GOVERNMENT OF THE NORTHWEST TERRITORIES

TECHNICAL REPORT

FOR

DE BEERS CANADA MINING INC.
SNAP LAKE MINE ENVIRONMENTAL ASSESSMENT
EA1314-02

Submitted to:

Mackenzie Valley Environmental Impact Review Board
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PLAIN LANGUAGE SUMMARY

Background

Regulatory Background

In 2003 the Snap Lake Diamond mine project underwent an environmental assessment (EA) with the Mackenzie Valley Environmental Impact Review Board (Review Board). The original 2003 EA determined that some level of change was allowable in Snap Lake as a result of the development, but that there were outstanding concerns related to water quality. To ensure that there were not significant adverse impacts the Review Board recommended a measure in its Report of EA (2003) that the total dissolved solids (TDS) concentration in Snap Lake could not exceed 350 milligrams per Liter (mg/L). This recommendation was approved by the Responsible Ministers at the time. However, since that time predictions related to the original environmental decision have been exceeded. Mine water and waste water amounts are higher than predicted and there is more TDS in the mine water Snap Lake. As a result of this, De Beers requested an amendment to its water licence, which limits TDS to 350 mg/L, in order to increase the amount of TDS and its components in Snap Lake.

The proposed change to the water licence with regard to TDS levels greater than 350 mg/L requires a new EA recommendation from MVEIRB, and a decision by the Responsible Ministers to approve the new recommendation and any measure(s) associated with that recommendation. As a result of this legal requirement, the Mackenzie Valley Land and Water Board referred the water licence amendment application to EA on January 22nd, 2014.

What are Total Dissolved Solids (TDS)?

TDS are made up of many different types of ions[1] in the water and is a measure of how 'salty' the water is. The different types and amounts of ions have different effects on the water quality and the environment. The different ions that make up TDS that are referenced in this report are:

- sulphates,
- chlorides,
- calcium,

[1] *Ions are electrically charged particles formed when atoms lose or gain electrons*.

- carbonates,
- nitrates, and
- nitrites.

Some water bodies naturally have high levels of TDS, but when a water body with naturally occurring low TDS levels experiences an increase in TDS (even gradual), the animals that live there will be affected since they are not used to living in water with high levels of TDS and the salts that come along with it. The Government of the Northwest Territories (GNWT) examined how changes in the amount and types of salt (TDS) could have adverse impacts on the water quality, the people who use the water and the plants and animals that live in the water.

Water Management in the NWT

While it is understood that Snap Lake has already undergone human-caused changes, the GNWT supports the concept of keeping water quality at as close as possible to natural levels. This approach is consistent with government policies at a territorial, national and international level. The GNWT's standard approach brings government policies, as well as industry position statements, into practice.

> "*Waters that flow into, within or through the NWT are substantially unaltered in quality, quantity and rates of flow."* – Goal of the NWT Water Stewardship Strategy (AANDC and GNWT, 2010)

Impact Prediction and Assessment

Prior to mining, Snap Lake was classified as a relatively clear, soft water lake. Even though Snap Lake had low to moderate nutrient inputs, there are many different species that live in the lake including large-bodied fish such as grayling, trout and whitefish.

During the original 2003 EA for this project, De Beers predicted that TDS concentrations would increase 22 times from pre-mining levels. Levels of TDS were 15 mg/L before mining started and were predicted to reach a maximum whole lake average of less than 350 mg/L after mining. Wastewater that came from the mine was expected to be measured downstream as far as Mackay Lake. However, since construction, there has been more groundwater than expected flowing into the mine, which in turn has caused more mine-water to be pumped into

Snap Lake. The additional water has more TDS (or salts) than De Beers had initially predicted. The TDS that have been added to Snap Lake from the mine waste water discharge have built up in the lake since construction, which has led to the increased TDS concentrations currently observed.

While De Beers has indicated that mitigation to take out some of the TDS from the mine water will be implemented in the future, it has not committed to when or what type of mitigation this will be. As such, GNWT was required to assess an unmitigated scenario where no TDS was removed from the water. When determining the result of increased concentrations of TDS in Snap Lake and the downstream environment, the GNWT looked at magnitude (how bad), duration (how long) and reversibility (ability to return to natural state), and the extent (how far) of impacts related to more TDS being released.

GNWT used the models and data that De Beers provided to predict and evaluate the impacts of an unmitigated 'worst case' scenario. With all models there are limits to the information and predictions may be more or less than what is expected. In the unmitigated, 'worst case' scenario the following outcomes will likely occur by the end of mine life:

- 90% of the water in Snap Lake is the wastewater discharged from the mine, with only 10% being natural water inflow similar in quality to the water conditions before the mine was developed.
- The TDS concentration in the mine water being released to Snap Lake may be as high as 1700mg/L.
- The ions that make up the TDS in Snap Lake have already changed from being mostly carbonate and sulphate to calcium and chloride. This change will continue and increase in magnitude by mine closure.
- After the mine closes and stops discharging wastewater into Snap Lake, it will take approximately 90 years for the water in Snap Lake to return to pre-mine levels of TDS (pre-December 2003 levels).
- The TDS concentration 65km (40 miles) downstream of the mine will be double what it was before the mine was constructed.
- The mine waste water will be detectable in lakes and rivers as far as 155km (96 miles) downstream.

Impacts to Aquatic Species

TDS is an expression of salinity (salinity = saltiness)[2] and is the sum of all dissolved ions (like carbonate or chloride ions) in freshwater. While some naturally salty lakes do exist, these lakes usually have salts made up of sulphates and carbonates as opposed to chlorides. This makes the condition within Snap Lake very different from naturally occurring salty lakes because it would be made up mostly of chlorides by the end of the mine life.

Guidelines do exist for salinity and TDS, and can be used to understand TDS-related impacts to the environment. For example, the Canadian Council of Ministers of the Environment factsheet on chlorides (2011) states that:

> *"Salinity is a measure of the total salt composition of water (Wetzel 1983). Water is classified according to salinity. Freshwater lakes are those with less than 500 mg/L salinity". (CCME 2011)*

While guidelines for TDS are established in other jurisdictions, it is important to note that it is the different types of ions that make up TDS that determine how harmful or toxic the water is to the aquatic life. For example, Alaska has established guidelines for TDS to protect the aquatic environment. The Alaskan guidelines are based on TDS that is made up of mostly calcium and carbonate. Thus, those guidelines are not applicable to TDS made up of mostly chlorides, as observed in Snap Lake. As well, individual components of TDS, such as chloride and nitrate, have been shown to cause toxic effects to aquatic organisms such as insects or fish. Regardless of guidelines, it is important to assess the impacts from both the amount of salt/TDS, and the types of ions that make up the salt/TDS in the water.

De Beers conducted studies for some of these issues in order to determine how increases in TDS and chlorides in the water at Snap Lake will affect the aquatic environment (fish, benthics, and invertebrates). The GNWT hired an independent expert consultant to review these studies. The independent expert found several issues with the methods that were used to conduct the studies and the subsequent conclusions made from those studies. These

[2] Salinity describes how salty a substance is.

issues are important to assess and clarify in order to provide appropriate recommendations on how to mitigate impacts within the regulatory process.

Mitigating Impacts to Traditional Use of Snap Lake & Downstream Waters

GNWT notes that the perspectives of land users must be considered when establishing the extent and magnitude of allowable discharge limits. For example, during the recent public hearings for the Gahcho Kue water licence on May 7th, 2014, the representative for the Yellowknives Dene First Nation (YKDFN) noted:

> *"And it doesn't seem like you should be releasing proposed effluent with hundreds of times the background concentration into a receiving water body and call that protective. You can't exceed the CCME by orders of magnitude and call it protective…"*

As well, during the technical session for the current Snap Lake EA, GNWT heard evidence from the YKDFN that any detection of mining effluent at the Old Lady of the Falls – an important part of the cultural environment - would not be acceptable to YKDFN.

As a step towards minimizing the perception of risk to traditional land users, the GNWT suggests that drinking water quality be maintained within Snap Lake and downstream including Old Lady of the Falls. The key outcomes to achieve are:

- no change in water quality conditions at Old Lady of the Falls should occur due to mining operations, and
- the water quality in Snap Lake and downstream should be maintained at a level that protects traditional use.

To achieve these outcomes requires mitigation measures that would (i) limit concentrations of TDS so that taste will not be impacted, and (ii) limit potential and perceived health risks to users.

Conclusion

As the primary roles and responsibilities for land and water management were recently devolved from the federal government (i.e. AANDC) to the GNWT, the GNWT believes it is very important to protect the traditional use of the area, which includes minimizing perceived risks to land users, and respecting Aboriginal and treaty rights. Specific attention should be paid to recommendations provided by Aboriginal groups. The GNWT has determined that:

1. The magnitude of impact under unmitigated conditions is significant based on future concentrations of TDS and its constituents (chlorides) both in Snap Lake and downstream from Snap Lake..
2. The loss of traditional use in the area and the ability to drink water at Snap Lake should be assessed as a significant adverse impact on the environment[3], based on the concerns raised by Aboriginal groups (i.e.. YKDFN).

The GNWT believes that an unmitigated scenario at Snap Lake would likely result in both of these outcomes, and therefore measures must be recommended to mitigate these adverse impacts to the environment.

The GNWT provides the following ten recommendations for the Review Board to consider in assessing the likelihood of significant adverse impacts from TDS levels:

1. **The GNWT recommends that the Review Board include a specific statement in the Report of Environmental Assessment that the conclusions and measures that result from this environmental assessment are specific to the Snap Lake Mine and Snap Lake.**

2. **The GNWT recommends that the Review Board consider the unmitigated, worst case scenario for the Snap Lake Mine as a significant deviation from the original impacts authorized in the Report of Environmental Assessment in 2003.**

3. **The GNWT recommends that the Review Board include a measure requiring De Beers to conduct a robust study on the anticipated reduction time of hardness during the recovery of Snap Lake (post operation) and how this reduction will**

compare to metals and nutrients over time. Specific attention should be given to impacts that would result from the utilization of any hardness-adjusted Site Specific Water Quality Objectives (SSWQOs).

4. **The GNWT recommends that the Review Board assess the uncertainties related to varied concentration reductions over time for various hardness-adjusted parameters and that these uncertainties be taken into account when assessing the significance of proposed increases in TDS and its constituents.**

5. **The GNWT recommends that the Review Board consider that an unmitigated, worst case scenario for the Snap Lake Mine will likely lead to a significant adverse impact on the traditional use of Snap Lake (i.e. fishing, drinking water, etc.) and its downstream aquatic environment.**

6. **The GNWT recommends that the Review Board include a measure requiring De Beers to minimize the degree or extent of project related impacts to Snap Lake and the downstream aquatic environment.**

7. **The GNWT recommends that the Review Board include a measure requiring De Beers to take necessary steps during operation and at closure to return Snap Lake to pre-mining conditions as soon as possible post-closure.**

8. **The GNWT recommends that the Review Board include a measure to require De Beers to prevent measurable changes to water quality at Old Lady of the Falls.**

9. **The GNWT recommends that the Review Board include a measure to require DeBeers to ensure protection of the traditional use of water in Snap Lake and downstream.**

10. **The GNWT recommends that the Review Board include a measure requiring De Beers to implement, no later than 18 months following the issuance of the water licence, mitigation sufficient to protect the aquatic environment and maintain traditional use of Snap Lake.**

LIST OF ACRONYMS

Aboriginal Affairs and Northern Development Canada	AANDC
Aquatic Effects Monitoring Program	AEMP
Aesthetic Objective	AO
Canadian Council of Ministers of the Environment	CCME
Effluent Quality Criteria	EQC
Environmental Quality Objectives	EQOs
Environmental Assessment	EA
Effects Concentration	EC
Government of the Northwest Territories	GNWT
Inhibitory Concentration	IC
Lethal Concentration	LC
Mackenzie Valley Environmental Impact Review Board	Review Board
Mackenzie Valley Land and Water Board	MVLWB
Mackenzie Valley Resource Management Act	MVRMA
Maximum Allowable Concentration	MAC
Northwest Territories	NWT
No Observed Effect Concentration	NOEC
Site Specific Water Quality Objectives	SSWQOs
Total Dissolved Solids	TDS
Water Quality Objectives	WQOs

1.0 INTRODUCTION

The concerns and issues in this technical report are the result of both the GNWT's and the GNWT's retained expert's review of plans, proposed monitoring programs and submissions as part of the De Beers Canada Mining Incorporated (De Beers) Snap Lake Mine water licence amendment application MV2011L2-0004. The currently regulated limits for total dissolved solids (TDS) have their origins within measures of the Report of Environmental Assessment from 2003, so the Mackenzie Valley Land and Water Board (MVLWB) referred the water licence amendment application to increase the TDS limit to the Mackenzie Valley Environmental Impact Review Board (the Review Board) on January 22nd, 2014. The scope of the development being assessed (EA1314-02) is the potential impacts from increased TDS and its constituents to Snap Lake and the downstream environment. This technical report explains the GNWT's concerns and provides recommendations for the Review Board's consideration. This submission takes into consideration all of the documents provided on the Review Board Public Registry.

Of note, there were several questions throughout the April 15-16, 2014, technical sessions regarding the point from where impacts to Snap Lake are to be assessed, that is whether the assessment is considering potential impacts of the amendment application on Snap Lake from a pre-mining scenario as opposed to only considering changes to Snap Lake from its current state as of 2013. Review Board staff provided clarification during the technical session that the scope of this environmental assessment (EA) is focussed on the impacts of this current "project", that is the increase of TDS and its constituents beyond that which currently exists in Snap Lake. However, the Review Board staff also noted during the technical sessions that cumulative effects would be considered within the scope of EA1314-02 (Snap Lake Technical Sessions, April 16th, 2014). As such, the GNWT has included some information on pre-mining conditions at Snap Lake, to assist in assessing long term changes to the area, evaluating the potential for reversibility to pre-mining conditions, and assessing the potential for cumulative impacts in the watershed.

The GNWT appreciates the opportunity to express its concerns and provide recommendations to the Review Board for this environmental assessment. The GNWT and its retained experts intend to provide technical input at the public hearing on June 5 and 6, 2014, to assist the Review Board in making a significance determination related to proposed water licence amendments that are within the scope of this EA. The retained expert's report is provided as Appendix 1. Curricula vitae for the retained experts are in Appendix 2.

1.1 Report Outline

This technical report is structured to explain the likely impacts from proposed changes to effluent quality discharged into Snap Lake in the context of historic, pre-mining background conditions in Snap Lake, and the predicted impacts on Snap Lake and its downstream environment as described in the Developer's Assessment Report (EA01-004) and Report of Environmental Assessment from 2003 (Review Board, 2003). The report is divided into the following sections:

Section 1 – Introduction to the technical report and the GNWT's involvement in the regulatory review and environmental assessment process for the proposed amendment application for water licence MV2011L2-004.

Section 2 – Summary of overarching principles for water management and the protection of water resources in the Northwest Territory (NWT). This section outlines important statements and concepts from environmental policies, guidelines and strategies that are relevant to development projects in the NWT.

Section 3 – Description of the original (pre-2003) water quality conditions in Snap Lake and an overview and comparison between impact predictions for the Snap Lake Mine from the original 2003 Report of Environmental Assessment (EA01-004) and the anticipated impact from the proposed amendment to the contaminant concentrations which is part of the current assessment (EA1314-02). These descriptions and assessments have been generally categorized into magnitude, extent, duration and reversibility of impacts. The section includes an assessment of impacts to Snap Lake and the environment if mitigation measures are not implemented at the site

Section 4 – Outline of the GNWT and its technical expert's review of the methodology and proposed concentrations of TDS and its constituents provided by De Beers as part of the water licence amendment application. Parts of this section are technical and the sections are provided to provide context and support for the review of the proposed amendments and effluent concentrations.

Section 5 – Overview of the potential for significant impacts to traditional use of Snap Lake and highlights concerns expressed by Aboriginal parties to this assessment. The section concludes with a recommendation to prevent significant adverse impacts to existing and future traditional use and/or Aboriginal and treaty rights.

Section 6 – Provides an overview of the GNWT and its technical expert's review and contains concluding remarks for the Review Board's consideration as part of this environmental assessment process.

Recommendations to the Review Board are provided throughout the technical report in bolded text.

2.0 OVERARCHING PRINCIPLES OF WATER MANAGEMENT IN THE NWT

The GNWT would like to preface this technical report with some background on the uniqueness of this environmental assessment and the applicability of the conclusions made throughout this report – as well as this EA - to other projects in the future.

A significant component of the operations at the Snap Lake Mine has been the ongoing discharge of underground mine water into Snap Lake and ultimately into the downstream receiving environment. As noted in the project description, connate groundwater infiltrating into the underground workings from the footwall contains elevated concentrations of total dissolved solids (TDS). This water has been discharged to Snap Lake and, as a result, TDS levels in Snap Lake have trended upward over the past six years. The trend has been much greater than De Beers predicted during the original EA and TDS concentrations in Snap Lake will exceed the original EA predictions (De Beers, 2013a).

When conducting the current assessment of potential impacts to Snap Lake (as a result of the proposed increase in effluent quality criteria (EQC) which includes TDS), it is relevant to note that Snap Lake has already experienced anthropogenic changes. The conclusions and recommendations within this report are made within that context. The GNWT cautions that outcomes and measures resulting from this environmental assessment should not be arbitrarily applied to new or existing developments in the NWT. The GNWT wishes to flag that the scope of this EA, as established by the Review Board, is specific to the Snap Lake Mine and the existing mine conditions at the site.

The GNWT supports the concept of non-degradation, or maintaining receiving water quality at as close as possible to natural background levels. This approach is consistent within government policies at territorial, national and international levels, as well as industry position statements, illustrated by the following statements:

> *"Waters that flow into, within or through the NWT are substantially unaltered in quality, quantity and rates of flow." – Goal of the NWT Water Stewardship Strategy* (AANDC and GNWT, 2010)

> *"For waters of superior quality or that support valuable biological resources, the CCME non-degradation policy states that the degradation of the existing water quality should always be avoided."* (CCME, 2003)

> *"The Boards regulate the "quantity, concentration, and types of waste" that may be deposited from a project to the receiving environment. In accordance with the guiding principles listed in Section 5, the Boards regulate, through water licence requirements, the deposit of waste such that the following two objectives are met:*
>
> 1. *Water quality in the receiving environment is maintained at a level that allows for current and future water uses.*
> 2. *The amount of waste to be deposited to the receiving environment is minimized."* (MVLWB, 2011a)

> *"Any mining has an impact on the environment. Through careful planning and consultation with all of our stakeholders, we aim to minimize any environmental disturbance by our exploration and mining activities. We are committed to identifying any potential environmental issues early in the planning process."* (https://www.canada.debeersgroup.com/Sustainability/Safety-Health-and-Environment/)

With these policies and industry statements as its foundation, the GNWT acknowledges the importance of evaluating all reasonable efforts to eliminate or minimize the discharge of waste to the receiving environment for any new or existing development project in the NWT. This position aligns with statements made within the MVLWB Water and Effluent Quality Policy (MVLWB, 2011a).

The GNWT notes that some of the existing concentrations in Snap Lake (whole lake concentrations) are approaching levels that are higher than other development projects or facilities licenced in the NWT. Given the unique circumstances of the Snap Lake Mine, GNWT submits that the conclusion and measures that result from this environmental assessment are specific to the Snap Lake Mine and Snap Lake.

RECOMMENDATION:

1. **The GNWT recommends that the Review Board include a specific statement in the Report of Environmental Assessment that the conclusions and measures that result from this environmental assessment are specific to the Snap Lake Mine and Snap Lake.**

3.0 IMPACT PREDICTION AND ASSESSMENT

3.1 Historical and Existing Conditions

3.1.1 History of TDS and Snap Lake

The original Environmental Assessment (EA) and Ministerial decision on the Snap Lake Diamond Project (EA001-004) determined that some level of change was allowable in Snap Lake as a result of the development of the Snap Lake Mine. However, operation of the mine has shown that several predictions that were important to that EA decision have been exceeded, namely the mine water and effluent volumes and TDS concentrations of inflows into the mine workings. As a result, effluent discharged from the mine has caused greater than predicted changes to Snap Lake. These changes have led De Beers to request amendments to various conditions within water licence MV2011L2-004. One of these amendments to the water licence conditions relate to TDS limits, which are defined within the water licence in accordance with a measure from EA01-004. The request to increase the TDS values in Snap Lake beyond the values that the Review Board recommended and that the Responsible Ministers accepted is what triggered this EA.

The water licence MV2011L2-004 lists a condition that limits the whole-lake average for TDS in Snap Lake to 350 mg/L. This condition resulted directly from Measure 5 within the Report of Environmental Assessment on the Snap Lake Diamond Project (Review Board, 2003) which stated:

> "…*the Production Water Licence for the Snap Lake project shall specify that the whole lake average TDS concentration in Snap Lake not exceed 350 mg/L at any point in the mine life. This shall be achieved through a total annual load which will not exceed the loads used by De Beers to drive its EA predictions in each year of the mine" (Review Board, 2003)*

The Review Board's 2003 recommendation of, and the Responsible Ministers' acceptance of the 350 mg/L TDS limit in the EA Measures was largely based upon De Beers's conclusions that high flows of highly saline connate groundwater into the mine were not likely, and that in cases where flows into the mine were greater than expected, most of this increased flow would come from Snap Lake (which would have lower values of TDS) rather than connate groundwater. While several parties (i.e. Aboriginal Affairs and Northern Development Canada, Dogrib Treaty 11 Council (Tlicho), Natural Resources Canada, Environment Canada and the North Slave Metis) stated concern that TDS concentrations and volumes of connate groundwater inflow to the mine would be substantially higher than those predicted by De Beers (Review Board, 2003), the Board accepted De Beers' position that:

> *"…flows which exceed EA predictions are more likely to consist of dilute Snap Lake inflows rather than of saline connate groundwater, so higher inflows will not significantly influence loadings of TDS to Snap Lake.*" (*Review Board, 2003)*

In making this decision in 2003, the Review Board also noted that there was a commitment from De Beers to flood the mine to avoid discharging untreated mine water volumes. Note this commitment is still in place under the current contingency plan.

During cross examination on TDS concentrations in mine water and effluent at the EA001-004 public hearings, De Beers maintained that the provided estimates of TDS concentrations were conservative. Specifically, in response to questions regarding potential impacts from TDS concentrations beyond 350 mg/L, De Beers responded:

> *"…, as we carefully explained, we are convinced that the maximum total dissolved concentrations that we've presented, of three hundred and fifty (350) milligrams per litre incorporate more than enough layers of safety, and represent a very credible, worst thing that could happen example. I really have a hard time even thinking about or discussing anything even higher than that, because as I explained in my talk, we get beyond the description of what is a reasonable worst case that can happen, and we are in the territory of having to combine things that don't make sense scientifically."(Stella Swanson, Consultant to De Beers, Snap Lake EA Public Hearing Transcripts, Day 3, April 30, 2003, p. 76-77*)

De Beers predicted in 2003 that TDS concentrations in Snap Lake would increase 22-fold from the pre-mining levels of 15 mg/L. De Beers predicted that a maximum whole lake average for TDS of 330 mg/L with peak concentrations of <450 mg/L within 250m of the diffuser (<1% of Snap Lake) would occur. De Beers also predicted that calcium and chloride ions would increase to 88 and 137 mg/L as a whole lake average, respectively.

In the Report of Environmental Assessment, which the Responsible Ministers accepted, the Board stated that De Beers had not provided sufficient information during the proceeding to adequately predict that TDS loadings would not exceed 350 mg/L, and as such accepted that precautionary measures would best address and prevent potential adverse impacts (Review Board, 2003). Given the predictions provided by De Beers, coupled with the uncertainty outlined by several parties to the EA, the Board determined that a measure limiting the whole lake average to 350 mg/L of TDS was required to protect against any exceedance of EA predictions made by the proponent. This measure was subsequently formalized as a condition in the water licence issued by the MVLWB, in conjunction with criteria for constituents of TDS such as chloride, fluoride, nitrogen species and sulphate.

3.1.2 Historical condition of Snap Lake

While this current environmental assessment is focused on impacts above and beyond existing water quality conditions within Snap Lake and the downstream environment, it is important not to lose sight of pre-mining conditions in Snap Lake in terms of cumulative impacts and assessing the overall degree of change from the project. Note this will also be vital to assessing the reversibility of impacts to Snap Lake, which was noted to be of importance in the original environmental assessment.

Prior to mining, Snap Lake was classified as a relatively clear, soft-water lake, with a neutral to slightly acidic pH ((De Beers, 2002) Nutrient concentrations in Snap Lake were moderately low and, based on total phosphorus conditions, the trophic status of Snap Lake was considered to be in the upper oligotrohic to lower mesotrophic (moderate to low nutrient inputs) range. The lake provided habitat for a number of aquatic species including fish such as arctic grayling, lake trout, burbot and round whitefish. Regarding TDS and its constituents, TDS was recorded at 15 mg/L, chloride was less than 1 mg/L, calcium was 2.43 mg/L, fluoride was 0.06 mg/L, sulphate was 36 mg/L (however median sulphate was 3 mg/L), nitrate was 0.04 mg/L and nitrites were less than 0.002 mg/L (De Beers, 2002). This information is important to note as the ionic composition of TDS in Snap Lake was originally dominated by carbonate and sulphate ions (50-60%) with calcium and chloride ions contributing less than 20% of the TDS (De Beers, 2013a).

3.1.3 Existing Conditions in Snap Lake

Despite the understanding in the original EA that a certain level of change would occur in Snap Lake, current predictions by De Beers indicate that the magnitude of this change will exceed the original EA predictions, and would also require a change to the Measures originally accepted by the Ministers. A rapid increase in concentrations of TDS and chloride was observed at the mine water collection sump when mining operations began in 2005 and 2006 (De Beers, 2013a) and concentrations have continually trended upwards during the life of the mine.

In 2012, TDS concentrations in Snap Lake (excluding the northwest arm stations) ranged from 167 to 279 mg/L, which are below the current water licence limit of 350 mg/L. The overall whole-lake average for TDS in 2012 was 212 mg/L (De Beers, 2013a). De Beers has also observed an overall change in the ionic composition of the TDS within Snap Lake which is the result of the high concentration of chlorides that are associated with the connate groundwater. While relatively stable during the past few years, the ionic composition of TDS in Snap Lake as of 2012 was chloride 45-47%, calcium 20%, sodium 10%, sulphate 9% and carbonate, nitrate, fluoride, potassium, and magnesium each contributing 1-7% (De Beers, 2013a).

3.2 Future Conditions in Snap Lake

3.2.1 Issue

De Beers has indicated that mitigation to control TDS in effluent will be implemented. To date, no firm commitment has been made to implement such mitigation. The GNWT notes that De Beers committed throughout the initial EA (EA01-004) to achieving a whole lake average for TDS. For this reason the Review Board included a measure to ensure that the predicted whole lake TDS concentration would not be exceeded. Further, De Beers committed to achieving this whole lake average during the original regulatory process and through the water licence renewal in 2011, which was accepted by the Minister of Aboriginal Affairs and Northern Development Canada.

However, De Beers has not altered its mining operations in response to changes in the mining and effluent conditions which were originally used to determine the whole lake average and conduct an assessment of change and impacts to Snap Lake and the downstream receiving environment. The GNWT notes that the AEMP monitoring results have identified changes and impacts to Snap Lake that are beyond the original predictions and impacts in the 2003 Report of EA.

In the absence of a defined or proposed mitigation plan from De Beers, the GNWT has attempted to determine the potential concentration of TDS and its constituents that will occur in Snap Lake if the operation is allowed to continue without any additional mitigations. The GNWT acknowledges that this would likely be a worst case scenario and that additional project mitigations have been proposed by De Beers. Nonetheless, it is the GNWT's view that this unmitigated condition (or worst case scenario) is warranted for the Review Board to assess in the absence of firm project mitigation commitments from De Beers. The GNWT notes for the Review Board's consideration that the absence of additional project mitigations would result in the greatest magnitude, duration, and extent of impact to Snap Lake and the downstream environment. The GNWT describe this unmitigated scenario in the following sections and includes an assessment of the potential for significance if such a scenario were realized.

3.2.2 Uncertainty in Assessing the Magnitude of Change in Snap Lake

Prior to determining the impact of the worst case scenario as described in section 3.2.1, the GNWT must stress for the Review Board the degree of uncertainty in the De Beers models used to determine concentration and loadings from the Snap Lake Mine.

The GNWT has used all data made available to the GNWT to predict the magnitude of impacts to Snap Lake, with emphasis on the data provided in the TDS Response Plan (Figure 3-4), the Hydrodynamic Model Update, and the Groundwater Flow Model Update. From these documents, the GNWT has used the Upper Bound (maximum predicted mine flow rate of 90,000 m^3/day) and Lower Bound (minimum predicted mine flow rate of 66,000 m^3/day) scenarios and has extracted all of the available data as provided by De Beers that show the maximum concentrations of TDS that are likely to be discharged into Snap Lake. The GNWT considers the Upper Bound, presented by De Beers, to represent the currently modelled worst case scenario as seen below in Figure 3-4 (De Beers 2013a). It is important to note that several assumptions have been presented by the developer and there is a level of uncertainty with the available data. Examples of conflicting assumptions which lead to uncertainty in the modeled predictions include:

- *"Data-related uncertainty in long-term predictions of TDS and major ions concentrations was high. Uncertainty in predicted concentrations is carried forward from assumptions used in the site model and the hydrogeological model. The three models are sensitive to the assumptions used for deep groundwater (connate water) inflows, because these inflows will have very high TDS, chloride, and calcium concentrations."(De Beers, 2013b)*

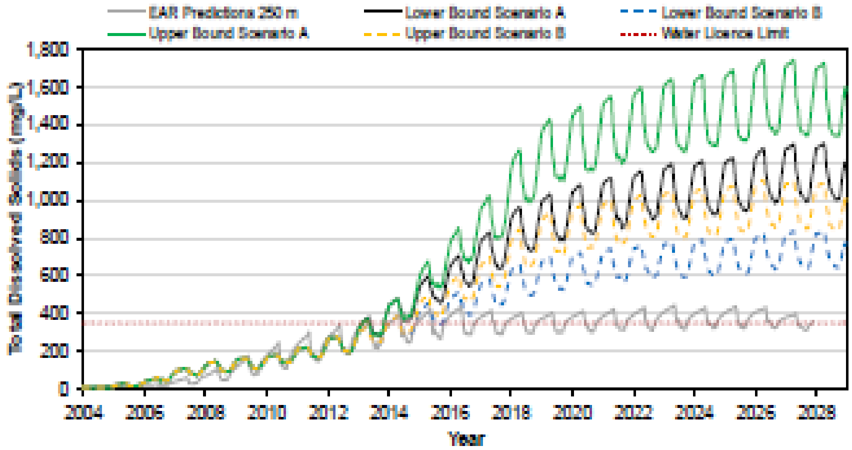
- For the Site Water Quality model the major assumption was: *"… that site water will be highest between now and 2018. After that the increases will be slower" (De Beers, 2013c)*

- Changes to Mine or Site Condition- "*The mine description and site conditions as identified in both projected and monitored data are the basis for the model. Changes in Mine or site conditions will necessarily result in changes to predictions" (De Beers, 2013d)*

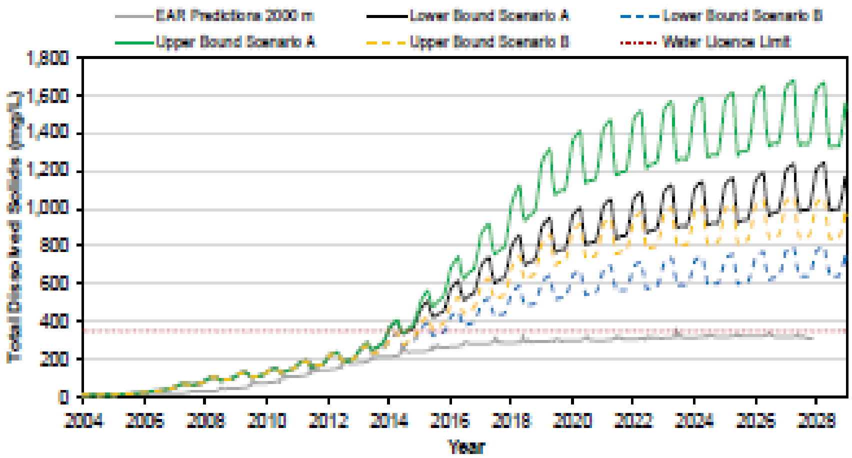
- Groundwater Inflow Data- *"Uncertainty related to groundwater inflows is due to a lack of measured groundwater amounts, and the uncertainty of the potential extent of hydraulic conductivity (K) values of structure zones" (Itasca 2013)*

Figure 3-4 Predicted Total Dissolved Solids Concentrations in Snap Lake Compared to the Water Licence Limit, 2004 to 2029

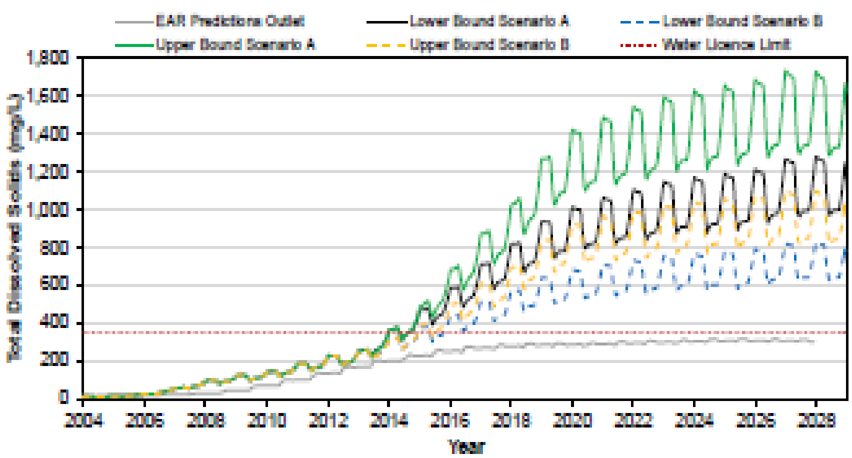
a. Diffuser Area



b. Main Basin



c. Outlet



Note: Data shown are from representative stations within Snap Lake: Diffuser Area = SNAP13 (2004 to April 2006) and SNP 02-20e (July 2006 to 2012); Main Basin = SNAP09; Outlet = SNAP08; mg/L = milligrams per litre.

Figure 1 – De Beers TDS Response Plan (Figure 3-4)

To determine the magnitude of impacts to Snap Lake, the GNWT included the following in its analysis to determine the worst case scenario as described in Section 3.2.1:

1. The mine water inflow and its total volume in m^3 /day
2. The assimilative capacity of Snap Lake over Mine Life
3. The ionic composition of mine water
4. The loading of mine effluent related to assimilative capacity within Snap Lake

3.2.2.1 Mine Water Inflow Predictions

The GNWT has utilized the predictions presented in the Groundwater Model and Supplemental information in the EA1314-02. However, it is important to note that in both the original EA as well as the current EA (Review Board, 2014) there have been discussions on the predicted variability of connate groundwater and the volume of mine effluent to be discharged into the environment. The GNWT notes that Dr. Houmao Liu stated on Day 1 pg 50 of the Technical Session Transcript from April 15th, 2014 that:

> "*Okay. Now, to go back to history of some other model[s], like 2005, 2006, when a test got did the model. You know, one (1) time we predict about 62,000 cubic meter per day. And at the other time, we predicted about, you know, fifty (50) to like 90,000 cubic meter per day. And it's all within the range of even this update model.*"

Based upon information and date presented by Dr. Liu, it appears that there are several assumptions in this model. However, the maximum appears to be reasonably accurate when compared to current conditions. The GNWT has therefore carried forward the inflow prediction of 90,000 m^3/day to represent the potential maximum daily discharge for assessing the magnitude of impacts to Snap Lake.

3.2.2.2 Assimilative Capacity of Snap Lake

Assimilative capacity is defined as *"the capacity of a natural body of water to receive wastewaters or toxic materials without deleterious effects and without damage to aquatic life or humans who consume the water*". (Environmental Engineering Dictionary, 2005)

As mining progresses, the volume of discharge increases from original predicted maximums of 42,000 m^3/day, peaking at 90,000 m^3/day. The volume of effluent discharged per day has a direct bearing on the assimilative capacity of Snap Lake: as the volume of mine effluent discharge is increased, the assimilative capacity of a water body will be reduced. For EA1314-002, at the end of the mine life approximately 90% of Snap Lake (based on De Beers Upper Bound ice covered condition) will be mine effluent. Using 90 % of Snap Lake's assimilative capacity means that there is 1 part unaltered "natural" water to 9 parts mine effluent which reduces the ability of the water body to assimilate mine effluent prior to release to the downstream receiving environment. This represents an overall change in magnitude compared to what the Responsible Ministers accepted in the 2003 Report of EA. The Responsible Ministers accepted that the maximum mine effluent discharge rate would be on

the order of 16,000-32,000 m^3/day, and GNWT estimates that this corresponds to using approximately 30-40% of the assimilative capacity of Snap Lake.
The volumes and water quality of the mine effluent water that would be discharged into Snap Lake would use nearly the full assimilative capacity of the Lake. The result will be that the concentration of Snap Lake will over time will become mine effluent (9 parts mine effluent to 1 part natural condition). The assimilative capacity of Snap Lake is shown in Figure 2.

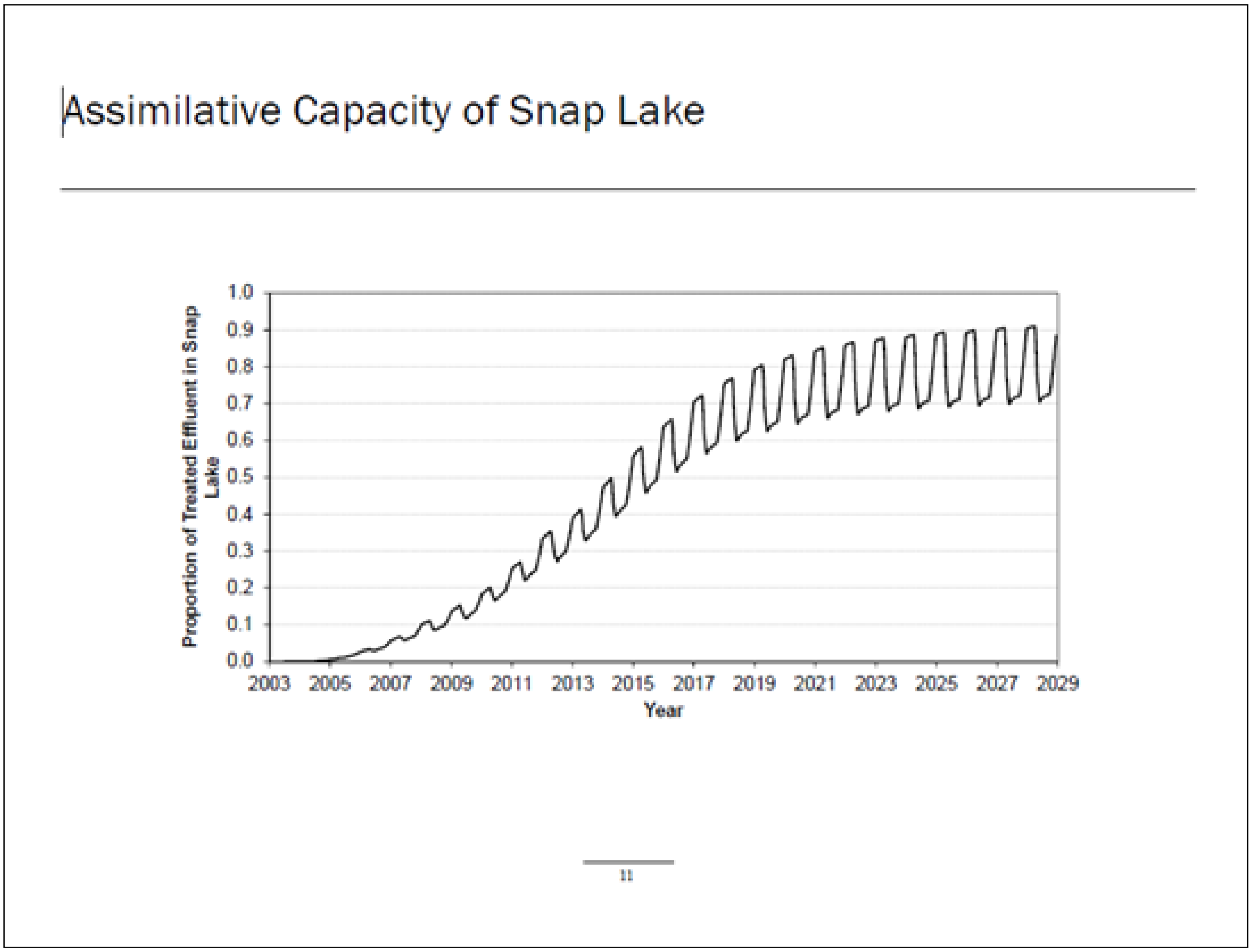
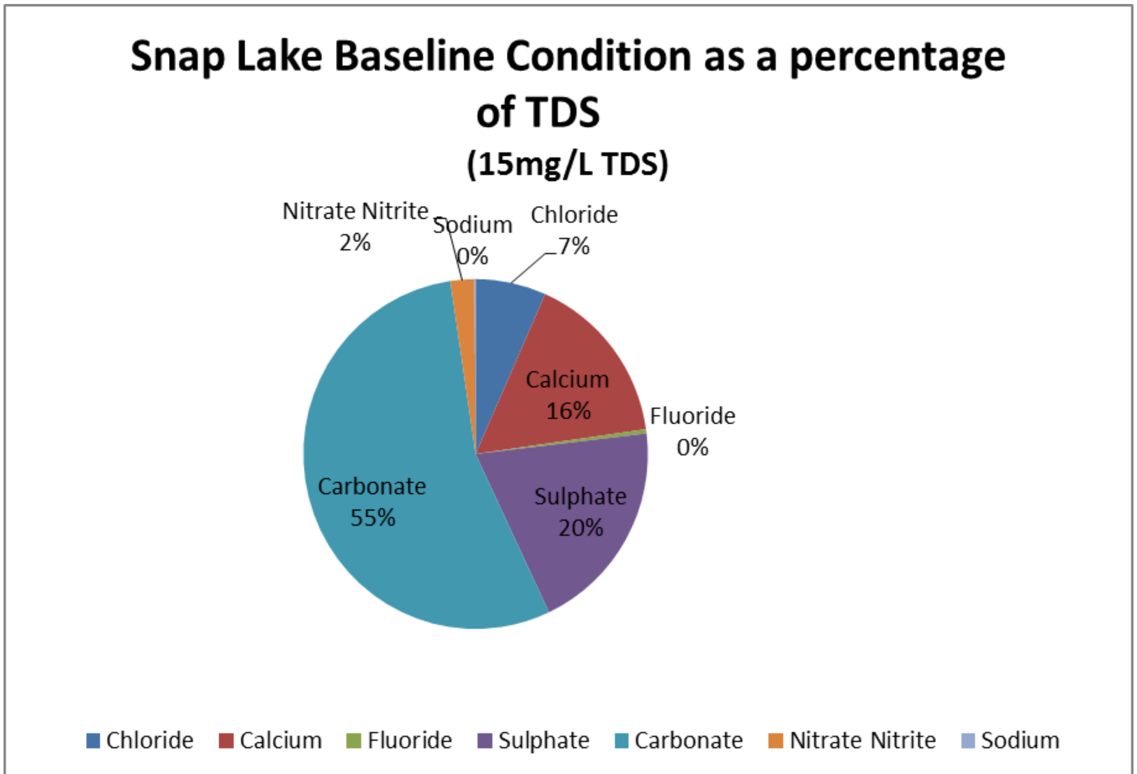


Figure 2: Assimilative Capacity of Snap Lake (Technical Session Presentation Nitrogen Reponse Plan pg. 30)

3.2.2.3 Ionic Composition and Concentration of Snap Lake (Magnitude of Impact)

As per the information presented by De Beers, the worst case scenario for Snap Lake (Upper Bound) is predicted to be 1700mg/L of TDS in Mine effluent during the later years of the mine life (2022-2029) (De Beers, 2013a). GNWT notes this value is a prediction, and actual concentrations may in fact be higher or lower than has been predicted. However, this value remains the best information available to date, and GNWT has assumed that it represents worst case conditions.

Mine effluent, as provided by De Beers from its 2012 sampling data, is estimated to be composed of 47% chloride, 28% calcium, 11% sodium, 9% sulphate and 5% representing carbonate, nitrate fluoride, potassium and magnesium. The relative ionic composition of Snap Lake will change from pre-mining conditions as the assimilative capacity is reduced. This change is illustrated in Figure 3 below.



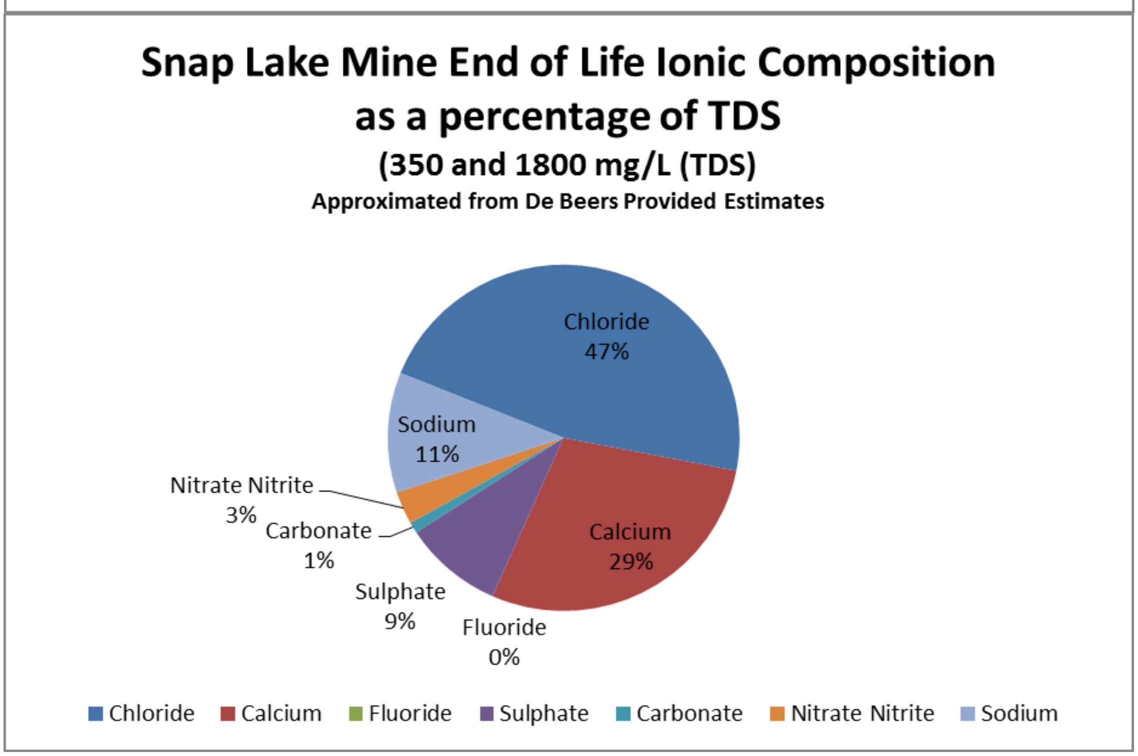


Figure 3: Ionic Composition within Snap Lake Pre-Mining vs. End-of-Life

Assuming that the ionic composition in the effluent will remain constant, GNWT has calculated the concentration of TDS constituents at increasing TDS increments within Snap Lake up to a worst case scenario and provided these values in Table 1.

TABLE 1: Calculated Ionic Composition of Snap Lake Mine Water as a Percentage of Total Dissolved Solids (TDS)						
	TDS Concentration (mg/L)	Chloride 47% of TDS in Mine Effluent (mg/L)	Calcium 28% of TDS in Mine Effluent (mg/L)	Sodium 11% of TDS in Mine Effluent (mg/L)	Sulphate 9% of TDS in Mine Effluent (mg/L)	Carbonate /Nitrate/Nitrite/ Fluoride/Potassium/ Magnesium 5% of TDS in Mine Effluent (mg/L)
freshwater[3]	0	0	0	0	0	0
	50	23.5	14	5.5	4.5	2.5
	100	47	28	11	9	5
	150	70.5	42	16.5	13.5	7.5
	200	94	56	22	18	10
	250	117.5	70	27.5	22.5	12.5
	300	141	84	33	27	15
	350	164.5	98	38.5	31.5	17.5
	400	188	112	44	36	20
	450	211.5	126	49.5	40.5	22.5
	500	235	140	55	45	25
Sub-saline[1]	550	258.5	154	60.5	49.5	27.5
	600	282	168	66	54	30
	650	305.5	182	71.5	58.5	32.5
	684	321.48	191.52	75.24	61.56	34.2
	700	329	196	77	63	35
	750	352.5	210	82.5	67.5	37.5
	800	376	224	88	72	40
	850	399.5	238	93.5	76.5	42.5
	900	423	252	99	81	45
	950	446.5	266	104.5	85.5	47.5
	1000	470	280	110	90	50
	1050	493.5	294	115.5	94.5	52.5
	1100	517	308	121	99	55
	1150	540.5	322	126.5	103.5	57.5
	1200	564	336	132	108	60
	1250	587.5	350	137.5	112.5	62.5
	1300	611	364	143	117	65
	1350	634.5	378	148.5	121.5	67.5
	1400	658	392	154	126	70
	1450	681.5	406	159.5	130.5	72.5
	1500	705	420	165	135	75
	1550	728.5	434	170.5	139.5	77.5
	1600	752	448	176	144	80
	1650	775.5	462	181.5	148.5	82.5
	1700	799	476	187	153	85
	1750	822.5	490	192.5	157.5	87.5
	1800	846	504	198	162	90

De Beers Proposed SSWQO and EQC

De Beers Worst Case Upper Bound

[3] CCME 2011

The GNWT anticipates, as an unmitigated worst case scenario, the magnitude of change proposed under EA1314-02 would represent a total whole lake average of 1700 mg/L TDS in Snap Lake. Of this 1700 mg/L TDS, 799mg/L would be chloride, 476 mg/L would be calcium, 187 mg/L would be sodium, 153 mg/L would be sulphate and 85 mg/L would be a mixture of nitrate, carbonate/fluoride/potassium and magnesium. In the GNWT's opinion this represents a significant deviation from the anticipated water quality that was assessed and approved as part of the original assessment and regulatory review process. Further, the unmitigated scenario could result in significant adverse impacts to the Snap Lake ecosystem and would likely impinge on traditional use (i.e. fishing, drinking, etc.) of Snap Lake and its downstream aquatic environment.

RECOMMENDATION:

2. **The GNWT recommends that the Review Board consider an unmitigated, worst case scenario for the Snap Lake Mine as a significant deviation from the original impacts authorized in the Report of Environmental Assessment in 2003.**

3.2.3 Duration and Reversibility

Duration and reversibility are two key considerations when determining the significance of adverse effects. The analysis of the significance for these parameters relies largely on opinion, with consideration given to the level of public concern; past experience and knowledge; and personal and societal values.

While the reversibility and duration of impacts to water quality can be characterized and quantified, it is much harder to assess the reversibility of impacts to the aquatic ecosystem and overall ecological integrity of an area. Reversibility can be viewed as the ability to return to baseline (pre-impact) conditions. Most systems will eventually return to a semblance of baseline conditions through time. However, as ecological systems are dynamic it is unlikely that they will ever exactly resemble their pre-impact state (Review Board, 2003).
On the basis of chemical parameters alone, GNWT estimates that 90 years would be required to return Snap Lake to baseline concentrations from worst case concentrations (Upper Bound). Using the significance definition provided by the proponent in its 2002 Environmental Assessment Report, this would be considered "long-term reversible" (De Beers, 2002; p. 9-11). However, it is unknown what the aquatic ecosystem will look like after experiencing almost a century of anthropogenic change and how closely it would resemble pre-impact conditions. Consequently, the duration of change to water quality and the aquatic ecosystem as contemplated under EA1314-02 would be observed by traditional users for multiple generations.

3.2.3.1 Duration and Reversibility - EA01-004

As part of the original EA, GNWT notes that De Beers's position was that any changes to Snap Lake would be reversible after the cessation of mining. The following statements about the duration and reversibility of TDS in mine water based upon a 350 mg/L whole lake average were made in the record of decision (Review Board, 2003):

The proponent stated

> *"All predicted effects to non-fish aquatic life in Snap Lake were considered reversible because mine water discharge would cease at the end of operations and the lake would recover as natural runoff displaces lake water impacted by mine water discharge."* (Review Board, 2003, pg 84).

Also,

> *"De Beers identified this impact as reversible in the short term but did not provide an assessment of the time required for Snap Lake to revert to baseline conditions of TDS, beyond its calculation of a water replacement time of 13 years for Snap Lake."* (Review Board, 2003, pg 67)

GNWT notes that Aboriginal Affairs and Northern Development (AANDC) stated on Day 5 (May 2, 2003) of the Public Hearing:

> *"However, and this is important, our conclusion is that while the project is very likely to have environmental effects greater than those predicted by De Beers, we believe that Snap Lake will largely recover thirty to forty years after mining ceases. Changes in the species numbers, composition and ecosystem structure will occur, and while recovery is not likely to be to pre-development conditions, these effects are tolerable in our view…"*
> (David Livingstone, Director, Renewable Resources, INAC, Public Hearing Transcripts, Day 1; in Review Board 2003, pg 70).

The GNWT's interpretation of the 2003 EA findings is that there is a water replacement time of 13 years for Snap Lake which means that it would take 30-40 years for Snap Lake to recover to pre-mining conditions from a value of 350 mg/L.

3.2.3.2 Duration and Reversibility - EA1314-02

The GNWT notes that De Beers has not provided a duration and reversibility assessment for EA1314-02. However, De Beers has provided a single graph in response to Information Request MVRB/MVLWB #11. This figure (11-1) appears to suggest that conditions in Snap Lake, based upon a 1700 mg/L whole lake average, are reversible after 40 years. The proponent has not provided rationale on how this was derived, but based upon the GNWT's review, it appears that De Beers has utilized a 7.5-8 year water replacement time. The proponent has not provided a sufficient rationale to justify this change from the 13 year time used in the 2003 EA.

The GNWT has not used the 7.5 – 8 year time proposed by De Beers, and instead has carried forward the 13 year water replacement time as per the original conclusions of the 2003 Environmental Assessment. to determine the potential duration of impact and the reversibility of water quality conditions within Snap Lake. Table 2 illustrates the GNWT's assessment of the time required to reverse the TDS conditions in Snap Lake if the 1700 mg/L worst case scenario described in Section 3.2.1 occurs. The GNWT's assessment is that Snap Lake will take approximately 35 years to return from 1700 mg/L to 350 mg/L and more than 90 years to return from 1700 mg/L to pre-development conditions. .

Table 2: Reversibility of Snap Lake Mine Water Quality

Cycle	Total Years	Whole Lake Concentration (mg/L)
1	-	1,700
2	13	850
3	26	425
4	39	212.5
5	52	106.25
6	65	53.26
7	78	26.56
9	91	13.28

The duration that aquatic receptors will be exposed to elevated levels of TDS will be 3 times longer than what was originally predicted for Snap Lake. Note that this model only considers the recharge of "natural" runoff that is not impacted by mine water.

The GNWT notes that lack of site specific information about the following factors contributes to uncertainty about duration and recovery times, and that these times could therefore be longer than set out in Table 2 above:.:

a) Continued loading and recharge from underground workings,
b) Flushing of sediment due to upset events,
c) Ice scouring and sedimentation turnover
d) Post Closure contact with water elevated in TDS from mine components (North Pile)
e) Mechanisms and accumulation of bioaccumulated/biomagnified elements within the aquatic species of Snap Lake through water quality and sedimentation exposures.

The GNWT further notes that the proponent has not provided an assessment of the mechanism for the reversibility of each mine effluent constituent. The GNWT has concerns that there is a potential for TDS, and therefore hardness (which is composed of the constituents of TDS), to decrease at an accelerated rate relative to other parameters after mine closure. The proponent has used hardness as a modifying factor for the toxicity to aquatic organisms (for parameters like aluminum, copper and nitrate), so if hardness is reduced at an accelerated rate, the possible protection afforded by hardness will no longer be realized. This may be of particular concern for parameters that are accumulating in sediment, and which will continue to cycle once effluent discharge ceases.

RECOMMENDATIONS:

3. **The GNWT recommends that the Review Board include a measure requiring that De Beers conduct a robust study on the anticipated reduction time of hardness during the recovery of Snap Lake (post operation) and how this reduction will compare to metals and nutrients over time. Specific attention should be given to impacts that would result from the utilization of any hardness-adjusted SSWQOs.**

4. **The GNWT recommends that the Review Board consider uncertainties related to varied concentration reductions over time for various hardness-adjusted parameters and that these uncertainties be taken into account when assessing significance of proposed increases in TDS and its constituents.**

3.2.4 Original and Potential Spatial Extent of Impact

The original EA for Snap Lake predicted that water quality would be affected by discharge into Snap Lake for some distance downstream. Changes to TDS were expected to be measurable to a distance 44 km downstream of Snap Lake, which corresponds to Monitoring Site 22 at Mackay Lake. At this location, the predicted maximum TDS is 41 mg/L, compared to a baseline concentration of 20 mg/L. Predicted TDS concentrations become closer to local background at Monitoring Site 11 where the predicted concentration is 16 mg/L compared to a local background concentration of 12 mg/L. Note, monitoring Site 11 is 54 km downstream from Snap Lake (Table MVRB/MVLWB_IR#11-4).

In 2013, AEMP monitoring has identified evidence of the influence of effluent into Lac Capot Blanc to a point 5 km from the inlet, which is 11 km downstream of Snap Lake. An increasing trend in TDS was also identified at a monitoring station in King Lake, 25 km downstream of Snap Lake.

Under the unmitigated worst case scenario (1700 mg/L TDS) as described in Section 3.2.1, predicted TDS concentrations will double the local background concentrations at Monitoring Site 23, located 65 km downstream of Snap Lake. Predicted concentrations at this location are 20 mg/L compared to local background concentrations of 10 mg/L. Predicted TDS concentrations become closer to local background at Monitoring Site 3 where the predicted concentration is 25 mg/L compared to a local background concentration of 20 mg/L. The GNWT notes that Monitoring Site 3 is 155 km downstream from Snap Lake (Table MVRB/MVLWB_IR#11-4).

As described in the response to IR#11 from the technical session, waters in Snap Lake and downstream as far as Lac Capot Blanc, 11 km from Snap Lake, would be above the aesthetic drinking water guidelines for TDS and chloride under the unmitigated, worst case scenario.

RECOMMENDATIONS:

5. The GNWT recommends that the Review Board consider that an unmitigated, worst case scenario for the Snap Lake Mine has the potential to lead to a significant adverse impact on traditional uses of Snap Lake (i.e. fishing, drinking, etc.) and its downstream aquatic environment.

6. The GNWT recommends that the Review Board include a measure requiring De Beers to minimize the degree or extent of project related impacts to Snap Lake and the downstream aquatic environment.

7. The GNWT recommends that the Review Board include a measure requiring De Beers to take necessary steps during operation and closure to return Snap Lake to pre-mining conditions as soon as possible post-closure.

4.0 REVIEW OF WATER LICENCE AMENDMENT REQUEST

4.1 Proposed Amendments and Impact to Aquatic Species

TDS is an expression of salinity and is the sum of all dissolved ions in freshwaters (e.g. Cl, Ca, Mg, K, etc). It should be noted that natural saline lakes are commonly dominated by sulphates and carbonates and relatively rarely dominated by chlorides, which makes the existing anthropogenically altered condition within Snap Lake unique.

> *"Salinity is a measure of the total salt composition of water, with freshwater lakes being dominated by the cations Ca2+, Mg2+, K+ and Na+ and the anions HCO3 -, CO3 2-, SO4 2- and Cl- (Wetzel 1983). Water is classified according to salinity. Freshwater lakes are those with less than 500 mg/L salinity" (CCME 2011)*

> *"Salinity is a key factor in controlling survival and distribution of both freshwater invertebrates and fish (Holland et al 2010). Naturally saline lakes within Canada (commonly dominated by SO4/CO3 and relatively rarely by Cl) are systems with naturally low biodiversity." (Derry et al 2003).*

While TDS is relevant as a coarse screening tool, its variability between water bodies results in a requirement to investigate the individual constituents within it. These constituents will be the driving force behind any potential toxicity. To that end, because s chlorides will account for 47% of the TDS values, the GNWT has focused on potential impacts of chlorides, while giving a general background and overview of TDS in Snap Lake. Additionally, as nitrates are related to explosive use in the Snap Lake underground working, nitrogen *forms* have the potential to highly influence the productivity of a lake. For this reason nitrate will also be assessed.

4.1.1 Total Dissolved Solids

While the GNWT agrees that consideration must be given to the composition of site specific TDS, a summary of TDS limits in other jurisdictions and a literature review has been provided in Appendix 1. As the list is substantial, the GNWT will briefly outline the ones that are particularly applicable to the Snap Lake project and/or were discussed at the April 2014 technical sessions.

Looking to other regulatory jurisdictions, there were several discussions that made reference to the Red Dog Mine in Alaska and a maximum limit of 1500 mg/L. However, the GNWT notes that this value was specific to "calcium-dominated TDS" as opposed to chloride dominated TDS in Snap Lake. Additionally, a TDS of 500 mg/L is used at the Red Dog Mine during spawning periods for Arctic Grayling. For comparison to the Snap Lake scenario, the GNWT notes that the proposed TDS concentrations will occur lake wide on a year-round basis. This means that all species during all life stages will be exposed to the elevated TDS concentrations. The long-term, lake-wide exposure in Snap Lake should be taken into account by the Review Board when determining the significance of any impacts that may result from elevated TDS concentrations.

Further, with regard to Brix et al. (2009), the authors found that “Arctic Grayling and Dolly Varden fertilization success is not sensitive to elevated TDS with EC20s[4] of >2782 and >1817 mg/L (the highest concentrations tested), respectively.” However, the GNWT notes that the test water used to conduct these tests were heavily dominated by calcium and sulphates, with relatively low levels of chlorides. Therefore this testing is of limited applicability to the Snap Lake context. Note that other studies have identified chloride as one of the more significant toxicity causing constituents of TDS.

During the GNWT’s review of TDS literature and jurisdictional reviews, it was apparent that the general composition of TDS in the various test waters utilized in research studies were largely comprised of calcium carbonate salts, and that there is a lack of chloride specific test data (i.e. high TDS concentration with chloride dominated test water). To this end, the GNWT concurs with De Beers that it is important to focus on the specific blend of constituents within the Snap Lake groundwater which consists of nearly 50% chlorides.

4.1.2 Chloride

Toxicity tests related to chlorides have shown that toxic effects of chloride are often related to the form of chloride salts that have been incorporated into the tests. For example, toxic effects using potassium and magnesium chloride suggest that the toxicity is more related to the potassium and magnesium cations, rather than the chloride anion. Conversely, toxic effects using calcium chloride and sodium chloride are likely due to the chloride ion (CCME 2011). In the case of Snap Lake, calcium and chloride are the dominant ions and as such it is likely that any potential toxicity will be driven by the chloride ion.

Holland et al. (2010) outline that freshwater organisms tend to be hyperosmotic, in that their internal salt concentration is higher than the surrounding environment. As a result they have to excrete water to maintain equilibrium and uptake ions to replace the ones that are lost. Increased chloride concentrations can therefore affect the ability to osmoregulate, potentially resulting in effects to endocrine balance, oxygen consumption and overall changes in physiological processes.

In this context, the GNWT contrasts the status of chlorides in Snap Lake with the levels proposed in this proceeding, as set out in Table 3 below.

[4] Concentrations causing 20% effect.

Table 3: Chloride Conditions and Regulatory Limits for Snap Lake

Source	Chloride (mg/L)
Snap Lake Pre-Mining	Less than 1
Current Snap Lake Whole Lake (Sept 2013)	108
Current Effluent Avg. Conc. (April 2014)	305-321
Water Licence (until December 31, 2014)	310 mg/L Max Average 620 mg/L Max Grab
Water Licence (starting January 1, 2015)	160 mg/L Max Average 320 mg/L Max Grab
Requested Amendment	378 mg/L Max Average 607 mg/L Max Grab

Note: During the 2011 water licence renewal, a higher interim EQC was granted to allow De Beers sufficient time to complete mitigation investigations related to groundwater management or review of SSWQOs. This interim EQC is to be reduced to a lower EQC (based on an SSWQO of 120 mg/L for chloride) in 2015 (MVLWB Reasons for Decision).

4.1.3 Nitrate

Increases to nitrogen species in Snap Lake are associated with anthropogenic sources within mine effluent that has been impacted primarily from residues generated through the use of nitrogen based explosives (i.e. ANFO, etc.). As noted in De Beers Nitrogen Response Plan, the nitrate ion (NO3) is the common form of nitrogen found in natural waters. It may be biochemically reduced to nitrite (NO2), usually under anaerobic conditions. The nitrite ion is rapidly oxidized to nitrate (Chapman, 1992).

De Beers ha noted that explosive residue containing nitrate and ammonia enters the water management system at the Snap Lake Mine in two ways: underground due to pumping directly to the water treatment plant; and, via tailings management in the North Pile and water management pond (DeBeers 2013e).

Regarding nitrate, CCME states:

> *"Nitrate is considerably less toxic than ammonia or nitrite, with acute median lethal concentrations of NO3-- N being up to two orders of magnitude higher than for NH3-N and NO2 --N (Colt and Armstrong 1981). Nonetheless, nitrate can produce toxic effects. There are two suspected mechanisms for the observed nitrate toxicity in aquatic animals: a) through methaemoglobin formation, resulting in a reduction in the oxygen carrying capacity of blood and b) through the inability of the organisms to maintain proper osmoregulation under high salt contents associated with elevated nitrate levels (Colt and Armstrong 1981)."* (CCME 2012)

In Snap Lake the pre-mining baseline condition for nitrate/nitrite was approximately 0.002 mg/L. Nitrate concentrations in 2012 reached 3 mg/L as NO3-N in the diffuser area and 2.5 mg/L in the main basin. DeBeers has predicted that the concentration of 'nitrogen' will reach 9 mg/L in the diffuser area and 8 mg/L in the main basin (De Beers 2013e). Table 4 sets out nitrate regulatory limits for Snap Lake.

Table 4: Nitrate Conditions and Regulatory Limits for Snap Lake

Source	mg – N/L
Snap Lake Pre-Mining	Less than 0.002
Current Snap Lake (2012)	2.5-3
Predicted Snap Lake End of Mine (2028)	9
Current Effluent Avg. Conc. (March 2014)	3.85
Water Licence (until December 31, 2014)	22 Max Average 44 Max Grab
Water Licence (starting January 1, 2015)	4 Max Average 8 Max Grab
Requested Amendment	14 Max Average 32 Max Grab

Note: During the 2011 water licence renewal, a higher interim EQC was granted to allow De Beers sufficient time to complete mitigation investigations related to groundwater management or review of SSWQOs. This interim EQC is to be reduced to a lower EQC (based on an SSWQO of 120 mg/L for chloride) in 2015 (MVLWB Reasons for Decision).

It is important to note that CCME has reviewed available evidence and concluded that there is no substantial relationship between nitrogen species and hardness, so it is not justifiable to use hardness as a toxicity modifying factor for nitrogen species. The CCME stated that:

> " *…., it was decided that the data would not be combined in order to generate a pooled slope, and there would be no derivation of either a hardness dependant short-term or long-term equation for use in hardness-dependent short-term or long-term guideline derivation*." (CCME Nitrate Factsheet 2012)

The GNWT conducted a preliminary jurisdictional review for nitrate. Table 5 below illustrates the different guidelines from various sources in North America.

During the 2011 water licence renewal, the MVLWB created nitrate-specific SSWQO-development procedures. In the Nitrogen Response Plan (DeBeers 2013e) De Beers refuted the applicability of the MVLWB's procedures.

Table 5: Jurisdictional Review of Nitrate Water Quality Objectives

Source	mg – N/L
CCME Nitrate Factsheet for the protection of aquatic life (chronic)	3.0
BC Ministry of Environment (chronic)	3.0
State of Minnesota (chronic)	4.9
State of Pennsylvania (Nitrate+Nitrite) (maximum limit)	10

USEPA Gold Book National Water Quality Standard	10
Health Canada Drinking Water Standard	10

As per the above, the GNWT remains concerned based upon a jurisdictional review that the WQO for nitrate may not be protective of all species within Snap Lake. Further, the GNWT is concerned that the WQO objective will be above the US and Canadian National Standards for Drinking Water (10 mg N/L).

4.2 Review of the De Beers Site Specific Water Quality Objective Methodology

4.2.1 Toxicity Testing Requirements

As outlined in the “Protocol for the Derivation of Water Quality Guidelines for the Protection of Aquatic Life” (CCME 2007), a specific standard of SSWQO derivation is expected by the CCME. The minimum required evidence includes:

- the use of a statistically significant population to derive a line of best fit for a Species Sensitivity Distribution (SSD) Curve at 95% confidence level (Type A); or
- a safety factor applied to the most sensitive test species (Type B1)

The minimum test species requirements, for both Type A and B1, are:

- the use of three aquatic invertebrate species, including at least one planktonic crustacean
- the use of three fish species (including at least salmonid and one non-salmonid), and
- plant species are desirable.

The methodology used by De Beers appears to be based on a Type B1 and the species list includes five invertebrate species, plant species and two fish species (arctic grayling and lake trout). Of note, the requirement for a third (non-salmonid) fish species) was not fulfilled. The GNWT notes that the requirements above are *minimum* requirements, and that De Beers has not met these requirements.

Additionally, CCME outlines various options for the calculation of SSWQOs based on the result of site specific toxicity testing results: the utilization of a SSD curve (Type A) or a calculation based on the use of the chronic toxicity of the most sensitive species in conjunction with a safety factor (typically in the range of 2-10) (Type B). De Beers determined that a SSD curve was not appropriate from the data compiled at Snap Lake due to the presence of unbounded values resulting from tests at which no effect was shown. As a result, De Beers proceeded with the alternate Type B method of deriving SSWQOs, using a modified SSD curve based on the calculated chronic toxicity of the most sensitive species that was tested. The most sensitive species in the Golder benchmark studies (De Beers 2013a) was

Ceriodaphnia dubia, which displayed an IC(10) at 560 mg/L TDS. However, as noted in the TDS Response Plan (De Beers 2013a):

> *"Applying one of the other CCME (2007) WQG derivation approaches would involve applying a safety factor to the most sensitive test endpoint. A safety factor of 10 applied to that value would yield a benchmark of 56 mg/L TDS if the IC10 for C. dubia reproduction were used. That would be an overly conservative and technically indefensible benchmark given that the 2012 whole-lake average TDS concentration was 212 mg/L (range 167 to 279 mg/L) and there were no sublethal effects to C. dubia reproduction reported in toxicity tests performed on Snap Lake water samples collected at the diffuser stations in 2012 (De Beers 2013). Given that C. dubia are not present in Snap Lake, but Daphnia species are, it was considered more appropriate to use the IC20 for D. magna reproduction for the benchmark derivation and to apply a safety factor of 1.0 to yield a CEB of 684 mg/L TDS for Snap Lake."*

The rationale used by De Beers to exclude specific toxicity values from its SSWQO derivations (Type B with proposed safety factors) is unclear, and as such this creates uncertainty regarding the protectiveness of values put forward by De Beers. Of note, the safety factor of 1.0 used by De Beers will not provide an adequate level of conservatism to the original number. CCME has specifically identified that applying a safety factor of 1.0 is inadequate, as the proposed safety factor in the 2007 CCME guidance ranges from 2-10.

De Beers has applied a safety factor of 1.0 to the most sensitive species that was present in Snap Lake, *Daphnia magna* which displayed a 20% effect at 688 mg/L (De Beers proposed SSWQO).

The CCME recommends a safety factor in order to:

> "*account for differences in sensitivity to a chemical variable due to differences in species (intra and interspecies), exposure conditions (laboratory vs field, varying environmental conditions), and test endpoints, as well as a paucity of toxicological data,* ***cumulative exposures****, and policy requirements (in particular, extrapolating from a low-effect toxicological thresholds to a protective environmental management benchmark)."* (CCME, 2007, emphasis added)

Of note, the safety factor of 1.0 used by De Beers will not provide an adequate level of conservatism to the original number. CCME has specifically identified that applying a safety factor of 1.0 is inadequate, as the proposed safety factor in the 2007 CCME guidance ranges from 2-10. GNWT notes that the biological environment of Snap Lake will have 'cumulative exposures' at high levels; safety factors exist not just for exposure to one constituent of TDS, but for multiple exposures. Chlorides will be high, and so will other constituents of TDS.

4.2.2 Use of Hardness as a Toxicity Modifying Factor

As stated previously, the GNWT has chosen to focus its efforts on the predominant COPCs (TDS and chloride) as part of its technical report. However, increases to nitrogen species must also be considered since the anthropogenic source of nitrogen species (nitrate, nitrite and

ammonia) are from a source other than connate ground water and these other TDS constituents contribute to the overall impact.
Regarding the use of toxicity modifying factors, De Beers has modified the SSWQOs for chloride and nitrate based on hardness concentrations.

4.2.2.1 Chloride

De Beers has referenced Elphick at al. (2011) which indicated evidence that there was a relationship between hardness and chloride toxicity. While the CCME was aware of this work during the 2011 update to the chloride guidelines, it was not incorporated into the update due to their conclusion that:

> "Insufficient data were available to develop a hardness relationship for chronic toxicity and thus, a hardness based CWQG was not developed [for chloride]. CCME will re-visit the chloride guidelines when sufficient studies are available. Jurisdictions may choose to derive site-specific hardness-adjusted water quality criteria (or objectives) where appropriate."

Specific details on GNWT's concerns with the use of hardness as a toxicity modifying factor are provided in Section 9.1 of Appendix 1.

It is the GNWT's position that De Beers has not provided any additional rationale for the utilization of this modifying factor. Further, as noted above, De Beers has not met the minimum testing requirements.

4.2.2.2 Nitrate

Nitrogen is present in mine effluent primarily from blasting. The GNWT notes that CCME has raised concerns about the use of a hardness toxicity modifying factor for nitrate similar to the concerns CCME has raised for chloride:, \

> "*Toxicity Modifying Factors: Recent work by Elphick (2011) investigated the effect of hardness on the toxicity of nitrate using both short-term and long-term toxicity tests. Short-term exposures were conducted using rainbow trout (Oncorhynchus mykiss) and an amphipod (Hyalella azteca). Long-term exposures were conducted using the fathead minnow (Pimephales promelas), a water flea (Ceriodaphnia dubia), an amphipod (Hyalella azteca), and a midge (Chironomus dilutus – formerly Chironomus tentans). Tests with fish (rainbow trout and fathead minnow) were conducted using four hardness levels (approximately 15, 45, 90 and 160 mg·L-1 as CaCO3). Tests with invertebrates (amphipod, water flea and midge) were not tested at the lowest hardness of 5 mg·L-1, and only tested at 45, 90 and 160 mg·L-1 as CaCO3 hardness. In order to understand the relationship between hardness and nitrate toxicity, data were plotted into a regression of natural logarithmic (ln) of toxicant concentration as the dependent variable against the ln of hardness as the independent variable. Overall, the trend was one of decreasing toxicity with increasing hardness.*

> *However, in order to be able to derive a national hardness adjusted guideline value, the calculated slopes for the hardness-toxicity relationships have to be compared to one other (e.g. comparison of slopes for short-term and long-term exposures separately). If it is concluded that the slopes for all species are not significantly different from one another, a pooled slope can be calculated, one using the short-term data and the second using the long-term data. This single pooled slope (one for short-term and a second for long-term exposures) is then used to derive hardness-adjusting equations for the development of a hardness-adjusted short-term and long-term guideline value. An F-test showed that the slopes for the two species (O. mykiss and H. azteca) for the short-term exposures were significantly different from one another (p=0.012). The slopes for the four species (P. promelas, C. dubia, H. azteca and C. dilutus) for the long-term exposures were also found to be significantly different from one another (F-test p value = 0.001).* ***As a result, it was decided that the data would not be combined in order to generate a pooled slope, and there would be no derivation of either a hardness dependant short-term or long-term equation for use in hardness-dependent short-term or long-term guideline derivation***." (CCME 2012, emphasis added)

Additionally, the GNWT notes that the Ecometrix review identified the following concern:

> *"[A} lower response level [was observed]s for C. dubia at hardness 350 mg/L as compared to 140 mg/L. This raises a question as to whether nitrate response levels may be even lower at the upper bound of future hardness around 950 mg/L.* ***Nitrate toxicity was not tested at this level of hardness****."* (Ecometrix 2014, emphasis added)

In derivation of the SSWQO for nitrate, the GNWT notes that nitrate was added to the water to determine what concentration would affect the fish and the small animals that form their food chain (De Beers 2013e).

The GNWT notes that the proponent used spiked samples instead of Snap Lake water in its establishment of SSWQOs for nitrate. Further, the spiked samples had varied concentrations of hardness. While the GNWT acknowledges that it is standard practice in primary research to use laboratory water, De Beers did not also include metalloids that are commonly present in the Snap Lake Mine effluent. The GNWT submits that these tests do not adequately account for the unique composition of mine effluent being discharged into Snap Lake and the overall toxicity of water in-situ. This is another example of why CCME requires the use of safety factors, and the GNWT again notes that De Beers has not met the minimum test requirements.

The GNWT further believes that in accordance with the spirit and intent of the NWT Water Stewardship Strategy that any SSWQOs that are subject to toxicity modifying factors should be based upon the natural baseline (pre-impact) concentrations of these factors. This policy is consistent with other Canadian jurisdictions, and is clearly stated in the BC Ministry of Environment Document "Guidance for the Derivation and Application of Water Quality Objectives in British Columbia":

> "When there are toxicity-modifying factors (ameliorating or aggravating) present, WQOs must be based on the natural background concentrations of these factors, not levels that have been altered due to human land use (e.g., hardness)." (BCMOE 2013, p. 12)

GNWT believes that based upon the uncertainty related to hardness modification of water quality objectives, it is the GNWT's view that De Beers has not provided sufficient rationale and linkage to all species within Snap Lake to justify the proposed SSWQO. Further discussion is needed regarding the appropriate level of hardness to be applied should toxicity modifying factors be utilized.

4.3 SSWQOs Derived by Using Appropriate CCME Methodology

The GNWT retained the services of MacDonald Environmental Sciences Ltd. (MESL) to assist in the derivation of robust SSWQOs for Snap Lake and the downstream receiving environment. MESL (2014, provided as Appendix 1) used standard SSWQO derivation methodology as per CCME 2007 and provided the following recommendations. The GNWT has included them for the Review Board's information and consideration, as appropriate, within its assessment. It is recognized that more detailed discussions on numerical values of SSWQOs will occur as this process moves forward to the water licence review.

4.3.1 Water Quality Objectives for TDS

As indicated by MESL, the recommended approach for developing the WQO for Snap Lake for TDS is to derive a *de novo* water quality guideline using the guidance provided by CCME (2007). The results of the Phase I toxicity testing program presented in De Beers (2013a) and compiled literature on the effects of TDS on aquatic organisms provide applicable information to derive a WQO for use in Snap Lake. It was MESL's conclusion that insufficient information to generate a WQG using the Phase 1 toxicity test results alone (i.e., only two fish species were tested) was available, however, the primary literature was reviewed to find additional information for inclusion in the SSD. Additionally, it is important to consider the relative ion composition of the TDS in the information compiled. While no information on the toxicity of TDS at the appropriate ion composition was available, the literature compiled for the review of the toxicity of chloride (chloride makes up approximately 47% of the TDS in Snap Lake) was evaluated to identify appropriate no-effect concentrations for non-salmonid fish. The combined Phase 1 and literature-based no-effects data used in the generation of an SSD is as follows:

- *Navicula pelliculosa* (NOEC[5]; >1487 mg/L TDS);
- *Pseudokirchneriella subcapitata* (NOEC; >1474 mg/L TDS);
- *Salvelinus namaycush* (LC^{6}_{20}; 991 mg/L TDS);
- *Thymallus arcticus* (NOEC; >1414 mg/L TDS);
- *Pimephales promelas* (MATC[7] survival; 431 mg/L TDS; Birge *et al.* 1985);
- *Chironomus dilutus* (NOEC; > 1379 mg/L TDS);
- *Ceriodaphnia dubia* (IC^{8}_{10} reproduction; 560 mg/L TDS);

[5] NOEC – No Observed Effect Concentration
[6] LC – Lethal Concentration
[7] MATC – Maximum Acceptable Toxicant Concentration
[8] IC – Inhibitory Concentration

- *Daphnia magna* (LC_{10} 183 mg/L TDS); and,
- *Brachonius calyciflorus* (IC_{10} intrinsic rate of population increase; 241 mg/L TDS).

Thus a SSD was generated using SSD Master Version 3.0 (CCME May 2013). Four cumulative density function models were generated for the data set with the HC_5 concentrations ranging from 111 mg/L TDS (using the Extreme Value model) to 195 mg/L TDS using the Gumbel model. After review of the resultant curves, the Normal model (HC_5 of 160 mg/L TDS) best fit the data at the lower end of the curve, even though the Extreme Value model best fit the data overall.

However, as water quality conditions in Snap Lake have already been changed by releases of effluent from the Snap Lake mine, it became apparent that a shift in derivation strategy for SSWQOs for TDS was required for Snap Lake. As such, a use-protection approach may be better suited to derive water quality objectives that are protective of water uses in Snap Lake. Based on the information compiled on water quality guidelines for chloride, drinking water is the most sensitive water use during short-term exposure, while aquatic life is the most sensitive water use under long-term exposure. These are important considerations moving forward in this process when setting numerical values for SSWQOs established to be protective of Snap Lake and the downstream aquatic environment. Note: The GNWT will provide recommendations regarding SSWQOs and EQCs to the MVLWB as this process moves forward to the water licence review.

4.3.2 Water Quality Objectives for Chloride

Again, as discussed above with respect to assimilative capacity, water quality conditions in Snap Lake have already been impaired by releases of effluent from the Snap Lake mine. Therefore, it is again recommended that a use-protection approach should be employed to derive water quality objectives that are protective of water uses in Snap Lake. The use-protection strategy is applied when some degradation of water quality conditions is considered to be tolerable, provided that the designated uses of the water body are maintained (e.g. traditional use, protecting freshwater life, drinking water, etc.). Based on the information compiled on water quality guidelines for chloride, it is clear that the aquatic life is the most sensitive water use.

As discussed previously, there are concerns with the use of hardness as a toxicity modifying factor for chloride. Therefore, based on the guidance provided in CCME (2003), the promulgated water quality guidelines developed for use in Canada should be adopted as the water quality objective for Snap Lake. While other methods, such as the recalculation method or the resident species approach, could be employed to derive SSWQOs, it is unlikely that the resultant WQOs would be higher than the current WQG, since the species that define the lower of the SSD (i.e., mollusks and cladocerans) are present in Snap Lake and the Lockhart River system.

4.3.3 Water Quality Objectives for Nitrate

De Beers has also requested an increase to its nitrate discharge limit. As noted previously, justification for this increase was based on the modifying ability of hardness on nitrate toxicity.

The GNWT has overarching concerns with both the scientific validity of deriving SSWQOs based on uncertainties shown by the CCME in this regard, as well as with the policy issue of the use of anthropogenically modified hardness values, both present and predicted. Thus, the GNWT does not support the requested increase to the nitrate limits. Options to mitigate the loss of nitrate during underground mining should be investigated to curtail the increase in nitrate concentrations over time. The GNWT would like to discuss and investigate these options further as part of the regulatory process for the requested water licence amendment.

As described previously, the GNWT remains concerned, based upon a jurisdictional review, that the WQO for nitrate will not be protective of all species within Snap Lake. In addition, the GNWT notes that the Health Canada Maximum Acceptable Concentration (MAC) for nitrate is 10 mg/L as nitrogen.

5.0 PROTECTION OF SNAP LAKE AND TRADITIONAL USE

The perspectives of the land users must be considered when establishing the extent and magnitude of allowable discharge limits and when assessing the potential for significant adverse effects from a development project.

As stated by Yellowknives Dene First Nation representative, Todd Slack, during the recent Gahcho Kue regulatory hearings on May 7th, 2014:

> *"…it doesn't seem like you should be releasing proposed effluent with hundreds of times the background concentration into a receiving water body and call that protective. You can't exceed the CCME by orders of magnitude and call it protective."."*

During the technical sessions for EA1314-02, the GNWT heard evidence from the Yellowknives Dene First Nation regarding the cultural significance of the Lockhart System and the Old Lady of the Falls. Based on this evidence, the GNWT submits that any detection of effluent at the Old Lady of the Falls would cause significant adverse cultural impacts and would therefore not be acceptable. The GNWT expects that other Aboriginal parties may raise similar concerns in their technical report, and reserves comment on those concerns.

Additionally, the issues of perception of risk and loss of use of the Snap Lake area have been raised by the Yellowknives Dene First Nation and should not be discounted. The GNWT is aware of other examples where traditional users have avoided areas based on a perception of risk. This perception of risk may even prolong such avoidance. The GNWT assumes that a perception of contaminants and its effect on traditional use would be brought forward and considered by the Review Board during its deliberations for this environmental assessment.
SSWQOs established in the water licence for Snap Lake and the downstream must be protective of the aquatic environment and must also reflect traditional uses of the area. The GNWT notes that the aesthetic objectives (AO) have been developed by Health Canada for TDS and chlorides, and Health Canada has also produced a health based Maximum Acceptable Concentration (MAC) for nitrate.

For TDS, Health Canada provides an AO of 500 mg/L. This threshold was developed in part by a panel that rated TDS levels as follows:

- excellent, less than 300 mg/L;
- good, between 300 and 600 mg/L;
- fair, between 600 and 900 mg/L;
- poor, between 900 and 1200 mg/L; and
- unacceptable, greater than 1200 mg/L.

The GNWT emphasizes that while a TDS AO of 500 mg/L is provided, the individual components of TDS outlined in that report are dominated by sulphates and bicarbonates as opposed to chlorides. (Bruvold and Ongerth, 1969).

In response to discussion regarding the TDS aesthetic objective at the technical session, De Beers provided some commentary in its April 2014 Information Request Responses. De Beers noted that "mineral water, which many prefer to drink rather than tap water, typically has relatively high TDS concentrations. For example, Vichy water has >3000 mg/L TDS." From the reference provided by De Beers in response to Information Requests, GNWT notes that the major component of Vichy water is bicarbonate (2135 mg/L - which accounts for approximately 70% of the TDS content). For comparison purposes, Perrier water reports TDS (dry residue) concentrations of 480 mg/L with 430 mg/L as bicarbonate, 33 mg/L as sulphate and only 22 mg/L as chloride. (http://www.perrier.com/en/discoverperrier.html). The important point to note here is that the dominant ion in both waters is bicarbonate, with chlorides present at a much lower percentage of the total. De Beers has presented no evidence as to the water-consumption preferences of the traditional users of Snap Lake. GNWT submits that the reference to bottled mineral water is not relevant.

As discussed previously, the major ion in Snap Lake Mine effluent is chloride. The aesthetic objective (AO) for chloride in drinking water is 250 mg/L. As described by Health Canada:

> *"The taste threshold for chloride is dependent on the associated cation and is generally in the range of 200 to 300 mg/L. Chloride concentrations above 250 mg/L in drinking water may cause corrosion in the distribution system. The chloride ion's ability to form soluble salts with many metal ions prevents the formation of films that could prevent the further corrosion of metal surfaces. Taste thresholds for chloride from sodium chloride, potassium chloride and calcium chloride in drinking water are 210, 310 and 222 mg/L, respectively; the taste of coffee is affected when brewed with water containing chloride concentrations of 400, 450 and 530 mg/L from the same salts. Chloride concentrations above 250 mg/L in drinking water may cause corrosion in the distribution system. The aesthetic objective for chloride in drinking water is therefore <250 mg/L. Chloride concentrations in Canadian drinking water supplies are generally much lower than 250 mg/L."* (Health Canada 1987)

The GNWT notes that at Snap Lake, assuming that chloride makes up approximately 47% of the effluent, a chloride concentration of 250 mg/L would correspond to a TDS concentration of 532 mg/L.

With regard to nitrate, the GNWT notes that the Health Canada MAC for nitrate is 10 mg/L (as nitrogen), which aligns with the US and Canadian National Standards for Drinking Water. The GNWT will provide specific recommendations regarding protective SSWQOs and EQCs to the MVLWB as this process moves forward to the water licence review.

RECOMMENDATIONS:

8. The GNWT recommends that the Review Board include a measure to require De Beers to prevent measurable changes to water quality at the Old Lady of the Falls.

9. The GNWT recommends that the Review Board include a measure to require De Beers to ensure protection of the traditional use of water in Snap Lake and downstream.

6.0 CONCLUDING REMARKS

As the primary roles and responsibilities for land and water management have recently been devolved from AANDC to the GNWT, the GNWT is now the primary water manager in the NWT. In this new role, the GNWT has a responsibility to ensure that the use of water is conducted in a sustainable manner which protects the use of the system, now and into the future. The current and future use of the system by Aboriginal peoples must be protected.

Within its review, the GNWT has identified that:

1. The magnitude of adverse impact under unmitigated conditions would likely be significant based on the anticipated concentrations of TDS and its constituents within Snap Lake and in the downstream aquatic environment, for a duration of 90 years.

2. The loss of traditional use in the area (fishing, use as drinking water, etc) under worst case conditions is likely and should be considered as a potential significant adverse cultural impact.

Consequently, GNWT submits that an unmitigated scenario (as described in Section 3.2.1) would likely result in both of these outcomes in the future, and that mitigation would therefore likely need to be implemented at some point in the future.

Prior to making our final recommendation in this regard, the GNWT would like to comment on the achievability of SSWQOs by the proponent with specific reference to the Reasons for Decision (RFD) from the MVLWB during De Beers 2011 Water Licence renewal. During the renewal, the MVLWB decided to use a WQO of 120 mg/L of chloride as the basis for EQC derivation. However, it was noted in the RFD that EQCs to meet the SSWQOs were not achievable as median values of chloride in the effluent were already at 247 mg/L (current values are in the range of 300 mg/L).

As a result, a higher interim EQC was granted to allow De Beers sufficient time to complete mitigation investigations related to groundwater management or review of SSWQOs. This interim EQC is to be reduced to a lower EQC (based on an SSWQO of 120 mg/L for chloride) in 2015. De Beers has used the time provided since 2011 to propose new SSWQOs, however, for the reasons outlined in this technical report, the GNWT does not have confidence that the proposed objectives are sufficiently protective of the aquatic environment nor will they sufficiently protect and maintain traditional uses in the area. As such, the GNWT cannot, at this time, support the proposed SSWQOs currently proposed by De Beers.

RECOMMENDATION:

10. **The GNWT recommends that the Review Board include a measure requiring De Beers to implement, no later than 18 months following the issuance of the water licence, mitigation sufficient to protect the aquatic environment and maintain traditional use of Snap Lake**

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