Council of Ministers of the Environment (CCME) water quality guidelines for the protection of aquatic life (CCME 1999); CDWQG = Canadian Drinking Water Quality Guidelines (Health Canada 2012).

(C) = concentration higher than the relevant chronic CWQG or beyond the recommended pH or DO concentration range.

(D) = concentration higher than the relevant CDWQG or beyond the recommended pH or DO concentration range.

(DL>C) = analytical detection limit was higher than the relevant chronic CWQG.

(U) = concentration higher than the relevant under ice 2014 Baseline Condition or beyond the recommended DO concentration range.

(O) = concentration higher than the relevant open water 2014 Baseline Condition or beyond the recommended DO concentration range.

<= less than; >= greater than; - = no guideline or no data; DO = dissolved oxygen.

Water quality data and guidelines shown in this table were rounded to reflect laboratory or field instrument precision after comparisons to guidelines. Therefore, values slightly above guidelines may be displayed as being equal to the guidelines and identified as exceedances. Measured concentrations equal to the guideline values were not identified as exceedances.

pH set to 6.7 (median of the 2010-2014 dataset) for the purpose of pH-dependent guidelines.

Table 17-7 Predicted Water Quality (Depth-Averaged Maximum) in Lac de Gras (LDG-P6) by Operations, Closure, and Post-Closure

Part A

Parameter Name	Unit	Lac de Gras (whole lake) - Reference Condition				Lac de Gras (FFA) - 2014 Baseline Condition								LDG-P6 - Application Case, Early Operations (2019 - 2023)					
		Open-Water and Under-Ice				Under-Ice (2010 to 2012)				Open-Water (2010 to 2012)				Under-Ice			Open-Water		
		Count	Median	Range (25^{th} to 75^{th} %ile)	Percent of Samples Less than the Analytical Detection Limit	Count	Minimum	Median	Maximum	Count	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum
Field Measured																			
Temperature	°C	-	-	-	-	-	-	-	-	-	-	-	-	0.2	0.5	2.0	0.6	7.6	14
Dissolved oxygen	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	10	13	14	9.7	11	14
Conventional Parameters																			
Hardness	mg/L	-	-	-	-	10	5.9	6.4	7.1	30	4.7	5.5	<10	**8.0**$^{(U)}$	**9.5**$^{(U)}$	**10**$^{(U)}$	**7.8**$^{(O)}$	**8.1**$^{(O)}$	**8.3**$^{(O)}$
Total dissolved solids	mg/L	-	-	-	-	10	9	12	21	30	<5.0	13	30	17	20	**24**$^{(U)}$	16	18	19
Total suspended solids	mg/L	433	2	1.0 to 3.0	75	5	<3.0	<3.0	<3.0	15	<3.0	<3.0	3	1.5	**1.8**$^{(U)}$	**2.0**$^{(U)}$	1.4	1.5	1.5
Major Ions																			
Calcium	mg/L	-	-	-	-	10	1.1	1.2	1.3	30	0.89	1.1	1.1	**1.6**$^{(U)}$	**1.9**$^{(U)}$	**2.1**$^{(U)}$	**1.6**$^{(O)}$	**1.6**$^{(O)}$	**1.7**$^{(O)}$
Chloride	mg/L	-	-	-	-	10	0.8	0.93	1.2	30	0.81	1	1.7	**2.9**$^{(U)}$	**3.5**$^{(U)}$	**4.0**$^{(U)}$	**2.7**$^{(O)}$	**3.1**$^{(O)}$	**3.3**$^{(O)}$
Fluoride	mg/L	-	-	-	-	10	0.02	0.03	<0.05	30	0.01	0.03	<0.05	0.012	0.014	0.015	0.012	0.012	0.012
Magnesium	mg/L	-	-	-	-	10	0.75	0.8	0.92	30	0.61	0.71	0.76	**0.96**$^{(U)}$	**1.1**$^{(U)}$	**1.3**$^{(U)}$	**0.94**$^{(O)}$	**0.97**$^{(O)}$	**0.99**$^{(O)}$
Potassium	mg/L	-	-	-	-	10	0.61	0.64	0.75	30	0.35	0.59	0.7	**0.96**$^{(U)}$	**1.1**$^{(U)}$	**1.3**$^{(U)}$	**0.93**$^{(O)}$	**1.0**$^{(O)}$	**1.1**$^{(O)}$
Sodium	mg/L	-	-	-	-	10	0.8	0.95	<1.0	30	0.76	0.82	<1.0	**1.9**$^{(U)}$	**2.3**$^{(U)}$	**2.6**$^{(U)}$	**1.8**$^{(O)}$	**2.0**$^{(O)}$	**2.2**$^{(O)}$
Sulphate	mg/L	-	-	-	-	10	2.3	2.6	2.8	30	1.4	2.5	3.2	**3.2**$^{(U)}$	**4.0**$^{(U)}$	**4.8**$^{(U)}$	3.0	**3.5**$^{(O)}$	**3.8**$^{(O)}$
Nutrients																			
Nitrate	mg N/L	-	-	-	-	10	<0.006	<0.013	<0.02	30	<0.006	<0.013	<0.02	**0.039**$^{(U)}$	**0.057**$^{(U)}$	**0.062**$^{(U)}$	**0.039**$^{(O)}$	**0.047**$^{(O)}$	**0.057**$^{(O)}$
Total ammonia	mg N/L	433	0.007	0.005 to 0.010	59	10	0.015	0.024	0.046	30	<0.005	0.0085	0.042	0.018	0.029	0.04	0.017	0.022	0.027
Total phosphorus	mg P/L	448	0.003	0.002 to 0.0042	25	10	0.002	0.0033	<0.005	30	<0.001	0.0049	<0.005	**0.0027**$^{(U)}$	**0.0032**$^{(U)}$	**0.0036**$^{(U)}$	0.0024	**0.0026**$^{(O)}$	**0.0028**$^{(O)}$
Dissolved orthophosphate	mg P/L	-	-	-	-	10	<0.001	<0.003	<0.005	30	<0.001	<0.003	<0.005	0.0013	0.0018	0.0022	0.00097	0.0012	0.0014
Reactive silica	mg/L	-	-	-	-	-	-	-	-	-	-	-	-	0.12	0.14	0.15	0.11	0.12	0.12
Chlorophyll *a*	µg/L	-	-	-	-	-	-	-	-	-	-	-	-	0.2	0.69	2.4	0.7	1.9	3.3
Total Metals																			
Aluminum	µg/L	458	7.95	3.2 to 18.75	7	10	3	3.7	4.6	30	3.2	5	7.2	**18**$^{(U)}$	**23**$^{(U)}$	**28**$^{(U)}$	**18**$^{(O)}$	**20**$^{(O)}$	**22**$^{(O)}$
Arsenic	µg/L	411	0.2	0.18 to 0.21	23	10	0.081	0.16	0.19	30	0.15	0.18	0.23	**0.29**$^{(U)}$	**0.33**$^{(U)}$	**0.36**$^{(U)}$	**0.27**$^{(O)}$	**0.29**$^{(O)}$	**0.3**$^{(O)}$
Barium	µg/L	-	-	-	-	10	1.8	2	2.3	30	1.7	1.8	2.8	**4.5**$^{(U)}$	**5.2**$^{(U)}$	**6.1**$^{(U)}$	**4.1**$^{(O)}$	**4.5**$^{(O)}$	**4.8**$^{(O)}$
Beryllium	µg/L	-	-	-	-	10	<0.01	<0.11	<0.2	30	<0.01	<0.11	<0.2	**0.11**$^{(U)}$	**0.12**$^{(U)}$	**0.12**$^{(U)}$	**0.12**$^{(O)}$	**0.12**$^{(O)}$	**0.12**$^{(O)}$
Bismuth	µg/L	-	-	-	-	5	<0.005	<0.005	<0.005	17	<0.005	<0.005	<0.2	**0.0072**$^{(U)}$	**0.0094**$^{(U)}$	**0.012**$^{(U)}$	0.0068	0.0079	0.0092
Cadmium	µg/L	465	**0.05** $^{(DL>C)}$	**0.05** $^{(DL>C)}$ to **0.2** $^{(DL>C)}$	95	10	<0.005	<0.028	<0.05$^{(DL>C)}$	30	<0.005	0.006	<0.05$^{(DL>C)}$	**0.032**$^{(U)}$	**0.034**$^{(U)}$	**0.037**$^{(U)}$	**0.031**$^{(O)}$	**0.032**$^{(O)}$	**0.033**$^{(O)}$
Chromium	µg/L	459	0.33	0.185 to **1.2** $^{(C)}$	37	10	<0.06	0.074	<0.1	30	<0.06	<0.1	0.21	**0.085**$^{(U)}$	**0.1**$^{(U)}$	**0.12**$^{(U)}$	0.078	0.086	0.093
Cobalt	µg/L	-	-	-	-	10	0.006	0.02	0.19	30	0.019	0.028	<0.1	0.064	0.068	0.073	**0.068**$^{(O)}$	**0.071**$^{(O)}$	**0.074**$^{(O)}$
Copper	µg/L	459	0.7	0.6 to 1.0	51	10	0.53	0.61	0.67	30	0.48	<0.6	1	0.39	0.42	0.44	0.37	0.38	0.4

Table 17-7 Predicted Water Quality (Depth-Averaged Maximum) in Lac de Gras (LDG-P6) by Operations, Closure, and Post-Closure

Part A

Parameter Name	Unit	Lac de Gras (whole lake) - Reference Condition				Lac de Gras (FFA) - 2014 Baseline Condition								LDG-P6 - Application Case Early Operations (2019 - 2023)					
		Open-Water and Under-Ice				Under-Ice (2010 to 2012)				Open-Water (2010 to 2012)				Under-Ice			Open-Water		
		Count	Median	Range (25^{th} to 75^{th} %ile)	Percent of Samples Less than the Analytical Detection Limit	Count	Minimum	Median	Maximum	Count	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum
Iron	µg/L	-	-	-	-	10	1	3	9.1	30	4	5.8	9.5	**$22^{(U)}$**	**$28^{(U)}$**	**$36^{(U)}$**	**$24^{(O)}$**	**$27^{(O)}$**	**$30^{(O)}$**
Lead	µg/L	388	0.05	0.05 to 0.07	85	10	<0.005	0.028	0.074	30	<0.005	0.01	0.056	0.033	0.035	0.038	0.032	0.033	0.035
Manganese	µg/L	-	-	-	-	10	0.62	1.2	1.6	30	1.8	2.5	4.2	**$3.1^{(U)}$**	**$3.6^{(U)}$**	**$4.2^{(U)}$**	**$4.9^{(O)}$**	**$5.2^{(O)}$**	**$5.4^{(O)}$**
Mercury	µg/L	-	-	-	-	10	<0.01	<0.015	<0.02	25	<0.01	<0.02	0.02	**$0.011^{(U)}$**	**$0.012^{(U)}$**	**$0.012^{(U)}$**	0.012	0.012	0.012
Molybdenum	µg/L	-	-	-	-	10	0.08	0.13	0.15	30	0.073	0.12	0.73	**$2.5^{(U)}$**	**$3.1^{(U)}$**	**$3.8^{(U)}$**	**$2.1^{(O)}$**	**$2.5^{(O)}$**	**$2.8^{(O)}$**
Nickel	µg/L	459	0.69	0.5 to 1.40	16	10	0.92	1	1.7	30	0.79	0.94	1.3	1.3	1.3	1.4	1.2	1.3	1.3
Selenium	µg/L	-	-	-	-	10	<0.04	<0.07	0.1	30	<0.04	<0.07	<0.1	**$0.11^{(U)}$**	**$0.13^{(U)}$**	**$0.15^{(U)}$**	**$0.1^{(O)}$**	**$0.11^{(O)}$**	**$0.12^{(O)}$**
Silver	µg/L	-	-	-	-	10	<0.005	<0.053	<0.1	30	<0.005	<0.053	<0.1	**$0.056^{(U)}$**	**$0.058^{(U)}$**	**$0.061^{(U)}$**	**$0.056^{(O)}$**	**$0.057^{(O)}$**	**$0.058^{(O)}$**
Strontium	µg/L	-	-	-	-	10	7.7	8.3	10	30	7.9	8.7	9.8	**$30^{(U)}$**	**$35^{(U)}$**	**$41^{(U)}$**	**$25^{(O)}$**	**$28^{(O)}$**	**$32^{(O)}$**
Uranium	µg/L	-	-	-	-	10	0.023	0.031	0.05	30	0.02	0.03	<0.05	**$0.23^{(U)}$**	**$0.29^{(U)}$**	**$0.37^{(U)}$**	**$0.22^{(O)}$**	**$0.25^{(O)}$**	**$0.29^{(O)}$**
Vanadium	µg/L	-	-	-	-	10	<0.05	<0.13	<0.2	30	<0.05	<0.13	<0.2	**$0.39^{(U)}$**	**$0.49^{(U)}$**	**$0.62^{(U)}$**	**$0.36^{(O)}$**	**$0.41^{(O)}$**	**$0.47^{(O)}$**
Zinc	µg/L	369	1	0.8 to 6.5	46	10	0.5	1.3	2.3	30	0.3	<0.8	3.3	1.4	1.4	1.4	0.73	0.75	0.77

Source:

DDMI 2001 for data from 1994 to 2000; Stations included: Lac de Gras Mid-field Stations (LDG40, LDG41, LDG42, LDG43, LDG44, LDG45, LDG49), and Lac de Gras Far-field Stations (LDG46, LDG48, BHP-S); see DDMI 2001 for station locations within Lac de Gras.

DDMI 2011 and 2012 (FFA-1, FFA-2, FFA-3, FFA-4, and FFA-5 sampled in 2010 and 2011).

Note:

Bolded concentrations are higher than relevant water quality guidelines.

CWQG = Canadian Council of Ministers of the Environment (CCME) water quality guidelines for the protection of aquatic life (CCME 1999); CDWQG = Canadian Drinking Water Quality Guidelines (Health Canada 2012).

FF = far-field.

(C) = concentration higher than the relevant chronic CWQG or beyond the recommended pH or DO concentration range.

(D) = concentration higher than the relevant CDWQG or beyond the recommended pH or DO concentration range.

(DL>C) = analytical detection limit was higher than the relevant chronic CWQG.

(U) = concentration higher than the relevant under ice 2014 Baseline Condition or beyond the recommended DO concentration range.

(O) = concentration higher than the relevant open water 2014 Baseline Condition or beyond the recommended DO concentration range.

<= less than; >= greater than; - = no guideline or no data; DO = dissolved oxygen.

Water quality data and guidelines shown in this table were rounded to reflect laboratory or field instrument precision after comparisons to guidelines. Therefore, values slightly above guidelines may be displayed as being equal to the guidelines and identified as exceedances. Measured concentrations equal to the guideline values were not identified as exceedances.

pH set to 6.7 (median of the 2010-2014 dataset) for the purpose of pH-dependent guidelines.

DOMINION DIAMOND

Table 17-7 Predicted Water Quality (Depth-Averaged Maximum) in Lac de Gras (LDG-P6) by Operations, Closure, and Post-Closure

Part B

Parameter Name	Unit	LDG-P6 - Application Case																	
		Operations (2024 - 2029)						Closure - Pit Back-Flooding Period (2030 - 2033)						Post-Closure (2034 - 2060)					
		Under-Ice			Open-Water			Under-Ice			Open-Water			Under-Ice			Open-Water		
		Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum
Field Measured																			
Temperature	°C	0.2	0.5	1.6	0.7	7.0	14	0.2	0.5	2.3	0.7	7.4	13	0.2	0.5	2.8	0.6	7.5	14
Dissolved oxygen	mg/L	10	13	14	9.7	11	14	11	13	14	9.7	11	14	10	13	14	9.5	11	14
Conventional Parameters																			
Hardness	mg/L	7.1	**8.7**(U)	**10**(U)	**7.0**(O)	**7.4**(O)	**8.2**(O)	**7.5**(U)	**9.5**(U)	**11**(U)	**7.2**(O)	**8.2**(O)	**8.5**(O)	4.6	6.4	**10**(U)	4.5	**5.5**(O)	**8.2**(O)
Total dissolved solids	mg/L	17	20	**23**(U)	17	17	19	18	**21**(U)	**23**(U)	17	18	19	11	16	**23**(U)	11	13	18
Total suspended solids	mg/L	1.4	**1.7**(U)	**1.9**(U)	1.4	1.5	1.5	1.4	**1.6**(U)	**1.8**(U)	1.3	1.4	1.4	1.3	**1.5**(U)	**1.7**(U)	1.2	1.3	1.4
Major Ions																			
Calcium	mg/L	**1.5**(U)	**1.8**(U)	**2.0**(U)	**1.5**(O)	**1.5**(O)	**1.6**(O)	**1.7**(U)	**2.2**(U)	**2.5**(U)	**1.6**(O)	**2.0**(O)	**2.1**(O)	0.92	**1.4**(U)	**2.5**(U)	0.91	**1.2**(O)	**2.0**(O)
Chloride	mg/L	**2.7**(U)	**3.3**(U)	**4.0**(U)	**2.6**(O)	**2.8**(O)	**3.2**(O)	**3.3**(U)	**4.5**(U)	**5.2**(U)	**3.1**(O)	**4.1**(O)	**4.2**(O)	0.94	**2.2**(U)	**5.2**(U)	0.94	**1.9**(O)	**4.2**(O)
Fluoride	mg/L	0.011	0.013	0.015	0.011	0.011	0.012	0.01	0.012	0.013	0.01	0.01	0.011	0.0087	0.011	0.013	0.0084	0.0089	0.01
Magnesium	mg/L	0.82	**1.0**(U)	**1.2**(U)	**0.82**(O)	**0.89**(O)	**1.0**(O)	0.76	**0.94**(U)	**1.0**(U)	**0.76**(O)	**0.8**(O)	**0.82**(O)	0.55	0.7	**0.96**(U)	0.54	0.6	**0.77**(O)
Potassium	mg/L	**0.83**(U)	**1.1**(U)	**1.3**(U)	**0.83**(O)	**0.93**(O)	**1.0**(O)	0.74	**0.92**(U)	**1.0**(U)	**0.74**(O)	**0.78**(O)	**0.83**(O)	0.55	0.71	**0.93**(U)	0.54	0.61	**0.76**(O)
Sodium	mg/L	**1.7**(U)	**2.1**(U)	**2.6**(U)	**1.7**(O)	**1.8**(O)	**2.1**(O)	**1.8**(U)	**2.1**(U)	**2.3**(U)	**1.7**(O)	**1.8**(O)	**1.9**(O)	**0.75**(U)	**1.2**(U)	**2.3**(U)	**0.74**(O)	**1.0**(O)	**1.9**(O)
Sulphate	mg/L	**2.8**(U)	**3.8**(U)	**4.7**(U)	2.8	**3.3**(O)	**3.8**(O)	2.3	**3.0**(U)	**3.5**(U)	2.3	2.5	2.8	1.3	1.8	**2.9**(U)	1.3	1.6	2.3
Nutrients																			
Nitrate	mg N/L	**0.025**(U)	**0.034**(U)	**0.053**(U)	**0.023**(O)	**0.026**(O)	**0.039**(O)	**0.025**(U)	**0.034**(U)	**0.042**(U)	**0.024**(O)	**0.028**(O)	**0.032**(O)	**0.018**(U)	**0.023**(U)	**0.033**(U)	**0.018**(O)	**0.02**(O)	**0.031**(O)
Total ammonia	mg N/L	0.021	0.03	0.039	0.019	0.022	0.029	0.017	0.025	0.029	0.016	0.019	0.022	0.0085	0.012	0.022	0.0081	0.0094	0.015
Total phosphorus	mg P/L	**0.0025**(U)	**0.0032**(U)	**0.0037**(U)	0.0023	**0.0025**(O)	**0.0027**(O)	**0.0025**(U)	**0.003**(U)	**0.0032**(U)	0.0023	0.0025	**0.0026**(O)	0.0024	**0.0027**(U)	**0.003**(U)	0.0023	0.0024	**0.0026**(O)
Dissolved orthophosphate	mg P/L	0.0011	0.0018	0.0023	0.00092	0.0011	0.0013	0.0011	0.0016	0.0018	0.00095	0.0011	0.0012	0.001	0.0013	0.0016	0.00093	0.001	0.0012
Reactive silica	mg/L	0.12	0.14	0.15	0.11	0.12	0.12	0.12	0.14	0.15	0.12	0.12	0.12	0.12	0.14	0.16	0.11	0.12	0.12
Chlorophyll *a*	µg/L	0.33	0.82	2.5	1.1	2.0	3.4	0.24	0.52	1.4	0.72	1.3	2.0	0.07	0.17	0.73	0.15	0.5	1.0
Total Metals																			
Aluminum	µg/L	**19**(U)	**23**(U)	**27**(U)	**19**(O)	**20**(O)	**23**(O)	**18**(U)	**22**(U)	**23**(U)	**18**(O)	**19**(O)	**19**(O)	**7.0**(U)	**10**(U)	**21**(U)	6.9	**9.5**(O)	**18**(O)
Arsenic	µg/L	**0.29**(U)	**0.33**(U)	**0.36**(U)	**0.26**(O)	**0.28**(O)	**0.31**(O)	**0.27**(U)	**0.29**(U)	**0.31**(U)	**0.24**(O)	**0.25**(O)	**0.26**(O)	**0.22**(U)	**0.24**(U)	**0.29**(U)	0.2	0.21	**0.25**(O)
Barium	µg/L	**4.4**(U)	**5.2**(U)	**6.0**(U)	**4.0**(O)	**4.4**(O)	**4.9**(O)	**4.0**(U)	**4.6**(U)	**5.0**(U)	**3.6**(O)	**3.8**(O)	**4.0**(O)	**2.8**(U)	**3.2**(U)	**4.5**(U)	2.4	2.7	**3.6**(O)
Beryllium	µg/L	**0.11**(U)	**0.12**(U)	**0.12**(U)	**0.12**(O)	**0.12**(O)	**0.12**(O)	**0.11**(U)	**0.11**(U)	**0.11**(U)	**0.11**(O)	**0.11**(O)	**0.12**(O)	**0.1**(U)	**0.1**(U)	**0.11**(U)	**0.11**(O)	**0.11**(O)	**0.11**(O)
Bismuth	µg/L	**0.006**(U)	**0.009**(U)	**0.012**(U)	0.0058	0.0075	0.0095	**0.0044**(U)	**0.006**(U)	**0.0075**(U)	0.0042	0.0051	0.0058	0.00039	0.0015	**0.0054**(U)	0.00037	0.0011	0.0041
Cadmium	µg/L	**0.033**(U)	**0.035**(U)	**0.037**(U)	**0.031**(O)	**0.032**(O)	**0.033**(O)	**0.031**(U)	**0.032**(U)	**0.034**(U)	**0.031**(O)	**0.031**(O)	**0.031**(O)	**0.029**(U)	**0.029**(U)	**0.032**(U)	**0.026**(O)	**0.027**(O)	**0.031**(O)
Chromium	µg/L	**0.085**(U)	**0.1**(U)	**0.12**(U)	0.079	0.086	0.095	**0.078**(U)	**0.092**(U)	**0.098**(U)	0.072	0.076	0.08	**0.051**(U)	**0.061**(U)	**0.091**(U)	0.045	0.051	0.073
Cobalt	µg/L	0.067	0.071	0.078	**0.072**(O)	**0.074**(O)	**0.077**(O)	0.073	0.08	0.082	**0.078**(O)	**0.08**(O)	**0.081**(O)	0.051	0.059	0.08	**0.058**(O)	**0.063**(O)	**0.079**(O)
Copper	µg/L	0.4	0.43	0.44	0.38	0.39	0.4	0.4	0.42	0.43	0.38	0.38	0.39	0.36	0.38	0.43	0.34	0.35	0.38
Iron	µg/L	**20**(U)	**27**(U)	**35**(U)	**22**(O)	**26**(O)	**31**(O)	**16**(U)	**21**(U)	**24**(U)	**18**(O)	**21**(O)	**22**(O)	4.6	7.8	**20**(U)	7.0	9.4	**18**(O)
Lead	µg/L	0.033	0.036	0.038	0.032	0.034	0.035	0.033	0.034	0.035	0.032	0.032	0.033	0.027	0.029	0.035	0.026	0.027	0.031
Manganese	µg/L	**3.3**(U)	**3.7**(U)	**4.1**(U)	**5.1**(O)	**5.2**(O)	**5.5**(O)	**3.2**(U)	**3.6**(U)	**3.8**(U)	**5.0**(O)	**5.1**(O)	**5.1**(O)	**1.9**(U)	**2.3**(U)	**3.6**(U)	3.8	4.1	**5.0**(O)
Mercury	µg/L	**0.011**(U)	**0.012**(U)	**0.012**(U)	0.011	0.012	0.012	**0.011**(U)	**0.011**(U)	**0.011**(U)	0.012	0.012	0.012	**0.01**(U)	**0.011**(U)	**0.012**(U)	0.011	0.01	0.011
Molybdenum	µg/L	**2.6**(U)	**3.2**(U)	**3.7**(U)	**2.2**(O)	**2.5**(O)	**2.8**(O)	**2.4**(U)	**2.8**(U)	**3.1**(U)	**1.9**(O)	**2.1**(O)	**2.3**(O)	**1.6**(U)	**2.0**(U)	**2.9**(U)	**1.2**(O)	**1.5**(O)	**2.1**(O)
Nickel	µg/L	1.3	1.3	1.4	1.2	1.3	**1.3**(O)	1.2	1.3	1.3	1.2	1.2	1.2	1.1	1.2	1.3	1.1	1.1	1.2
Selenium	µg/L	**0.1**(U)	**0.13**(U)	**0.15**(U)	**0.098**(O)	**0.11**(O)	**0.13**(O)	0.089	**0.1**(U)	**0.11**(U)	**0.085**(O)	**0.091**(O)	**0.097**(O)	0.062	0.07	0.098	**0.06**(O)	**0.066**(O)	**0.085**(O)
Silver	µg/L	**0.055**(U)	**0.058**(U)	**0.061**(U)	**0.055**(O)	**0.057**(O)	**0.058**(O)	**0.053**(U)	**0.054**(U)	**0.056**(U)	**0.054**(O)	**0.054**(O)	**0.054**(O)	**0.051**(U)	**0.051**(U)	**0.055**(U)	**0.051**(O)	**0.05**(O)	**0.053**(O)

Table 17-7 Predicted Water Quality (Depth-Averaged Maximum) in Lac de Gras (LDG-P6) by Operations, Closure, and Post-Closure

Part B

Parameter Name	Unit	LDG-P6 - Application Case																	
		Operations (2024 - 2029)						Closure - Pit Back-Flooding Period (2030 - 2033)						Post-Closure (2034 - 2060)					
		Under-Ice			Open-Water			Under-Ice			Open-Water			Under-Ice			Open-Water		
		Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum	Minimum	Median	Maximum
Strontium	µg/L	**35(U)**	**42(U)**	**74(U)**	**30(O)**	**33(O)**	**47(O)**	**65(U)**	**83(U)**	**93(U)**	**48(O)**	**56(O)**	**58(O)**	**29(U)**	**45(U)**	**92(U)**	**22(O)**	**32(O)**	**56(O)**
Uranium	µg/L	**0.22(U)**	**0.29(U)**	**0.36(U)**	**0.21(O)**	**0.24(O)**	**0.29(O)**	**0.18(U)**	**0.24(U)**	**0.27(U)**	**0.17(O)**	**0.2(O)**	**0.21(O)**	0.039	**0.078(U)**	**0.22(U)**	**0.038(O)**	**0.068(O)**	**0.17(O)**
Vanadium	µg/L	**0.33(U)**	**0.48(U)**	**0.61(U)**	**0.32(O)**	**0.4(O)**	**0.48(O)**	**0.26(U)**	**0.33(U)**	**0.41(U)**	**0.24(O)**	**0.27(O)**	**0.31(O)**	**0.1(U)**	**0.15(U)**	**0.31(U)**	0.082	**0.12(O)**	**0.24(O)**
Zinc	µg/L	1.4	1.4	1.4	0.75	0.75	0.77	1.4	1.4	1.4	0.73	0.74	0.75	1.3	1.3	1.4	0.65	0.68	0.73

Source:

DDMI 2001 for data from 1994 to 2000; Stations included: Lac de Gras Mid-field Stations (LDG40, LDG41, LDG42, LDG43, LDG44, LDG45, LDG49), and Lac de Gras Far-field Stations (LDG46, LDG48, BHP-S); see DDMI 2001 for station locations within Lac de Gras.

DDMI 2011 and 2012 (FFA-1, FFA-2, FFA-3, FFA-4, and FFA-5 sampled in 2010 and 2011).

Note:

Bolded concentrations are higher than relevant water quality guidelines.

CWQG = Canadian Council of Ministers of the Environment (CCME) water quality guidelines for the protection of aquatic life (CCME 1999); CDWQG = Canadian Drinking Water Quality Guidelines (Health Canada 2012).

FF = far-field.

(C) = concentration higher than the relevant chronic CWQG or beyond the recommended pH or DO concentration range.

(D) = concentration higher than the relevant CDWQG or beyond the recommended pH or DO concentration range.

(DL>C) = analytical detection limit was higher than the relevant chronic CWQG.

(U) = concentration higher than the relevant under ice 2014 Baseline Condition or beyond the recommended DO concentration range.

(O) = concentration higher than the relevant open water 2014 Baseline Condition or beyond the recommended DO concentration range.

<= less than; >= greater than; - = no guideline or no data; DO = dissolved oxygen.

Water quality data and guidelines shown in this table were rounded to reflect laboratory or field instrument precision after comparisons to guidelines. Therefore, values slightly above guidelines may be displayed as being equal to the guidelines and identified as exceedances. Measured concentrations equal to the guideline values were not identified as exceedances.

pH set to 6.7 (median of the 2010-2014 dataset) for the purpose of pH-dependent guidelines.

Information Request Number:	DAR-MVEIRB-18
Source:	MVEIRB Jay Project Adequacy Review Item 9.2
Subject:	Water and Aquatic Life - Significance Determination for Water Quality
DAR Section(s):	4.1 and 8.7

Preamble (MVEIRB):

In Annex XVII, the "Traditional Land Use and Traditional Knowledge Baseline Report for the Jay Project", there are numerous references to the importance of water quality in the Ekati region, including the following three examples:

> *"The Elders recall the waters of the Ek'ati as being clear and pure. Beside caribou, water is the most important resource to the Dene people. When the Dene travel, they pay offerings of respect to the water. Water is used for transportation, drinking, fishing, cleaning, and preparing hides and other materials. The YKDFN Elders have said, "the water at Ek'ati is good. It tastes good; we do not have to add anything to make it taste better. It is almost like ice water." (from Section 3.2.3.1 of Annex XVII)*

> *"Metis have said that Lac de Gras: "has got to be one of the crown jewels of our lake country up here and it's a major sacrifice to see that degraded." (section 3.6.3.1 of Annex XVII)*

> *"The Tlicho Elders Committee have stated: "in the past, our elders looked on water as a type of medicine" (TG2012:27). "We depend on the land – animals and water – for life, therefore we do not want anything to be destroyed" (TG2012: 24). "If we wanted water – what will we be drinking? We need to think about this" (TG2012: 27)." (from section 3.7.3.1 of Annex XVII).*

On page 8-452, Dominion acknowledges that stakeholders consider surface waters in the area to be of high quality and to taste good; but these attributes are not specifically addressed in the residual impact classifications or the final significance determinations which Dominion defines on page 8-448 as:

> *"Not significant – impacts are measurable but are not likely to increase the risk to aquatic health and the sustainability of the aquatic ecosystem. Impacts occur at the local scale, and may be strong enough to be detectable at the regional scale."*

> *"Significant – impacts are measurable at a level such that there is a prolonged exceedance of a screening value (tied to a guideline) that has predicted effects on aquatic health and/or resulting effects to the sustainability of the aquatic ecosystem. A number of high magnitude and irreversible impacts at the regional scale would be significant"*

The magnitude criteria for residual impact classifications also do not mention effects to the suitability of the water for drinking or of the inherent importance of water quality in "one of the crown jewels of our lake country".

Request (MVEIRB):

Please provide a definition for significance that acknowledges potential impacts to the traditional use of surface waters in the area for drinking. This definition should acknowledge the importance of the water to traditional users as per the information presented in Annex XVII. As per section 4.2 of the TOR, if the determination is made that significant adverse effects to the use of water for drinking are not likely, then provide a "narrative statement that identifies what, in its opinion, the threshold for significance would be."

Response:

Within the DAR, significance focused on potential for effects to aquatic ecosystems and aquatic health, but the water quality assessment also included screening of the modelled water quality constituent results to drinking water guidelines. While the results were not assessed for aesthetics (e.g., taste, smell), as this is subjective to the individual, they were assessed for drinkability. As such, the significance definitions for water quality are amended as follows:

> ***Not significant*** *– impacts are measureable but are not likely to increase the risk to aquatic health, the sustainability of the aquatic ecosystem, or the continued opportunity for traditional use or drinkability of the water. Impacts occur at the local scale, and may be strong enough to be detectable at the regional scale.*
>
> ***Significant*** *– impacts are measureable at a level such that there is a prolonged exceedance of a screening value (tied to a guideline) that has predicted effects to aquatic health and/or resulting effects to the sustainability of the aquatic ecosystem, and/or changes to water that would prevent continued traditional use or drinkability of the water. A number of high magnitude and irreversible impacts at the regional scale would be significant.*

Within the DAR, water quality changes in both Lac du Sauvage and Lac de Gras under the Application Case were modelled for the life of mine and into the post-closure period (to 2060). The modelled predictions were compared to site-specific water quality objectives developed by the Ekati Mine, Canadian water quality guidelines (CWQG) for the protection of aquatic life (CCME 1999), Health Canada drinking water quality guidelines (DWQG; Health Canada 2012), a strontium effects benchmark (McPherson et al. 2014), other Provincial guidelines (BCMOE 2010), existing data representing current baseline conditions, and Reference Condition data, where applicable (Table 8.5-13 of the DAR). Through this process, for the majority of constituents, at least one screening value was developed. For six constituents (i.e., hardness, calcium, magnesium, total nitrogen, dissolved orthophosphate, bismuth), there were no published guidelines because these constituents do not pose a risk to aquatic life, wildlife, or humans. For constituents with both aquatic life and drinking water guidelines, the aquatic life guideline is typically substantially lower.

Results of the screened water quality predictions were provided in Tables 8.5-24 and 8.5-25 of the DAR for Lac du Sauvage and Lac de Gras, respectively. All predicted concentrations were less than the screening values, and thus, no constituents of concern were identified. In other words, the maximum predicted values for all assessment locations and snapshots were less than the site-specific objectives, CWQGs, DWQGs, the strontium benchmark, and the other Provincial guidelines. As reviewed in response to DAR-MVEIRB-17, revised predictions have been developed for Lac de Gras. The revised predictions are similar to those presented in the DAR and no constituents are predicted to exceed the screening values. An updated summary table of predictions for each assessment location and each snapshot are included as part of that response.

A high degree of conservatism was used in the input source terms that feed into the Lac du Sauvage and Lac de Gras hydrodynamic models. Thus, there is a high level of confidence that the predictions of residual effects have not been underestimated.

Based on the modelled water quality predictions for Lac du Sauvage and Lac de Gras for the Application Case, the Project will not have a significant adverse effect on the maintenance or suitability of water to support a healthy and sustainable ecosystem, or on the continued opportunity for the traditional use of water, including use as a drinking water source.

References:

BCMOE (British Columbia Ministry of Environment). 2010. Water Quality Guidelines (Criteria) Reports. January 2010. Available at: http://www.env.gov.bc.ca/wat/wq/wq_guidelines.html#working. Accessed July 2014.

CCME (Canadian Council of Ministers of the Environment). 1999. Canadian Environmental Quality Guidelines, with updates to 2014.. Publication No. 1299. Winnipeg, MB, Canada. ISBN: 1-896997-34-1.

Health Canada. 2012. Summary of Guidelines for Canadian Drinking Water Quality (CDWQ). Prepared by the Federal-Provincial Subcommittee on Drinking Water of the Federal-Provincial-Territorial Committee on Environmental and Occupational Health. Ottawa, ON, Canada.

McPherson C, Lawrence G, Elphick J, Chapman PM. 2014. Development of a strontium chronic effects benchmark for aquatic life in freshwater. Environ Toxicol Chem. DOI: 10.1002/etc.2696.

Information Request Number:	DAR-MVEIRB-19
Source:	MVEIRB Jay Project Adequacy Review Item 9.3
Subject:	Water and Aquatic Life - Residual Impact Classification and Significance Definition of Criteria
DAR Section(s):	8.7

Preamble (MVEIRB):

For water quality, the residual impact criteria are defined in Table 8.7-1 with respect to magnitude, geographic extent, duration, frequency, reversibility and likelihood. These criteria are further described in the text and section 8.7.1.2 describes the relative weight assigned to the criteria in making a significance determination (e.g., magnitude of effect is the primary driver in a significance determination).

Most definitions are clear with the exception of the moderate criteria for magnitude which states, “[m]easurable change in water quality such that the concentrations of some parameters are greater than screening values; however, no effect to aquatic health or to the sustainability of the aquatic ecosystem will occur.”

Based on the text on page 8-444, this criterion must necessarily be evaluated using best professional judgement and this is partially described here. However, no example is given as to how far a screening value could be exceeded without impairing aquatic health and it is difficult to envision a situation in which this criterion would be met or how an objective assessment could be made or how the professional judgement of the proponent could be confirmed.

Request (MVEIRB):

Please provide an example of either predicted or measured results that would meet the criteria proposed for a moderate magnitude of effect for water quality. This example will demonstrate to reviewers how the criterion could or would be met and will be presented with specific guidance on how to interpret values that exceed screening criteria.

Response:

The purpose of this response is to provide an example of when a moderate magnitude rating would be applied in the context of residual impact criteria used to evaluate the significance of predicted changes to water quality resulting from the Project. As described in Section 8.7 of the DAR, the magnitude rating takes into account the screening thresholds for water quality parameters in the water quality assessment, and the results of the aquatic health assessment, to determine the potential to adversely affect the sustainability of the overall aquatic ecosystem. The screening thresholds chosen for this assessment are conservative in regards to protecting aquatic life. They were selected from site-specific water quality objectives developed for the Ekati Mine and generic water quality guidelines (i.e., national or provincial water quality guidelines) for the protection of aquatic life.

As a reminder, a low magnitude rating was applied to all water quality effects statements in the DAR (Table 8.7-2); that is, measurable change in water quality is predicted, but the expected change to concentrations in the receiving environment (e.g., Lac due Sauvage and Lac de Gras) will be less than screening thresholds, so no measureable change to aquatic health or sustainability of the aquatic ecosystem, or use of the water, will occur.

Within the context of water quality, magnitude is a measure of the extent of change in the receiving environment caused by the Project (and other developments, if applicable) relative to baseline conditions (factoring in natural variation), guidelines, or established threshold values. Within the DAR (Table 8.7-1), three specific ratings were provided: low, moderate, and high. The criteria for the extent of water quality changes for a low or high magnitude rating are relatively straightforward. Where environmental assessment (EA) predictions indicate that screening thresholds will not be exceeded, and thus there would be no risk to aquatic health or use, a low rating is applied. Where predicted water quality indicates that screening thresholds for one or more constituents will be exceeded to the extent that there is a likelihood of risk to aquatic health, then a high magnitude rating will be assigned.

From Table 8.7-1 of the DAR, a moderate magnitude rating is defined as a measurable change in water quality such that the concentrations of some constituents are predicted to be greater than screening thresholds, but effects to aquatic health or to the sustainability of the aquatic ecosystem are not expected to occur. The exceedance of a screening threshold may indicate the potential for adverse effects, but not the likelihood that they will occur. Exceedance of a screening value typically leads to further evaluation within the EA as to whether an effect may occur. Within the context of the DAR, further evaluation means a detailed aquatic health assessment through three exposure pathways, as described in Section 8.5.5:

- direct effects resulting from direct exposure to the constituent of potential concern in the water column;
- indirect effects resulting from direct exposure of food chain components to the constituent of potential concern in the water column; and,
- indirect effects resulting from potential accumulation of the constituent of potential concern within fish tissue via uptake from both water and diet.

Should the aquatic health assessment determine that the predicted constituent concentration will not result in potential affects to aquatic biota, then the magnitude rating will be assigned as moderate; if the conclusion of the aquatic health assessment is that there is risk of potential aquatic effects, then the magnitude rating is assigned as high.

The classification of a moderate or high magnitude rating in the residual impact classification does not imply that the predicted change will be significant; magnitude is one of six criteria that are used in the impact classification and determination of significance. The geographical extent of a change and its duration are two other criteria that are critical in this evaluation; for a moderate or high magnitude rating to be significant, the geographical extent would need to extend to a regional or beyond regional extent and be long term or permanent.

DOMINION DIAMOND

Information Request Number:	DAR-MVEIRB-20
Source:	MVEIRB Jay Project Adequacy Review Item 9.4
Subject:	Water and Aquatic Life - Geographic Scope of the Assessment
DAR Section(s):	8.1.4.3

Preamble (MVEIRB):

Section 3.4 of the TOR: Geographic scope: "The geographic scope will include all areas that may be affected by activities within the Jay Project scope of development….The developer will provide rationale for the spatial boundaries it selects for the assessment of potential mine-related impacts on each valued component."

In Section 8.1.4.3, it states: "Based on the proposed design and associated mitigation of the Project, and the cumulative effects from existing and reasonable foreseeable developments, it is anticipated that changes in water quality will not be measureable at the outlet of Lac de Gras. Thus, setting the limit of the water quality ESA at the outlet of Lac de Gras is reasonable." However, this is inconsistent with the following:

a) The residual impact criteria for geographical extent for water quality. The "local" extent definition is only the outlet of Lac de Gras, which is, therefore, equal to the extent of the area assessed for potential impacts. The "regional" and "beyond regional" extent criteria, which extend to the outlet of Desteffany Lake and the mouth of the Coppermine River respectively, cannot actually be evaluated since effects has not been assessed further than the outlet of Lac de Gras;
b) The assumption that changes to water quality will not be measurable at the outlet of Lac de Gras is not consistent with the predictions presented in section 8.5.4.2.2 or with the impact assessment itself which determines that the geographic extent of the effects to water quality in Lac de Gras will be "local to regional" (table 8.7-2).
c) Setting the water quality ESA at the outlet of Lac de Gras also confounds interpretation of project-related vs. cumulative effects to water quality as the significance determination excludes explicit consideration of changes in Lac de Sauvage from the Jay project. Adoption of a "Local Study Area" to assess changes to Lac du Sauvage (area of direct effect of the project) and "Regional Study Area" to assess cumulative effects in areas affected by other activities downstream of Lac du Sauvage (Lac de Gras, Coppermine River) would provide a clearer distinction between project related and cumulative effects.

Request (MVEIRB):

Please provide further rationale for setting the Effects Study Area equal to the outlet of Lac de Gras and for not distinguishing project effects from cumulative effects. This rationale will be consistent with the actual effects predicted and with the ability of Dominion to determine the geographic extent of the residual impacts as per the definitions in Table 8.7-1.

Response:

The Effects Study Area (ESA) selected for the water quality component of the Project is appropriate as both Project and cumulative effects were evaluated and the magnitude of change at the outlet of Lac de Gras is low.

The ESA for water quality is the area within the baseline study area where Project activities could potentially have direct or cumulative effects on biological receptors or end-users. The ESA for water quality was limited to where measureable changes in water quality (both from Project and cumulative effects) are anticipated to occur.

The Lac de Gras hydrodynamic water quality model was developed to predict Project and cumulative changes to water quality in Lac de Gras. As described in Section 8.6.3.1, conservative assumptions were used in the hydrodynamic model and in the various inputs to the hydrodynamic model (i.e., surface flows, groundwater flows and seepage, baseline water quality, and geochemical characterization). All of the inputs have inherent variability and uncertainty, but conservatism was applied to the inputs assigned in the model to provide a high level of confidence that the modelled constituent concentrations through the Application Case were not underestimated.

In the assessment of residual effects to water quality in Lac de Gras, cumulative effects from the spatial and temporal overlap from the existing Diavik and Ekati mine operations have been taken into consideration in the water quality model predictions and the interpretation of results.

While the results from the hydrodynamic model suggest that there will be measureable water quality changes at the outlet of Lac de Gras, the absolute difference in constituent concentrations between the Base Case (i.e., Reference Condition or 2014 Baseline Condition measured data) and the Application Case (maximum predicted concentrations) is small, with all concentrations predicted to be well below the aquatic life and drinking water guidelines and objectives. No water quality constituents of concern were identified. Thus, it was concluded that the Project will not have a significant adverse effect on the maintenance or suitability of water to support a healthy and sustainable ecosystem.

The data and approach used to estimate future water quality are commensurate with industry best practices and are believed to provide a reasonable approximation of a complex system. Ultimately, even the best of models cannot compare with operational monitoring data, but it is the goal of modelling to conservatively predict concentrations, so concentrations of monitored constituents are anticipated to be less than predicted concentrations. Once the Project is operational, monitoring of water quality and periodic re-assessment of effects predictions based on measured data will be required.

Dominion Diamond is of the opinion that the assessment area and the quantitative water quality models developed for the DAR conform to the requirements of the ToR, and they are adequate to reasonably assess Project and cumulative effects and to determine the significance of the Project to water quality.

In light of the Board’s review comment, Dominion Diamond has initiated a modelling update to evaluate regional effects beyond the ESA (i.e., extending the water quality modelling boundary to the outlet of Desteffany Lake). This update accounts for the existing modelled water quality results at the outlet of Lac de Gras as referenced in the response to MVEIRB-17. The outcome of this modelling update will be to provide an estimate of water quality predictions in Desteffany Lake so as to confirm the downstream extent to which water quality changes may occur. Extending the regional extent of the effects study area in this manner does not change the conclusions reached in the DAR. The downstream extension modelling report will be provided to the Review Board as soon as it is available.

DOMINION DIAMOND

Information Request Number:	DAR-MVEIRB-21
Source:	MVEIRB Jay Project Adequacy Review Item 9.5
Subject:	Water and Aquatic Life - Biophysical Environment
DAR Section(s):	8.2.5.3 and Annex XI

Preamble (MVEIRB):

Section 5.1, item 13c of the Jay Project Terms of Reference: "Physical and chemical makeup of water body sediment in potentially affected water bodies (i.e. from direct or indirect (e.g., aerial deposition including particle size analysis, total metals, dioxins and furans), including baseline concentrations"

In Section 8.8.3, it suggests that water quality at least was measured for dioxins and furans. However, the baseline reports do not show any analysis for these parameters in either water or sediment – except for a mention in Annex XI of the studies on dioxins/furans in sediments in Kodiak Lake as done by Environment Canada.

Dioxins and furans were not measured in sediments sampled by Dominion in preparation for the baseline report.

Request (MVEIRB):

Please provide a rationale why dioxins and furans were not measured in sediments sampled by Dominion for the purpose of understanding baseline conditions for the project.

Response:

Dioxin and furan data were not available from the historic baseline dataset for the region, except for samples reported for the Ekati Mine AEMP lakes in a study conducted by Environment Canada (Wilson et al. 2011), which was referenced in Annex XI to the DAR. Note that Kodiak Lake, as reported in the Environment Canada study, is not considered representative of natural reference conditions for the Jay Project, but represents the 2014 condition proximal to the Ekati Mine main camp.

During the Jay Project 2014 baseline water quality and sediment quality program, sediment samples for dioxins and furans analysis were collected from Lac du Sauvage, Duchess Lake, Lac de Gras, and four small lakes. Sediment samples were also collected for particle size, nutrients, and metals constituents. Dioxin and furan results are provided in Table 21-1 and Table 21-2.

The upper bound of the toxic equivalency (PCDD/F TEQ) (Table 21-1) is less than the probable effects level (21.5 pg/g) (CCME 2001) in all 2014 samples, and less than the interim sediment quality guideline (0.85 pg/g) (CCME 2001) in all samples except Counts Lake, Lake C1, and Christine Lake. A report on the Jay Project 2014 baseline water and sediment quality program, providing the results from the 2014 field program, will be provided to the Review Board in 2015.

DOMINION DIAMOND

Table 21-1 Dioxin and Furan Concentrations in Sediment from Lake Locations within the Jay Project Baseline Study Area, 2014

Lake		**Lac du Sauvage**					**Duchess Lake**	**Lac de Gras**				**Counts**	**Lake C1**	**Christine**	**Lake P5**
Sample Name		**Aa-1**	**Ab-1**	**Ac-1**	**Ad-1**	**Ae-1**	**Af-1**	**S3**	**S5**	**FF2-2**	**FF2-5**	**Counts-1**	**C1-1**	**Christine-1**	**P5-1**
Sampling Season		**Fall**	**Fall**	**Fall**	**Fall**	**Fall**	**Fall**	**Fall**	**Fall**	**Fall**	**Fall**	**Fall**	**Fall**	**Fall**	**Fall**
Date Sampled		**11-Sep-14**	**11-Sep-14**	**11-Sep-14**	**5-Sep-14**	**5-Sep-14**	**9-Sep-14**	**8-Sep-14**	**8-Sep-14**	**12-Sep-14**	**12-Sep-14**	**13-Sep-14**	**14-Sep-14**	**14-Sep-14**	**14-Sep-14**
Easting (NAD 83, 12W)		**552282**	**547766**	**543339**	**539898**	**542494**	**542494**	**505912**	**503125**	**541583**	**544734**	**7169862**	**537612**	**7163705**	**530615**
Northing (NAD 83, 12W)	**Unit**	**7165025**	**7162266**	**7165138**	**7168781**	**7170252**	**7170252**	**7164431**	**7161481**	**7158573**	**7158898**	**534303**	**7167085**	**539626**	**7169282**
Dioxin (Polychlorinated dibenzo-p-dioxins [PCDDs])															
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	pg/g	<0.32	<0.37	<0.26	<0.17	<0.13	<0.18	<0.32	<0.31	<0.11	<0.16	<0.56	<0.46	<0.46	<0.46
1,2,3,7,8-Pentachlorodibenzo-p-dioxins (PeCDD)	pg/g	<0.082	<0.083	0.400	<0.079	0.150	0.099	<0.15	<0.18	<0.043	<0.064	<0.21	<0.20	<0.24	<0.073
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	pg/g	<0.067	<0.059	<0.11	<0.055	<0.039	<0.047	<0.11	<0.16	<0.084	<0.049	<0.15	<0.13	<0.26	<0.067
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	pg/g	<0.065	<0.055	<0.11	<0.055	<0.040	<0.046	<0.11	<0.17	<0.082	<0.049	<0.15	<0.13	<0.27	<0.066
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	pg/g	<0.066	<0.057	<0.11	<0.055	<0.040	<0.047	<0.11	<0.17	<0.083	<0.049	<0.15	<0.13	<0.27	<0.067
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	pg/g	0.420	0.427	0.800	0.227	0.145	0.709	0.42	0.340	0.510	0.618	0.62	0.49	1.90	0.220
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (OCDD)	pg/g	2.27	2.12	5.77	1.29	0.490	4.12	1.79	0.93	2.84	2.88	2.91	1.93	12.4	1.01
Total Tetrachlorodibenzo-p-dioxin (TCDD) equivalents	pg/g	<0.32	1.21	1.64	2.28	<0.13	1.84	5.07	1.26	<0.11	<0.16	6.65	<0.46	4.97	<0.46
Furan (Polychlorinated dibenzofurans [PCDFs])															
2,3,7,8-tetrachlorodibenzofuran (TCDF)	pg/g	<0.52	<0.38	<0.28	0.27	<0.11	<0.23	0.47	0.24	0.130	0.26	<0.56	<0.48	<0.48	<0.32
1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)	pg/g	<0.12	<0.13	<0.12	<0.050	<0.055	<0.091	<0.14	<0.14	<0.048	<0.053	<0.17	<0.20	<0.19	<0.084
2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)	pg/g	<0.12	<0.13	<0.11	<0.043	<0.049	<0.079	<0.12	<0.12	0.043	<0.046	<0.15	<0.18	<0.17	<0.080
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	pg/g	<0.034	<0.044	<0.065	<0.034	<0.044	<0.029	<0.088	<0.18	<0.048	0.042	<0.13	<0.11	<0.27	<0.067
1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	pg/g	<0.030	0.044	<0.059	0.040	<0.040	<0.027	<0.079	1.00	<0.045	<0.033	<0.12	<0.10	<0.24	<0.063
1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)	pg/g	0.160	0.064	0.110	<0.045	<0.058	<0.038	0.19	<0.23	0.110	0.100	0.24	<0.13	<0.34	0.137
2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)	pg/g	<0.031	<0.038	<0.063	<0.033	<0.042	<0.029	<0.083	<0.17	<0.047	<0.034	<0.13	<0.10	<0.25	<0.058
1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	pg/g	<0.043	0.058	<0.048	<0.061	<0.024	0.070	<0.079	<0.12	0.042	<0.046	0.177	<0.088	0.22	0.091
1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)	pg/g	<0.066	<0.043	<0.073	<0.091	<0.036	<0.025	<0.12	<0.18	<0.040	<0.068	<0.10	<0.13	<0.25	<0.060
Octachlorodibenzofuran (OCDF)	pg/g	0.117	0.099	0.139	0.096	0.210	<0.043	<0.087	<0.14	0.092	0.147	<0.18	<0.11	0.42	0.110
Total Tetrachlorodibenzofurans (TCDF) equivalents	pg/g	<0.52	<0.38	0.78	1.76	0.62	1.07	4.91	1.54	0.806	0.42	5.47	3.31	8.54	<0.32
Toxic Equivalency (TEQ)															
Lower Bound TEQ		0.00492	0.00491	0.00177	0.0300	0.00145	0.00903	0.0516	0.000278	0.000852	0.0113	0.0264	0.00544	0.00372	0.0140
Mid Point PCDD/F TEQ		0.283	0.296	0.610	0.180	0.246	0.236	0.356	0.448	0.140	0.178	0.513	0.432	0.524	0.333
Upper Bound PCDD/F TEQ		0.545	0.576	0.798	0.327	0.340	0.364	0.641	0.769	0.237	0.309	0.993	0.859	1.02	0.648

pg/g = picograms per gram; % = percent; < = less than; NAD = North American Datum

Table 21-2 Quality Control Results for Dioxin and Furan Analysis in Sediment from Lake Locations within the Jay Project Baseline Study Area, 2014

Sample Name	Unit	R-01-14	Ac-1	RPD
Sampling Season		Fall	Fall	
Sample Date		11-Sep-14	11-Sep-14	
Dioxin (Polychlorinated dibenzo-p-dioxins [PCDDs])		<0.2	<0.26	-
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	pg/g	0.11	0.4	-
1,2,3,7,8-Pentachlorodibenzo-p-dioxins (PeCDD)	pg/g	<0.092	<0.11	-
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	pg/g	<0.091	<0.11	-
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	pg/g	<0.092	<0.11	-
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	pg/g	0.854	0.8	7%
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	pg/g	4.8	5.77	18%
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (OCDD)	pg/g	1.85	1.64	12%
Total Tetrachlorodibenzo-p-dioxin (TCDD) equivalents	pg/g	-	-	-
Furan (Polychlorinated dibenzofurans [PCDFs])		0.37	<0.28	-
2,3,7,8-tetrachlorodibenzofuran (TCDF)	pg/g	<0.077	<0.12	-
1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)	pg/g	<0.068	<0.11	-
2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)	pg/g	<0.034	<0.065	-
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	pg/g	<0.032	<0.059	-
1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	pg/g	0.11	0.11	0%
1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)	pg/g	<0.033	<0.063	-
2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)	pg/g	<0.08	<0.048	-
1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	pg/g	<0.12	<0.073	-
1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)	pg/g	0.12	0.139	15%
Octachlorodibenzofuran (OCDF)	pg/g	1.17	0.78	**40%**
Total Tetrachlorodibenzofurans (TCDF) equivalents	pg/g	-	-	-
Toxic Equivalency (TEQ)				
Lower Bound TEQ	-	0.00998	0.00177	**140%**
Mid Point PCDD/F TEQ	-	0.299	0.61	**68%**
Upper Bound PCDD/F TEQ	-	0.43	0.798	**60%**

Notes: **Bolded** values failed to pass one or more quality control checks (bolded RPD values are greater than 20%).
The percentage of RPD values over 20% for the entire dataset is 18%.
- = no data or not applicable; pg/g = picograms per gram; % = percent; < = less than; RPD = relative percent difference.

References:

CCME (Canadian Council of Ministers of the Environment). 2001. Canadian sediment quality guidelines for the protection of aquatic life: Polychlorinated dioxins and furans (PCDD/Fs). In: Canadian environmental quality guidelines, 1999, CCME, Winnipeg, MB, Canada.

Wilson A, Fox D, Poole G, Bujold R. 2011. Linking incineration to dioxins and furans in lakebed sediments (or the case of the missing water license condition). Integrated Environmental Assessment and Management 7:302-304.

DOMINION DIAMOND

Information Request Number:	DAR-MVEIRB-23
Source:	MVEIRB Jay Project Adequacy Review Item 9.7
Subject:	Permafrost Assumptions
DAR Section(s):	8.5.4.2.3

Preamble (MVEIRB):

Section 5.1.12b of the ToR requires the developer to "describe the permafrost conditions at the site, including thermal conditions and ground ice/moisture contents of underlying material particularly if maintenance of frozen conditions is required,"

Section 8, p. 8-379 states "the assessment assumes that permafrost will be maintained around the Misery Pit when it is full of water in the absence of a rationale that the thermal mass is not sufficient to develop and maintain a talik." In addition, it states,

> *"The saline water stored in the monimolimnion may thaw the permafrost under the base of the Misery Pit, which may be close to the base of permafrost, thereby creating a flow a pathway through the granite rock to the deep groundwater regime and, conceptually, Lac de Gras. However, lateral seepage from the Misery Pit to Lac de Gras would be prevented by permafrost between the pit and Lac de Gras."*

Filling of Misery pit with water may induce formation of a talik over the long term and provide a pathway for high TDS water to flow to Lac de Gras in the deep groundwater system, even if lateral movement from the pit was prevented.

Request (MVEIRB):

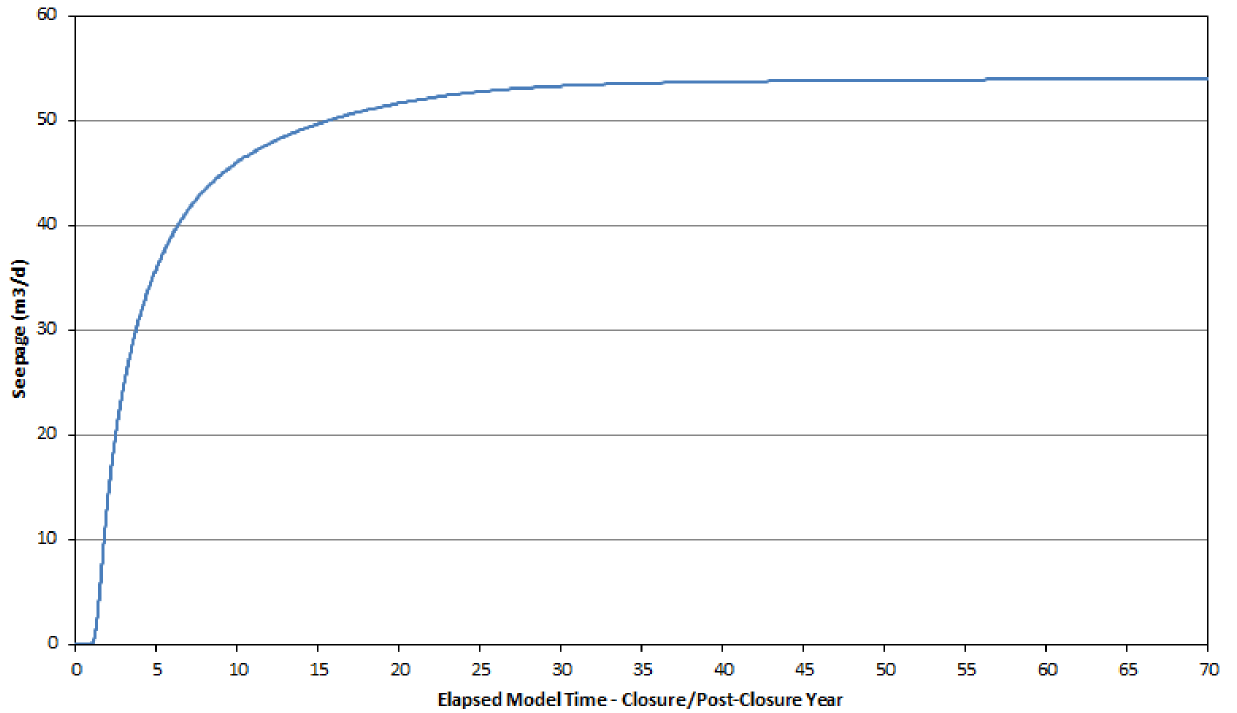
Please provide a thermal analysis of the long term stability of permafrost around the Misery Pit at closure and, if the deep groundwater pathway is valid, please include high TDS water from the Misery Pit as a source term to Lac de Gras for the effects assessment.

Response:

A thermal analysis (Golder 2014) was completed as part of the Jay Project (the Project) feasibility study and the results of the thermal analysis were used as an input in the hydrogeological study (Appendix 8C of the Developer's Assessment Report [DAR]). The thermal assessment consisted of a review of the original Misery Lake talik formation estimation, current ground thermal conditions in the Misery Pit area, expected ground thermal conditions for the mined-out Misery Pit, and thermal changes during and after back-filling the Misery Pit with minewater from the Jay open pit.

The results of the thermal analysis indicated that once pit back-filling begins, thawing with time and warming of the talik zone around the pit floor and walls will occur, resulting in an expanding talik that will be maintained in the long-term below the Misery pit lake. A memorandum presenting the details of the thermal analysis, including model design and assumptions, is provided in Attachment A. The thermal analysis report was finalized in December 2014; however, results were available at the time the DAR was being completed. As such, the results were used to support the hydrogeological study, and incorporated into the hydrogeological model (Appendix 8C of the DAR). The hydrogeological modelling, based on conservative input assumptions, indicated that seepage from the bottom of the Misery Pit will increase to a maximum rate of 54 m^3/day over a period of 70 years (Figure 23-1).

Figure 23-1. Projected Misery Pit Basal Seepage Rates



m^3/day = cubic metres per day.

In the site water quality model (Appendix 8E of the DAR), the maximum rate of basal seepage from the Misery Pit (i.e., 54 m^3/day) was assumed to advectively transport mass directly to Lac de Gras during post-closure. A mass flux was included in the Lac de Gras hydrodynamic water quality model (Appendix 8F of the DAR) to assess effects to surface water quality in Lac de Gras. The maximum projected water quality condition (total dissolved solids [TDS] of 5,520 milligrams per litre) during the post-closure period for the monimolimnion (i.e., bottom layer) of the Misery Pit lake was assigned to the seepage flow from the bottom of the Misery Pit to Lac de Gras to calculate the load of each model parameter. Therefore, the results provided in the DAR already include the transfer of high TDS water from the Misery Pit as a source term to Lac de Gras.

References:

Golder Associates Ltd. (Golder) 2014. Thermal Assessment for Misery Pit Lake. 1313280041-E14076-TM-Rev0-2020. December 18, 2014.

Information Request Number:	DAR-MVEIRB-24
Source:	MVEIRB Jay Project Adequacy Review Item 10.1
Subject:	Risk assessment - health and safety
DAR Section(s):	Appendix 3C section 1.1

Preamble (MVEIRB):

The (draft) risk assessment in Appendix 3C does not identify any risks to health or safety to humans for the seventeen year period of mine construction, operation and closure. It specifically excludes considering any risks to workers' health and safety.

Request (MVEIRB):

Please conduct a risk assessment using best practices on risks to human health and safety including mine workers. The results should be presented independently and in combination with risks to the environment (for example, using a holistic consequence function integrating health and safety consequences with environmental consequences for a given event).

Response:

The risk assessment for accidents and malfunctions included in Appendix 3C of the Developer's Assessment Report (DAR) includes an integrated consideration of consequences to the environment and to public health and safety, which is consistent with the Jay Project Terms of Reference and current environmental assessment practice.

Workers' health and safety is of paramount concern to Dominion Diamond. Dominion Diamond addresses workers' ongoing health and safety through its operational health and safety system. Workers' health and safety is regulated under the (NWT) *Mine Health and Safety Act*, where content expertise is brought to bear to review and authorize mine plans. While Dominion Diamond appreciates the Review Board may be interested in understanding that worker's health and safety is being adequately addressed for the Jay Project, it is our understanding that review and authorization in this area is properly the purview of the (NWT) *Mine Health and Safety Act*. This is also consistent with our understanding of past environmental assessment processes.

Consistent with standard industry practices and diligent project management, a Project risk assessment which includes potential consequences to workers' health and safety is being conducted by Dominion Diamond as part of the Jay Project engineering pre-feasibility study. Once this information becomes public in an updated Technical Report on the Ekati Mine property, that document can be provided to the Review Board for their interest and review.

DOMINION DIAMOND

Information Request Number:	DAR-MVEIRB-25
Source:	MVEIRB Jay Project Adequacy Review Item 10.2
Subject:	Risk assessment – likelihood categories
DAR Section(s):	Appendix 3C section 2.2, Table 7

Preamble (MVEIRB):

The risk assessment in Appendix 3C defines likelihood categories based on events per year. These categories are important because they are the foundation of the discussions and conclusions in section 4 and 5, and determine which events are carried forward for further consideration and mitigation.

1. The likelihood categories categorized an event that is expected to occur once in ten years as "possible". However, the project operation phase is ten years, and the construction to post closure is at least 17 years. A one in ten year event is not just possible, it is likely to occur in that period. The same table categorizes an event that is expected to occur once in 15 years as "not likely", even though an event with this return period is in fact likely to occur during the project life. No events with this frequency are included in the "expected" category even though they are statistically expected to occur during the Project life.
2. The inclusion of entire orders of magnitude in categories C and D results in categories that are unreasonably broad and do not provide readers with a meaningful understanding of risks. For example, an event with a return period of one in twelve years is likely to occur during the project, but is grouped in the same likelihood category as events with return periods of one in one hundred years. Similarly, category D includes events that have a one in six chance of occurring during the life of the Project in the same group as events that have a one in 50 chance of occurring during the life of the Project.
3. Category B is defined as "possible". However, this descriptor accurately applies to each event in every category.

Request (MVEIRB):

1. Please revise your likelihood categories to reflect probability of events over the life of the Project, revaluating your categories as necessary.

2. Please reclassify category B to a name that does not apply to equally to all other categories.

3. Please divide categories C and D into narrower categories that help to meaningfully describe likelihoods.

4. Please apply the revised likelihood categories to the Failure Modes and Effects Criticality Approach, carrying forward the results throughout the risk assessment and mitigations.

Response:

The risk matrix used in the accidents and malfunctions assessment is commonly used in the industry and for environmental assessments, and is based on Dominion Diamond's operational risk matrix. Section 11 of the Terms of Reference (TOR) for the Jay Project (MVEIRB 2014) does not specify categories to be used for the risk assessment.

In response to the above requests, the Risk Assessment for Accidents and Malfunctions for the Jay Project (Golder 2015) has been revised as follows:

- The risk matrix has been revised to reflect the likelihood of an event occurring over the life of the Project, instead of on a per year basis.
- Likelihood descriptors/labels (i.e., “expected,” “possible,” and so on) were used for ease of reference to the likelihood/frequency. These descriptors are commonly used in the industry and are based on Dominion Diamond operational risk matrix. However, to avoid confusion with the words used in these descriptors, these likelihood descriptors have been removed and replaced with descriptions that reflect likelihood (probability) over the life of the Project. Similarly, consequence descriptors/labels have also been removed.
- The reviewer requested that likelihood categories “C” and “D” be divided into narrower categories. However, at the current stage of preliminary design, likelihood estimates are meaningful at the order-of-magnitude level. Therefore, no changes on the category levels were made at this stage. Refinements to the risk estimates will continue during detailed design and throughout operations, in which narrower likelihood categories (e.g., as in Dominion Diamond operational risk matrix) will be used.
- Changes made to the risk matrix have been reflected throughout the document and in the risk register. Additional editorial changes have also been made for clarity. The changes in the likelihood definition resulted in lower likelihood levels for two hazard scenarios for the construction phase. Other likelihood levels remain unchanged given the order-of-magnitude level of estimates.

References:

Golder Associates Ltd. (Golder) 2015. Dominion Diamond Jay Project - Risk Assessment for Accidents and malfunctions of the Jay Project. 1313280041-E14066-TM-Rev1-4060. January 16, 2015.

MVEIRB (Mackenzie Valley Environmental Impact Review Board). 2014. Revised Terms of Reference (EA1314-01) Jay Project, Dominion Diamond Ekati Corporation. July 17, 2014. Yellowknife, NWT, Canada.