

# EA1314-02 SNAP LAKE WATER LICENCE AMENDMENT

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05 June 2014

# PART 1: EFFECTS ASSESSMENT

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## The Development Proposal

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- Discharge of treated minewater to Snap Lake of quality that is protective of the environment.
- Rescind current whole-lake average limit for total dissolved solids (TDS) concentration of 350 mg/L.
- Apply site-specific water quality objective (SSWQO) that is protective of the environment.
- Propose to the MVLWB a SSWQO for Snap Lake of at least 684 mg/L, and a monthly effluent limit (EQC) of at least 684 mg/L, with an interim EQC.

## The Development Proposal (cont'd)

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- Proposal, within the scope of this EA is derived from requirement in current water licence to submit by December 31, 2013:
  - TDS Response Plan
  - Nitrogen Response Plan
- These Plans to include recommendations to MVLWB:
  - *“...appropriate Water Quality Objectives for TDS, Chloride and Fluoride in Snap Lake derived from toxicity testing...”*;
  - *“...EQCs for TDS, Chloride and Fluoride, to be applied at SNP station 02-17 that would ensure protection of aquatic life in Snap Lake.”*
- Also to include sources of TDS and current practices, ongoing investigations and issues related to minimizing TDS loading

## The Development Proposal (cont'd)

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- Requirement to develop SSWQO for Snap Lake was discussed during renewal of operational water licence.
- De Beers presented information that showed that minewater discharge volume and TDS loadings were greater than predicted during original EA.
- There are no national guidelines for TDS.
- The need to develop mitigation to reduce TDS loadings was recognized.

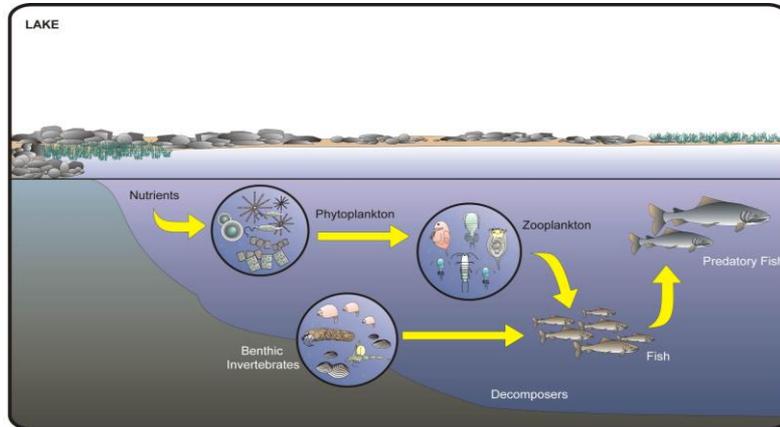
## The Development Proposal (cont'd)

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- The TDS Response Plan as well as materials filed in support of the Amendment Application include:
  - Results of comprehensive toxicology studies;
  - Current practices to reduce TDS loadings to the environment; and,
  - Studies completed or underway to reduce TDS loadings to the environment
- Current licence limits for TDS and its constituents are overprotective for Snap Lake.
- Proposed SSWQOs for TDS, including chloride and fluoride are appropriate – as they are protective of the environment, as well as achievable.

## Supporting Studies

- Completed chronic toxicity testing of nine aquatic species – seven of which are found in Snap Lake
- Results show chronic responses at TDS concentrations greater than 1,000 mg/L, with exception of one test of one species of water flea that does not live in Snap Lake.
- Additional replicated testing has provided more certainty and confidence that proposed SSWQO is conservatively protective.

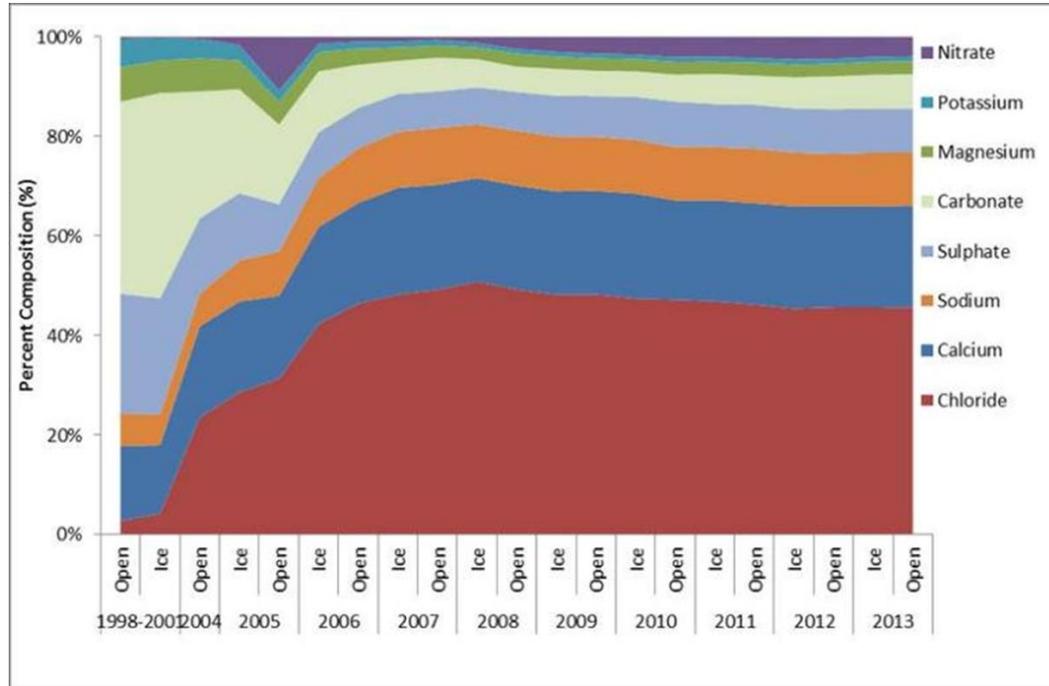


## Supporting Studies (cont'd)

Test Species	Endpoint	[TDS]	
<i>Ceriodaphnia dubia</i> (water flea)*	IC10/IC20	560/778	
<i>Daphnia magna</i> (water flea)	IC20 (geomean, n=5)	>1,099	NEW
<i>Chironomus dilutus</i> (insect larvae)	IC10	>1,379	
<i>Pseudokirchneriella subcapitata</i> (alga)*	IC10	>1,474	
<i>Cyclops vernalis</i> (copepod)	IC20	>1,508	NEW
<i>Brachionus calyciflorus</i> (rotifer)	IC20	>1,474	
<i>Navicula pelliculosa</i> (diatom)	IC10	>1,487	
Lake Trout	Dry fertilization LC20 fry survival IC20 fry weight and length (growth) Wet fertilization LC20 fry survival IC20 fry weight and length	991 >1,490 >1,484 >1,484	
Arctic Grayling	Dry fertilization LC20 fry survival IC20 fry weight and length (growth) Wet fertilization LC20 fry survival IC20 fry weight and length	>1,419 >1,419 >1,414 >1,414	

\*Species not in Snap Lake

## Supporting Studies (cont'd)



- Composition of minewater has remained quite constant since mining began.

## Supporting Studies – Response to Recommendations

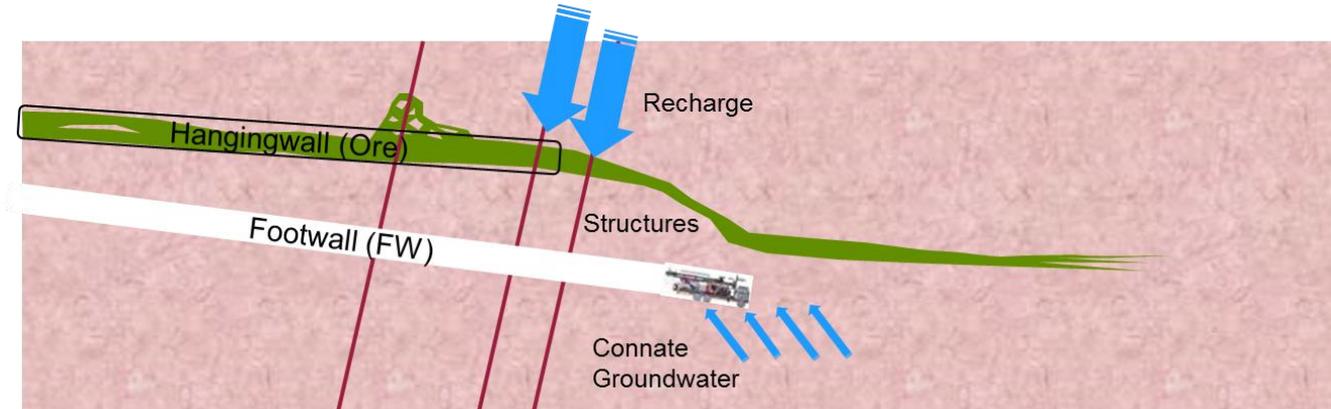
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*“..include a measure requiring De Beers to conduct a robust study on the anticipated reduction time of hardness during the recovery of Snap Lake (post operation) and how this reduction will compare to metals and nutrients over time. Specific attention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

- Modelling predicts that hardness will not decrease faster than hardness-adjusted site-specific water quality objectives (De Beers’ Response to Technical Reports May 28).

## Mitigation

- ~90% TDS loading to Snap Lake is from minewater. Connate groundwater entering mine workings is high in TDS.
- Full grouting to reduce overall mine inflows has been deemed impractical (MVRB/MVLWB\_IR#18, April 18).
- Selective grouting of areas of high-TDS groundwater continues to be undertaken and evaluated.



## Mitigation (cont'd)

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- Engineering studies and pilot testing of options to remove TDS are currently underway.
- Summary of investigations into treatment are summarized in IR#3-1 of EA1314-02. Results of current pilot studies are expected to be known Q3-4 2014.
- Based on proven technologies, but unique to Snap Lake
- Final determination by the MVLWB of a SSWQO and EQC is a critical design factor.

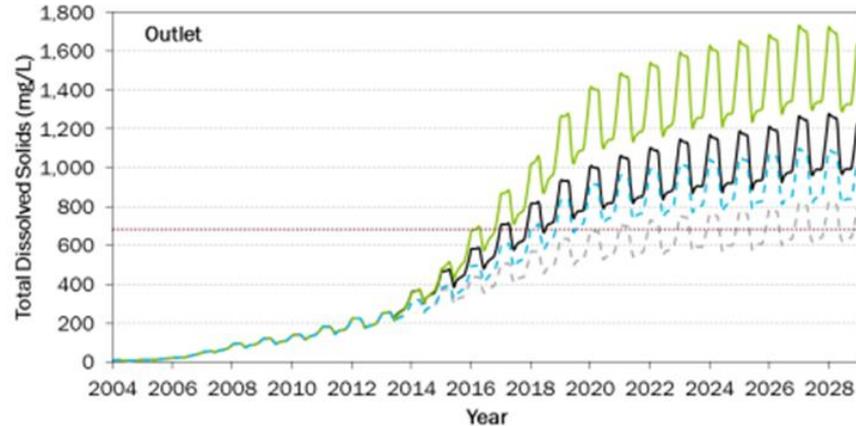
## Mitigation (cont'd)

- Evaluation of treatment options against factors to be considered will be complete in Q4 2014.
- Current pilot studies are based on proven technologies, but take into account the specific constraints of Snap Lake Mine.
- Assume SSWQO of 684 mg/L or higher TDS will be applied.
- Current licence limits are not achievable and are overprotective; proposed limits are conservatively protective and will support the current life of mine plan.



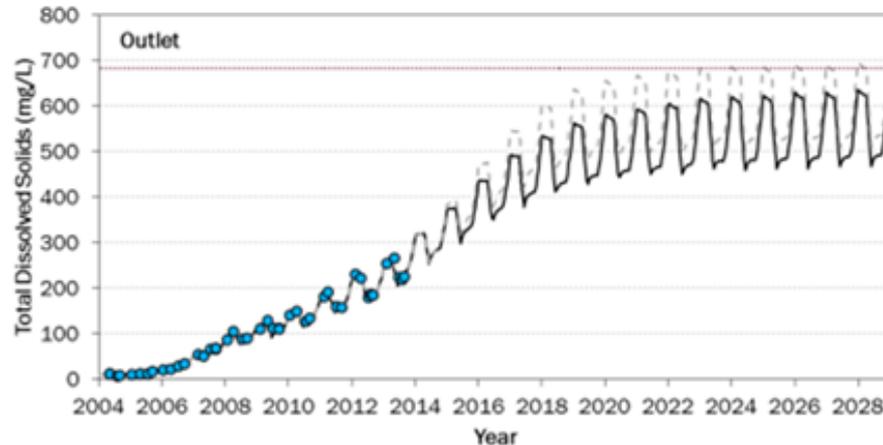
## Mitigation (cont'd)

- Models of long-term quality of Snap Lake and downstream lakes are presented as “mitigated” and “unmitigated”.
- Unmitigated scenarios show water quality with unregulated discharge over life of mine.
- The unmitigated scenario is unrealistic.

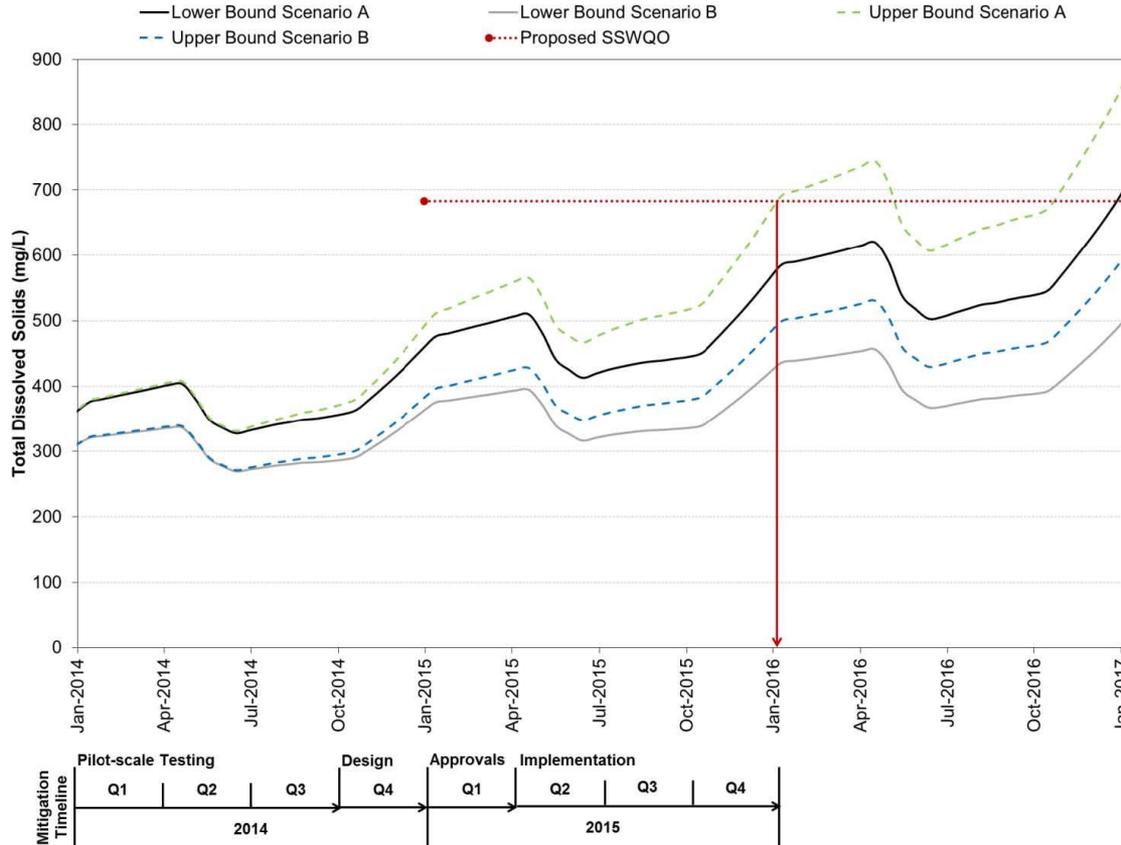


## Mitigation (cont'd)

- Mitigated scenarios depict water quality if the proposed interim and life of mine EQC are applied so as not to exceed the SSWQO.
- The mitigated scenario shows life of mine water quality that will not cause significant adverse effects to the environment.



## Mitigation (cont'd)



- Models indicate that TDS concentrations in Snap Lake may approach proposed SSWQO within 2 years without reduction in TDS loading.
- An interim EQC of 850 mg/L is proposed:
  - Snap Lake will not exceed a SSWQO of 684 mg/L
  - Will allow completion of mitigation designs

## Mitigation – Response to Recommendations

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*“..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.”*

- Scenario is unrealistic; an approved EQC will be regulatory limit.

*“..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.”*

- De Beers will implement mitigation to achieve an appropriate SSWQO in Snap Lake.

## Mitigation – Response to Recommendations (cont'd)

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*“Suspension of the environmental review decision phase until after the results of the above noted studies [water treatment/pilots; plume study; sic.] are completed and results are presented by De Beers”*

- Trials and evaluation of mitigation is underway.
- Dependent on decision by MVLWB on appropriate SSWQO.

*“If there is the potential for a deleterious substance to be deposited, Best available Technology Economically Achievable (BATEA) be applied to achieve end-of-pipe concentrations that will not result in harm to aquatic life in receiving waters.”*

- De Beers agrees with this recommendation.

## Mitigation – Response to Recommendations (cont'd)

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*“...provides regular updates to the MVEIRB/MVLWB on their treatment system pilot testing program in order that the Boards can have an understanding of what end-of-pipe limits could be achieved by treating a given volume of effluent.”*

- De Beers will provide regular updates regarding progress on source control and treatment to the MVLWB.

*“Require additional water treatment technology be installed by De Beers to reduce total dissolved solids in mine effluent to meet effluent quality criteria that is proven to protect the health of the aquatic environment.”*

- De Beers agrees that mitigation will be required to meet an approved SSWQO and notes that both source control and treatment are currently being tested and evaluated.

## Mitigation – Response to Recommendations (cont'd)

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*“That improved treatment and source control be the priority in terms of approaches to the water quality issues, not raising the licence limits.”*

- De Beers is evaluating and will implement effective mitigation as appropriate to reduce loadings to ensure that a protective SSWQO for TDS in Snap Lake, as approved by the MVLWB, is not exceeded.

## Effects Assessment

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- The proposed SSWQO are conservative and represent a TDS benchmark concentration below which there will be no adverse effects to the aquatic environment and above which there may or may not be adverse effects.
- An appropriate SSWQO for Snap Lake is protective – the development will not cause significant adverse impacts to the environment.
- The water will remain safe to drink, the fish safe to eat, and ecosystem function will be maintained.

## Effects Assessment (cont'd)

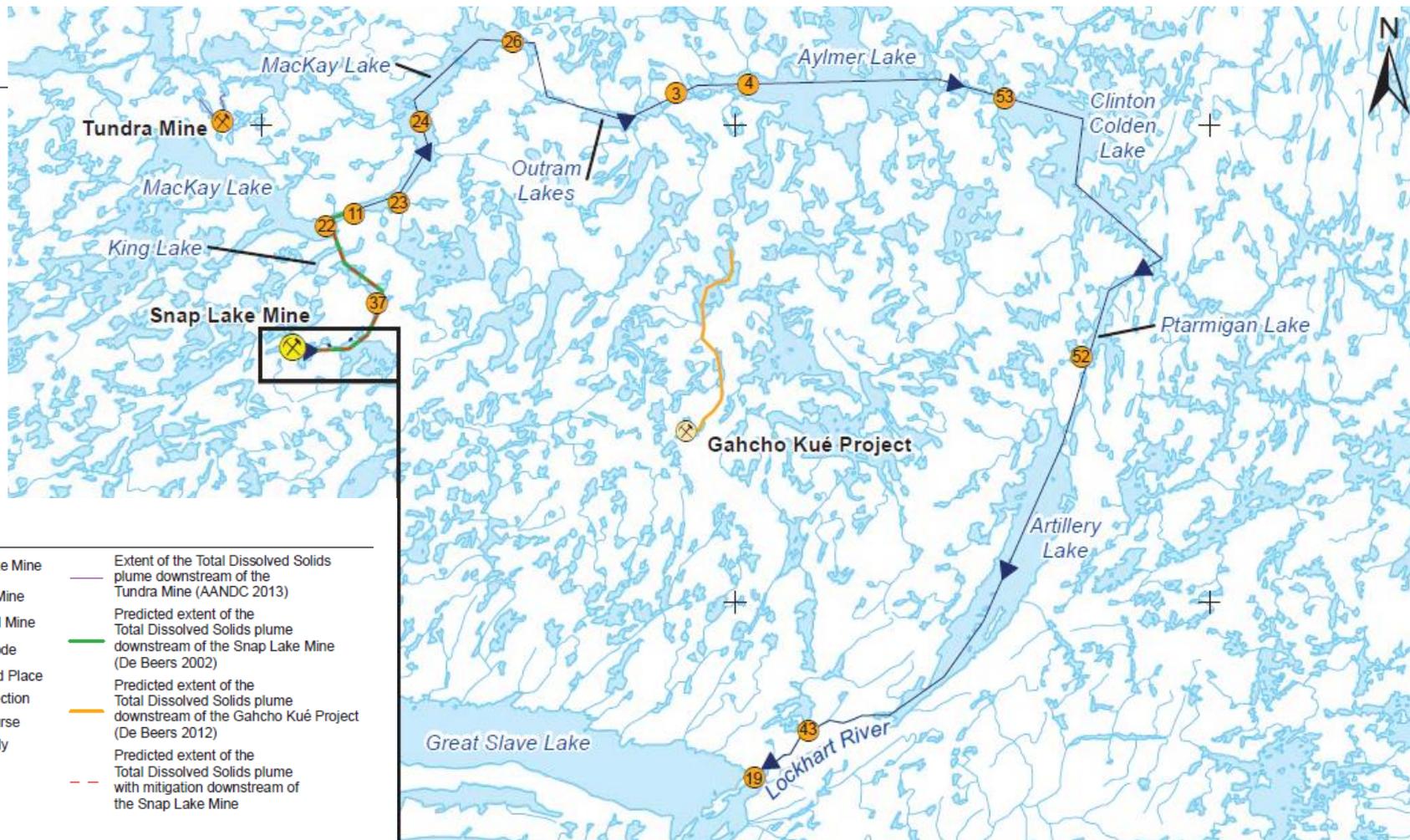
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- Concerns have been raised about the effects of the proposal on drinking water.
- The proposed SSWQO for Snap Lake do not pose any risk to human health – now or into the future.
- However, the taste of water may be affected; may be perceived as “fair” during mine operations (Canadian Drinking Water Quality Guidelines).
- Taste of water in Snap Lake will return to “good” (<600 mg/L TDS) within 4 years, and “excellent” (<300 mg/L) within 10 years of mine closure.
- Effects are reversible – the water will be safe and good to drink into the future.

## Cumulative Effects

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- Effluent from the Snap Lake Mine that achieves the proposed SSWQO in Snap Lake is predicted to be measurable approximately 44 km downstream from Snap Lake.
- There are no other past, present, or reasonably foreseeable developments that have an effect on water quality within this section of the Lockhart River watershed.
- Development proposal will replace the current development as it relates to minewater discharge and as such the combined effects of both have inherently been assessed for Snap Lake and downstream waters.
- Development does not contribute to cumulative effects on water quality within the Lockhart River watershed.



**LEGEND**

-  Snap Lake Mine
-  Existing Mine
-  Proposed Mine
-  Model Node
-  Populated Place
-  Flow Direction
-  Watercourse
-  Waterbody
-  Extent of the Total Dissolved Solids plume downstream of the Tundra Mine (AANDC 2013)
-  Predicted extent of the Total Dissolved Solids plume downstream of the Snap Lake Mine (De Beers 2002)
-  Predicted extent of the Total Dissolved Solids plume downstream of the Gahcho Kué Project (De Beers 2012)
-  Predicted extent of the Total Dissolved Solids plume with mitigation downstream of the Snap Lake Mine

## Effects Assessment – Response to Recommendations

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*“That the Board set the TDS limit no higher than Canadian Drinking Water Quality Guidelines of 500 mg/L for the protection of the way of life of the aboriginal people of the north.”*

- Completed scientific studies confirm that with the proposed SSWQO, the water will remain safe to drink and the fish safe to eat.
- Proposed SSWQO are conservatively protective; lower may not be achievable

*“That the Board set a fluoride limit no higher than Canadian Drinking Water Quality Guidelines of 1.5 mg/L.”*

- Guideline protects against cosmetic effects.
- Not based on adverse effects to human health.

## Effects Assessment – Response to Recommendations (cont'd)

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*“YKDFN strongly reject the ‘pollute up to’ approach and recommend that a more objective approach be employed, setting the TDS limit at 500 mg/L. This level will limit the impacts to the environment while protecting the land users, ensuring that their perception of the area is not significantly changed and the mine site can be remediated with public confidence.”*

- Proposed SSWQO are conservatively protective and based on scientific studies required to be undertaken.
- Water will be safe to drink and the fish safe to eat.

## Effects Assessment – Response to Recommendations (cont'd)

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*“The Board should put a measure in place to protect the Lady of the Falls. No level of change is acceptable at this site regardless of the source of the effluent.”*

- De Beers agrees with the intent of this recommendation but notes that Snap Lake effluent will not be measurable at Lady of the Falls.
- De Beers will continue to monitor at downstream stations as part of AEMP.

*“..include a measure requiring De Beers to minimize the degree or extent of project related impacts to Snap Lake and the downstream aquatic environment.”*

- The proposed SSWQO will meet this objective.

## Effects Assessment – Response to Recommendations (cont'd)

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*“..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.”*

- De Beers agrees with this recommendation and notes that water quality in Snap Lake will begin to improve immediately post-mining.

**PART 2: TECHNICAL RESPONSE**  
**DR. P.M. CHAPMAN, GOLDBER ASSOCIATES**

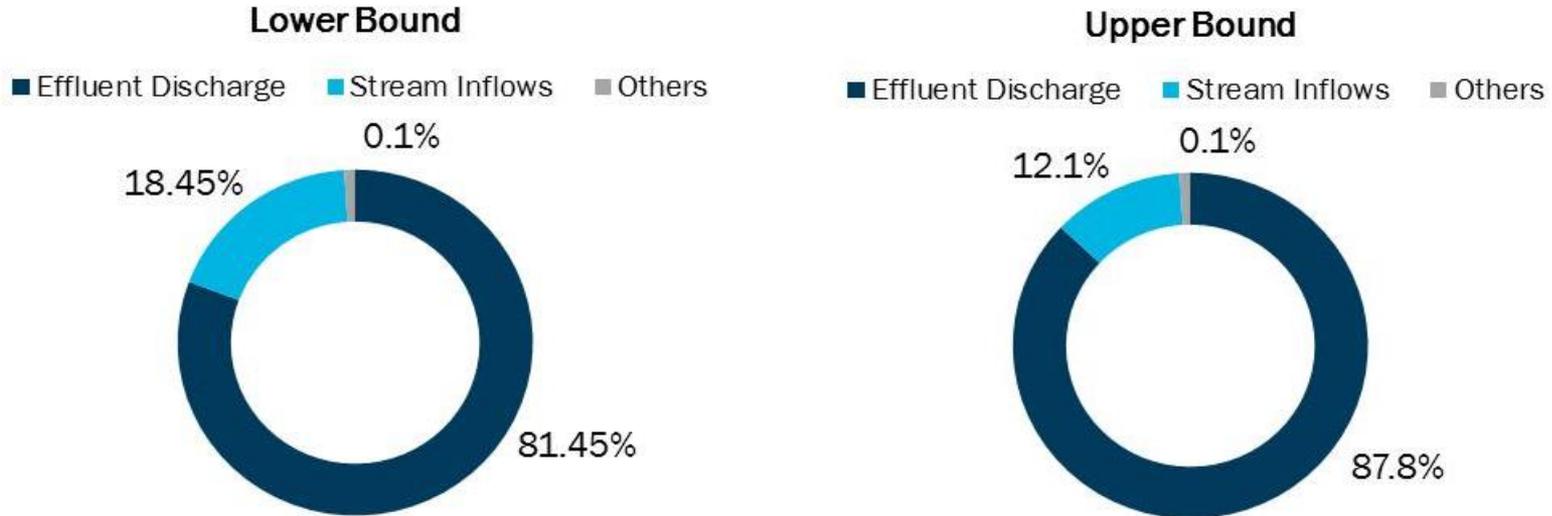
## Environment Canada Recommendation 1

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*“De Beers assess the seepages from the North Pile and the Water Management Pond and quantify the amount of TDS and chloride that are entering Snap Lake from these seepages.”*

- Effluent discharge is the major source of TDS and chloride to Snap Lake
- Seepages from North Pile and Water Management Pond not significant sources
  - Annual ARD Reports provide information on seepage quality.
  - Information on inflows to Snap Lake presented at Technical Session (April 15-16, 2014). [see next slide]

## Inflows to Snap Lake (as presented at Technical Session)



- “others” includes: site runoff that is not captured in the water management pond (WMP), seepage from the North Pile, seepage from the WMP, and discharge from a wetland

## Environment Canada Recommendation 2

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*“De Beers monitor water quality parameters, such as, temperature, pH, specific conductance, dissolved oxygen, and any other parameters that would help to identify water quality conditions related to the potential for stratification of Snap Lake, and that De Beers develop contingency mitigation measures which can be implemented in the event this is observed.”*

- The above water quality parameters are monitored and reported as part of the AEMP.
- No evidence that Snap Lake is becoming meromictic.
- Modeling provides no indication that meromixis will occur during operations.

## Peer Review: TDS Testing

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### **Ecometrix**

*“The proposed SSWQO of 684 mg/L is in the range of 500 – 1000 mg/L used for permitting by the State of Alaska...and seems appropriate as an adequately protective level for Snap Lake based on the site-specific toxicity testing.”*

### **MacDonald Environmental Sciences**

Testing done and findings of that testing not questioned.

Questions re TDS (all discussed later) on:

- Additional testing with a non-salmonid fish;
- Use of safety factor; and,
- Hardness adjustment for other SSWQOs.

## Publications Pending

Number	Title	Journal
1	Development of a strontium chronic effects benchmark for aquatic life in freshwater	Environ Toxicol Chem – accepted with revisions
2	Toxicity of strontium to <i>Hyalella azteca</i> and early life stages of rainbow trout	Bull Environ Contamination and Toxicology
3	Development of a fluoride chronic effects benchmark for aquatic life in freshwater	Environ Toxicol Chem – in review
4	Effect of total dissolved solids (TDS) on fertilization and development of two salmonids	Arch Environ Contam Toxicol
5	Development of a freshwater copepod chronic toxicity test	Arch Environ Contam Toxicol
6	Development of a total dissolved solids (TDS) site-specific water quality objective for a Canadian diamond mine	Integr Environ Assess Manage
7	Quantifying natural variability as a method to detect environmental change: definitions of the normal range for a single observation and the mean of m observations	Environ Toxicol Chem

## Publications Pending (cont'd)

Number	Title	Journal
8	The challenges in measuring low-level nutrients in a northern Canadian lake	Sci Tot Environ or Environ Intl
9	Hydrodynamic and water quality modelling of Snap Lake, NWT	Environ Model Software, Environ Model Assess, or Mine Water Environ
10	Weight of evidence assessment of mine-related chemical toxicity and nutrient enhancement	Integr Environ Assess Manage
11	Predicted no effect concentrations (PNECs) should not be based on a single toxicity test	Environ Toxicol Chem
12	The dietary niche of Lake Trout in a subarctic lake	N Am J Fish Manage
13	The food web supporting Lake Trout in a subarctic lake	N Am J Fish Manage

# GNWT SSWQO ISSUE 1

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## Additional TDS testing with a non-salmonid fish

- Species to be tested agreed to by all parties following extensive discussion and consultation that began during the Water Licence Renewal process in 2011.
- DFO recommendations for testing fish species followed.
- Independent review by Ecometrix supports proposed TDS SSWQO.
- Additional testing underway, as agreed upon during the Technical Session (April 15-16, 2014). [see next slide]

## GNWT SSWQO ISSUE 2

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### Use of appropriate safety factors

- Additional testing underway, as agreed upon during the Technical Session (April 15-16, 2014), indicates SSWQO of 684 mg/L is conservative:
  - 5 replicate *Daphnia* tests including two different toxicity testing laboratories: 684 mg/L the lowest benchmark of those 5 tests; highest benchmarks unbounded, i.e., >1,400 mg/L [geomean >1,099 mg/L].
  - Copepod species tolerant of Snap Lake TDS: >1,508 mg/L.
- 684 mg/L not greatly different than default 500 mg/L (Alaska Department of Environmental Protection; Wek'èezhìi Land and Water Board).
- Unnecessary overprotection is not useful.

## GNWT SSWQO ISSUE 3

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### Use of anthropogenically altered toxicity modifying factors

- A policy not a scientific decision; no additional environmental protection
- Canadian Council of Ministers of the Environment (CCME) allows application of technically defensible exposure and toxicity modifying factors (ETMFs) based on “*ambient*” conditions
- Wek’èezhìi Land and Water Board Reasons for Decision (May 17, 2013):
  - *“AANDC’s argument ignores the scientific fact that increased water hardness, no matter its source, does reduce the toxicity of some substances. When asked about the validity of using anthropogenically modified hardness values for calculating SSWQO, Dr. Don Hart replied: “As far as I’m concerned – and I recognize that there are various opinions out there. But as far as I’m concerned the organisms don’t make a distinction as to where the hardness came from. So, yes, we’re going to get a benefit from hardness that’s released anthropogenically. It’s still a benefit. I see no reason to ignore it.”*

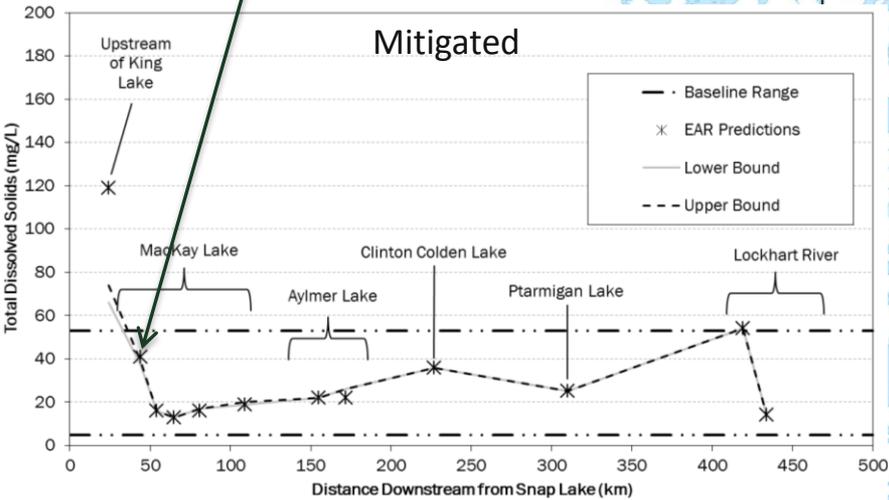
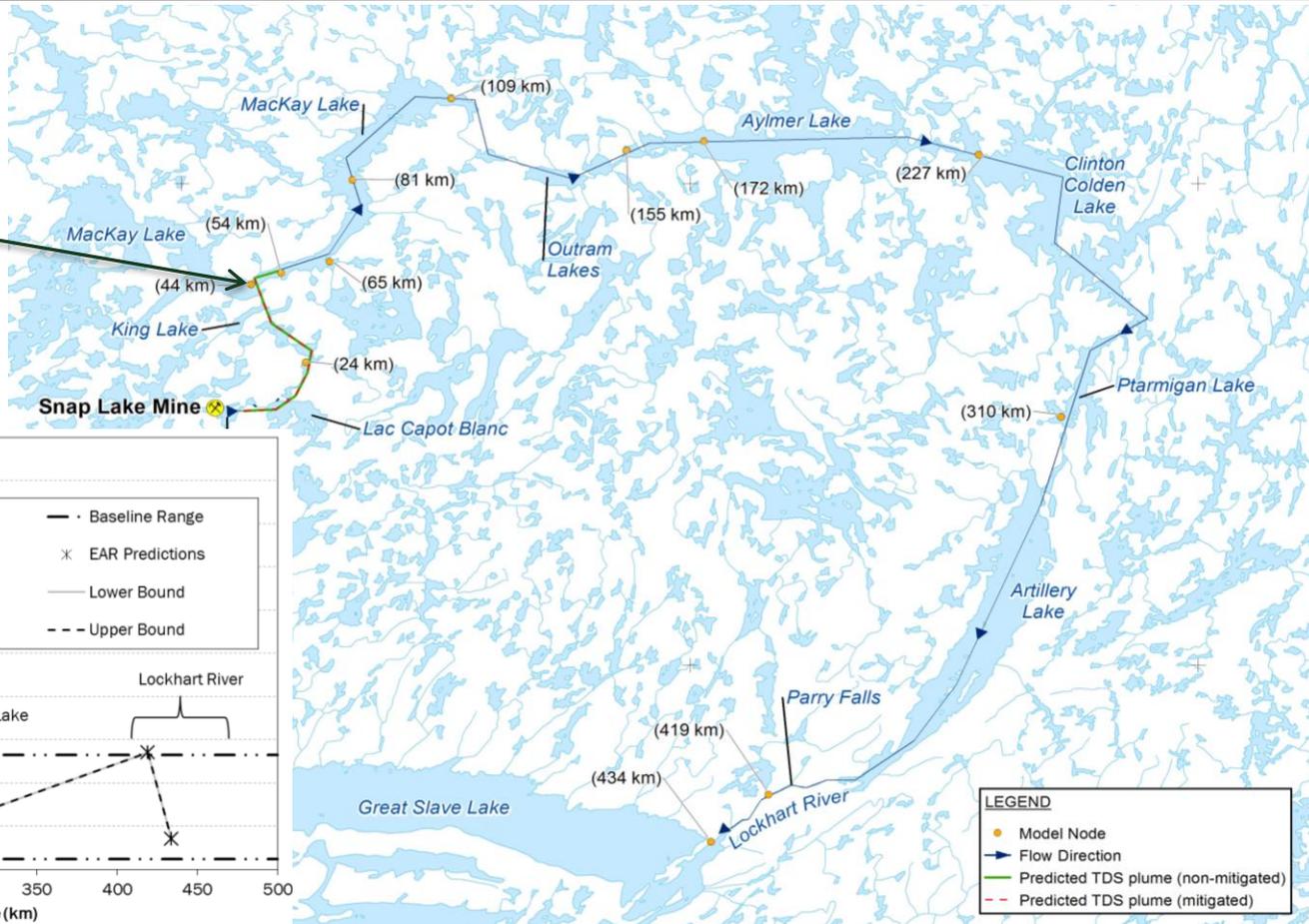
## SPATIAL EXTENT OF TDS DOWNSTREAM: MITIGATED SCENARIO

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- Spatial TDS changes not measurable > 65 km downstream as stated by GNWT in their presentation (analytical variability noted at Technical Session by Board Technical Staff; also natural variability).
- Nor as stated by GNWT in their presentation “*potentially up to 155 km downstream*”.
- Water in Lac Capot Blanc not predicted to exceed drinking water aesthetic objectives for TDS and chloride.
- See next slide which summarizes information provided in Supplemental Filing: “*Predicted TDS concentrations were generally within EAR predictions and the baseline range at Site 22 (MacKay Lake), which is approximately 44 km downstream of Snap Lake*”

# SPATIAL EXTENT OF TDS DOWNSTREAM (CONT'D)

Within EAR Predictions and Baseline at MacKay Lake



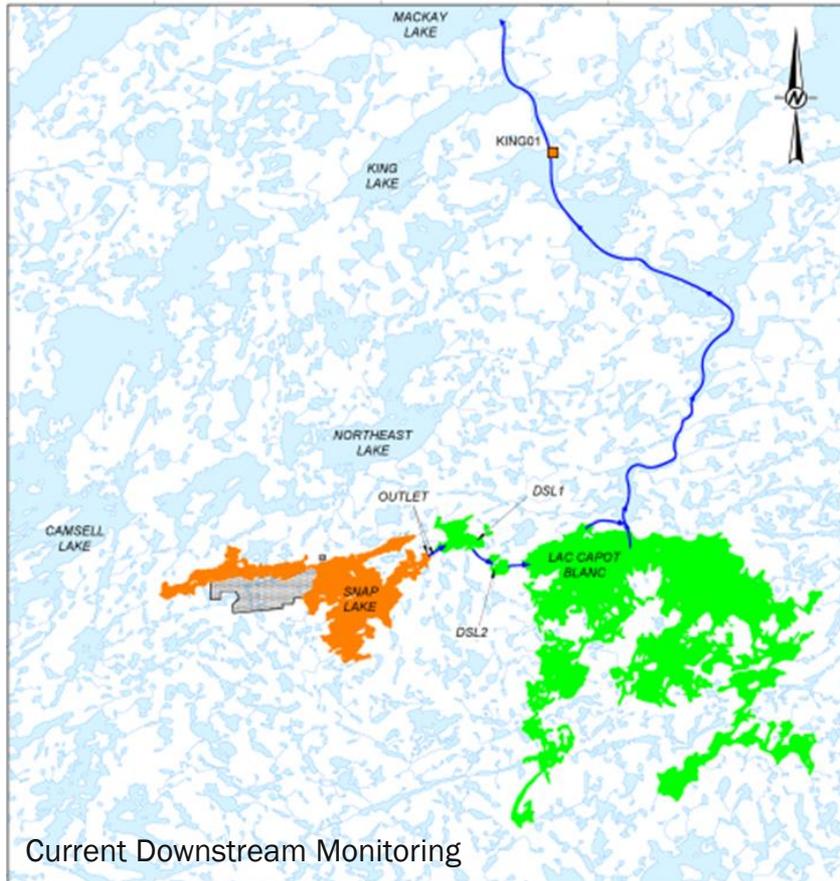
# PART 3: MONITORING and ENGAGEMENT

## Effects Monitoring

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- Aquatic Effects Monitoring Program (AEMP) under current licence; redesign approved in 2013. Includes:
  - Site characterization;
  - Water and sediment quality, plankton, benthic invertebrates, fish health, fish taste in Snap Lake;
  - Downstream lakes and other special studies;
  - Weight-of-evidence;
  - Action Levels per response framework; and,
  - Annual report (May 1).
- Surveillance Network Program (SNP):
  - Monthly compliance reporting; and,
  - Annual report (March 31).

## Effects Monitoring (cont'd)



- De Beers will undertake monitoring of water quality at the inlet to Mackay Lake to verify downstream predictions.
- The details and response framework should be incorporated into the AEMP.

## Effects Monitoring – Response to Recommendations

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*“That the Board work with the Land and Water Board to create a response framework where the ‘high’ action level is if the effluent plume reaches the outflow of Mackay Lake.”*

- De Beers is committed to working within the MVLWB process to review the AEMP Response Framework as may be required in the next AEMP redesign process.

## Engagement Update

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- Meetings in Deninu K'ue First Nation, North Slave Métis Alliance, Northwest Territory Métis Nation, Tlicho, and Yellowknives Dene First Nation communities regarding the proposed development – May 2014.
- Chiefs and other representatives of the Yellowknives Dene FN toured Snap Lake Mine Site with focus on water management – May 27, 2014.
- Presentation and discussion of effluent management specific to chloride with Snap Lake Working Group – May 28, 2014.
- Engagement update will be filed by June 23, 2014.
- All concerns raised related to the application have been addressed.

## Engagement – Response to Recommendations

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*“Require additional consultation and face-to-face meetings to occur with each Aboriginal party to further explain the quantity and quality of proposed mine effluent, how the environment will be protected, and what technology will be installed when.”*

- De Beers agrees with this approach and has recently undertaken additional consultation.
- Community visits to Snap lake mine are planned for July 2014.

*“..Require the project to resubmit the engagement record with only relevant engagements, indicating what concerns they gathered from these processes and how they sought to mitigate them..”*

- De Beers will endeavor to conduct more topic-specific engagement in the future, however notes that it has grouped topics during engagement in response to previous feedback from organizations regarding ‘consultation fatigue’.

## Summary

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- The Development Proposal, which is to change the quality of effluent to be discharged to Snap Lake from Snap Lake Mine, will not have significant adverse impacts on the environment.
- The proposed site-specific water quality objectives for TDS, chloride, fluoride, and nitrate are appropriate and protective.
- Snap Lake water will remain safe to drink and the fish safe to eat.
- Effects will be measurable downstream to Mackay Lake.
- The development will not result in adverse cumulative effects.