**Department of Fisheries and Oceans**
**Addendum Report March 14, 2003**

SUMMARY

The technical report submitted by the Department of Fisheries and Oceans (DFO) on February 14, 2003, identified outstanding issues and concerns with the Snap Lake Diamond Project. The outstanding issues and recommendations identified in the February 14th technical report are summarized below and where additional information has been considered, a discussion is provided in the addendum report.

FISH HABITAT ASSESSMENT AND DFO'S NO NET LOSS PRINCIPLE

A Technical Memorandum entitled *Fish Habitat of Inland Lakes* was submitted by DeBeers on February 11, 2003, but it was not possible to conduct a thorough review prior to the submission of DFO's February 14th technical report. The outstanding issue relates to the amount of habitat unit calculations for Stream 29.

ADEQUACY OF BASELINE AQUATIC DATA

Benthic invertebrate communities were not sampled in the deep waters of Snap Lake therefore confidence in the impact predictions to the whole aquatic community are low therefore collection of this data and monitoring are recommended.

IDENTIFICATION OF CRITICAL HABITAT AREAS

Potential fish spawning and rearing areas close to the mine near seepage and effluent sources have not been assessed for each fish species. DeBeers will provide a written rationale why this data was not collected. DFO will review and comment on the new information once it is provided and work towards resolving the issue with DeBeers.

EFFECTS OF MINE EFFLUENT DISCHARGE

The mine effluent will impact the aquatic community in Snap Lake by direct and indirect means. There are concerns with the whole effluent toxicity, chronic toxicity of increased metal concentrations, plume delineation and the percentages of the lake that will be affected. There may be greater impacts than predicted on fish and aquatic organisms due to the density and total dissolved solids in the effluent plume. Secondary effects from nutrient addition could also result in the loss of aquatic habitat and/or the loss of aquatic species due to decreased dissolved oxygen associated with increased BOD in deep areas of Snap Lake.

METALS FROM NON-POINT SOURCES: EFFECTS ON FISH HABITAT

The seepage collection system and mitigation measures proposed by DeBeers will alleviate the concern with seepage impacting Snap Lake. Monitoring of the collection system is recommended.

655

**Department of Fisheries and Oceans**
**Addendum Report March 14, 2003**

# FISH AND FISH HABITAT ISSUES AND THE SNAP LAKE DIAMOND PROJECT

## 1.0 INTRODUCTION

The following report is an addendum to the Department of Fisheries and Oceans Canada's (DFO) Technical Report as submitted to the Mackenzie Valley Environmental Impact Review Board (MVEIRB) on February 14, 2003.

In DFO's February 14, 2003 Technical Report, the following issues as listed were those considered to be unresolved from DFO's perspective:

- DESCRIPTION OF EXISTING FISH HABITAT ANDAQUATIC ORGANISMS
  - Fish Habitat Assessment and DFO's No Net Loss Principle
- ADEQUACY OF BASELINE AQUATIC DATA
  - Identification of Invertebrates at Depth
- IDENTIFICATION OF CRITICAL HABITAT AREAS
  - Spawning Habitat
- EFFECTS OF CONSTITUENTS IN EFFLUENT DISCHARGE
  - Metals in Discharge
- PLUME DELINEATION AND % OF LAKE AFFECTED
  - Elevated TDS in deep water zones
- EFFECTS OF TDS ON LAKE TROUT AND OTHER ORGANISMS
- BIOACCUMULATION OF METALS
- NUTRIENTS AND EFFECTS ON FISH HABITAT
- METALS FROM NON-POINT SOURCES: EFFECTS ON FISH HABITAT
  - Leaching of metals from Potential Acid Generating Rock

## 2.0 TECHNICAL COMMENTS

Technical memoranda have since been submitted to the MVEIRB by DeBeers Canada Mining Inc. (DeBeers) in an effort to resolve the outstanding technical issues. DFO offers the following comments to supplement its February 14, 2003 technical review of the proposed Snap Lake Diamond Project.

## 2.1 DESCRIPTION OF EXISTING FISH HABITAT AND AQUATIC ORGANISMS

Reference: ToR line # 222, 402, 410-412 EA Report Section 9.5, 9.5.1.2.6 Fish Habitat Mapping and 9.5.1.2.7 Stream Surveys Appendix IX.12 and *Fish Habitat Information and Loss Accounting for Waterbodies Situated on the Northwest Peninsula of Snap Lake.*

### 2.1.1 Fish Habitat Assessment and DFO's No Net Loss Principle

In order to adequately assess project-related impacts to aquatic systems, specifically fish and fish habitat, DFO must be assured that an adequate determination of the presence or absence of fish habitat has been undertaken. This determination is also necessary to assess if any aspect of the project is likely to cause a harmful alteration, disruption, or destruction (HADD) of the identified fish habitat, specific to DFO's requirements under the *Fisheries Act*. Based on the initial information provided by DeBeers, there was a lack of adequate assessment or at least a lack of demonstration to DFO that an adequate and defensible assessment of the impacted waterbodies had been undertaken.

**DeBeers' February 2003 Conclusion**

In its February 2003 report on **Fish Habitat Information and Loss Accounting for Waterbodies Situated on the Northwest Peninsula of Snap Lake**, DeBeers provides rationale for including or excluding waterbodies on the northwest peninsula in the fish habitat impact assessment and No Net Loss Accounting. The company concludes that of the 20 waterbodies identified within or near the project area, eight will not be affected by the proposed project. The remaining 12 (IL6, IL7, IL9, shallow ponds A, B and C, shallow pond stream B, S29, wetlands A, B, C, and D) waterbodies will likely be affected by the proposed project and were carried forward for further assessment. Of those 12, it was concluded that wetlands A and B, S29, and IL6 are considered to have potential for direct or indirect contributions to fish habitat. It is noted that no fish where captured or observed in IL6, even with significant fishing effort supports the assertion that fish do not directly use S29 or IL6.

For its indirect loss accounting for wetland A and B, and IL6, DeBeers states that there currently is no feasible way to quantify the indirect contributions from these lakes to the productive capacity of Snap Lake. The company concludes that a change in productive capacity and resulting effects on the aquatic community or fish population levels will be undetectable as these waterbodies represent 0.04% of the Snap Lake watershed.

For direct loss accounting, stream 29 was identified as providing direct fish habitat in the lower 30 m, at the outlet to Snap Lake. The total stream area associated with S29 is 600 $m^2$. The lower 30 m, with an average channel width of approximately 0.8 m was considered in the habitat calculation. It is concluded that S29 would not support spring spawning, rearing, or migration corridor habitat and is used as foraging habitat during the peak spring run-off period.

**DFO's Conclusion and Recommendation**

Upon review of the report, DFO is in general agreement with most of the conclusions as presented by the De Beers. There are two areas of the report that remain outstanding. The first concerns the calculation of habitat units (HUs) for S29. The area estimate and the evaluation of the habitat features seem reasonable but the introduction of a time-factor into the final calculation of HUs is unacceptable. Fish may only use the area for a few weeks

each year, however the conditions necessary for that piece of habitat to be present when fish choose to use it must be present all of the time. Photo 22 in the report clearly shows an area of enhanced vegetation growth that is dependent on the drainage from the pond above. Closing the hydrological connection will obviously lead to the loss those features. Hence, the calculation of HUs should only consist of the area (24 $m^2$) times the assessed suitability for arctic grayling (0.25) resulting in 6 HUs with no time factor. As such, compensation will be required for 6 HUs at a ratio of 2:1, gains to losses, rather than the 0.02$m^2$ as concluded by DeBeers. DFO will address this issue directly with DeBeers as the decision on the adequacy of habitat compensation rests with this Department.

The second issue relates to where DeBeers' February 2003 report states that no fish were captured or observed in IL3 yet the environmental assessment (EA) report (p. 9-284) notes that fish were observed in IL3. DeBeers has stated that it will provide written clarification including more detail on what is planned for the airstrip.

The NNL accounting by definition must include losses and gains to result in no net loss of fish habitat. Thus far, only losses are identified therefore additional information is required to complete the NNL accounting.

## 2.2 ADEQUACY OF BASELINE AQUATIC DATA

Reference: ToR line # 222 EA Report Section 9.5.1.2.3, pg. 9-261 & *Potential Effects of Increased Total Dissolved Solids on aquatic Communities in Snap Lake.*

### 2.2.1 Identification of Invertebrates at Depth

The adequacy of the benthic invertebrate sampling program was identified as being questionable based on Responses by DeBeers to many information requests and information presented at the public technical sessions.

**DeBeers' Conclusion**

DeBeers has maintained that they have undertaken a thorough baseline benthos sampling program and have not provided any additional rationale or information in this recent round of technical submissions.

**DFO's Position and Rationale**

DeBeers' baseline sampling program did not sample the benthic community in areas of Snap Lake deeper than 8 metres. The lack of these data compromises the assurance that an adequate baseline study has been undertaken and that prediction of impacts to the whole aquatic community are valid.

The benthic invertebrate baseline data are further discussed in the report: *Potential Effects of Increased Total Dissolved Solids on aquatic Communities in Snap Lake*, on page 15. However, no new information has been presented regarding invertebrate communities or

biomass at depth in Snap Lake. The Memorandum states that there were no effects on a benthic invertebrate community of a lake in Northern Saskatchewan receiving effluent with elevated TDS, but then reports that species richness declined with fewer oligochaetes, Hirudinea, and amphipods (page 16). Comparisons and data are also presented to show that Chironomids inhabit freshwater with high TDS. However the study cited and genera listed in Table 4.9 are from the San Joaquin River in California. The species in Snap Lake are most likely very different and comparisons are questionable.

The concern with the lack of information is more pronounced due to possible effects on the aquatic community in the deep or profundal zones of the Snap Lake. Dissolved oxygen levels are predicted to decrease at depth and total dissolved solids (TDS) are predicted to increase at depth: both being project-related effects which could negatively impact the benthic invertebrate community.

**DFO's Conclusion and Recommendation**

DFO has reviewed a number of technical memorandums that have been submitted by DeBeers during February 2003. The prediction of effects to the benthic invertebrate community is based on comparisons in non-arctic environments. Any change in species composition will likely have a negative impact on higher trophic levels that depend on these organisms as food supply. A reduction of the benthic community could impact fish populations and disrupt the ecological balance within Snap Lake. As such, the level of confidence in the prediction is low. In order for the company to be in a position to verify its predictions, it must have adequate baseline data to which monitoring results can be compared to facilitate appropriate adaptive management approaches.

## 2.3 IDENTIFICATION OF HABITAT AREAS

Reference: ToR line # 403 EA Report Section 9.5.2.3 pg. 9-338.

### 2.3.1 Spawning Habitat

Baseline studies had suggested that spawning habitat for lake trout was limited within Snap Lake. The preferred lake trout spawning habitat in Snap Lake was determined to be boulder-bedrock shoals near deep water. The most active spawning ground was located near the centre of Snap Lake. Although the deepest water is found at the extreme west end of the North Arm or Channel of Snap Lake no spawning areas for lake trout were identified in the North Arm. There are potential spawning areas located on shoals within the area of influence of the mine effluent, hence spawning fish, their eggs and fry could be negatively affected by discharges to Snap Lake.

**DeBeers' Conclusion**

DeBeers has identified all spawning habitat areas for lake trout within Snap Lake and concluded that none will be impacted by the mine. No new information has been provided to date.

**DFO's Position and Rationale**

The areas of Snap Lake in the vicinity of the minewater discharge and wasterock pile seepage have not been adequately surveyed for their potential to support spawning of lake trout or other fish species. The EAR states that spawning areas are outside of any areas impacted by effluent discharges, but the only spawning areas identified in the report were located in the main area of Snap Lake to the Southeast of the proposed mine. There are potential spawning areas located on shoals much closer to the mine within the area of influence of the mine effluent, hence eggs and larval fish in these area may experience acute and chronic toxicity resulting from project-related water quality changes.

Spawning surveys were only undertaken to document lake trout spawning sites. Potential effects to spawning areas of other fish in Snap Lake, such as round whitefish and burbot are also possible and were not assessed. Other habitat types i.e. rearing or feeding areas, etc. were also not identified or assessed for any fish species.

**DFO's Conclusion and Recommendation**

DFO's position has not changed since its February 14, 2003 Technical Report whereby the presence and use of spawning, rearing and feeding habitats by all fish species within the vicinity of the proposed diffuser needed to be determined and rationale/analysis provided to support the conclusions that there are no potential for impacts to any life stage of fish, or their habitat in the vicinity of the mine effluent.

DeBeers has stated in a conference call that it will provide a rationale why this particular data are not available. DFO will review the information and provide comments to DeBeers once it is received.

## 2.4 EFFECTS OF CONSTITUENTS OF EFFLUENT DISCHARGE

Reference: ToR line # 336-368, 395-397, 406-408 EA Report Section 9.4, 9.5 & *Snap Lake Diamond Project Mine Water Assessment and Variability (Table 6), Summary of Water Treatment Process Development, Selection and Comparison of Alternatives.*

### 2.4.1 Metals in discharge

The effluent from the water treatment plant will have effects on the aquatic community of Snap Lake. Effects will occur as a result of chronic toxicity in an area extending 230 m from the discharge location.

**DeBeers' Conclusion**

The impacts of the effluent are mitigated by the use of a multi-port diffuser, lake mixing and other limnological processes such as stratification. The EAR uses a zone of dilution and site specific benchmarks to rate the impact magnitude as negligible for environmental assessment purposes

**DFO's Position and Rationale**

Ammonia, chloride, cadmium, copper, mercury, molybdenum, nickel, lead, and selenium and whole effluent chronic toxicity are cited in the EAR as the parameters that will exceed water quality guidelines at end-of-pipe (p9-222,223, Table 9.4-18). A diffuser is proposed at the water outlet to aid in dispersion and to provide initial mixing of the effluent with water from Snap Lake. The intent of the diffuser is to reduce the toxicity of the mine effluent beyond end-of-pipe via dilution. Although the effluent is diluted within an initial mixing zone in Snap Lake, concentrations of hexavalent chromium, cadmium, copper and ammonia will exceed water quality guidelines in an area equivalent to 1% of Snap Lake (230m around the point of discharge). Chromium was not cited in the Table 9.4-18 as described above, but was carried forward as hexavalent chromium.

In Table 6 of DeBeers' report entitled *Snap Lake Diamond Project Mine Water Assessment and Variability*, revised metal levels in the discharge are essentially the same as those that were presented in the EAR. However, Table 12 of this report indicates that chromium concentrations in the treated mine water discharge are now predicted to be double the concentrations assessed in the EAR: 0.0020 mg/L vs. the current value of 0.0046 mg/L. There does not appear to be any revisions or discussion of the Snap Lake impact assessment due to a doubling in the input of Chromium.

Many of the impact predictions of toxicity presented by DeBeers are toxicological studies that were based on mine effluent or mine water obtained during the Advanced Exploration Stage. The effluent may not account for or test different formulations as predicted to occur with the paste backfill. In addition, many of the interpretations and toxicological tests have been undertaken on an individual parameter basis. The many different contaminants could affect toxicity interpretations due to synergistic effects.

In DeBeers' Memorandum entitled *Summary of Water Treatment Process Development, Selection and Comparison of Alternatives*, various treatment plant configurations are considered to meet DeBeers' own water quality guidelines. Although the report compares various configurations of flocculent and chemical additions, statements such as "appeared to represent the most practical option", "did not appear to provide a clear demonstrated benefit", and "appeared to produce some reductions" are not quantified and unsubstantiated. TSS removal to 5mg/L reportedly achieves all of DeBeers' own guideline concentrations for all parameters except copper, however, without the actual test results, reviewers cannot assess whether best available technology is being applied and whether the treatment plant configuration being proposed by DeBeers' is environmentally acceptable.

In its EAR, DeBeers cites studies that have apparently indicated that an affect to 20% of an aquatic ecosystem is a threshold, below which the integrity of an aquatic ecosystem will be preserved. "Affect" here is not defined, however, DeBeers goes on to equate this finding with the assumption that a 20% reduction in abundance of the aquatic community should not impair overall function. This is based on the assumption that there is niche overlap among species and that one species lost will be replaced by another of similar function. This notion does no account for keystone species, the reduction or elimination of which may have

serious consequences for an aquatic system. Impacts to an aquatic community tend to first start with the most sensitive species, and all species of a particular sensitivity may also be those that have a similar function in the ecosystem: loss of these species may not, therefore, be replaced by others with similar function. If for example, a sensitive species of zooplankton or benthic invertebrate, which also happen to be preferred food for whitefish or lake trout, is impacted by elevated harmful constituents in the discharge, the species may not necessarily be replaced by a species of the same preference or food value. If the replacement species is eventually preyed upon, the shift would not come without energetic costs to the fish that prey upon them.

**DFO's Conclusion and Recommendation**

DeBeers has provided information on treatment options they considered, however without the data to substantiate its claims, these options can not be fully assessed by reviewers. DeBeers may have underestimated the affects of metals discharge to Snap Lake as they use an affect to 20% of the entire aquatic ecosystem as an acceptable threshold. Finally, changing the scale of impact assessment due to effluent discharge to the whole lake to achieve a rating of negligible is questionable.

DeBeers appears to have conducted the EAR based on concentration of 0.002 mg/L Cr. Chromium is now predicted to be double but DeBeers has failed to revise its impact predictions. Revised impact predictions should be provided based on current Chromium concentrations.

## 2.5 PLUME DELINEATION

Reference: ToR line # 358-362, 406-408 EA Report Section 9.4.2.2.3, *Potential Effects of Increased Total Dissolved Solids on Aquatic Communities in Snap Lake.*

### 2.5.1 Elevated TDS in deep water zones

DFO is concerned with the potential for increased impacts to fish habitat and aquatic organisms especially during the winter under ice. After initial mixing as it leaves the diffuser, the effluent is expected to settle in the deeper water of Snap Lake due to its density (greater than the lake water due to high TDS concentrations) and lack of lake currents in the winter. Temperature differences could also result in a concentrated stratified layer of effluent in the water column. Effects are also likely to occur over a larger area due to increased total dissolved solids (TDS) and impacts are likely to extend to the whole lake as a result of nutrient addition.

**DeBeers' Conclusion**

The impacts of the mine effluent on fish habitat and aquatic organisms in Snap Lake are projected to be mitigated by rapid mixing of the effluent in the water column facilitated by a multi-port diffuser and by natural lake mixing processes as well as other limnological

processes such as stratification. The effluent will settle in the deep areas of the lake where it will have little impact on fish habitat or aquatic organisms.

**DFO's Position and Rationale**

The effectiveness of the multi-port diffuser, mixing and limnological processes were questioned and discussed in IR 2.1.6, 2.1.8 and during the public technical sessions.

Modeling predictions are based on a whole lake basis to incorporate mixing within the entire lake. However, the effluent plume will not interact or mix with waters within the North Arm of Snap Lake or small bays in the periphery during the winter, as it will settle at depth once it leave the diffuser, thereby reducing the water volume available for mixing and affecting the calculation of effluent concentration in Snap Lake. Concentrations of TDS and other parameters of concern may, therefore, be greater than predicted since the model incorporates the entire lake. These conditions will likely persist for the duration of the ice covered period (approximately 8 months of the year).

The denser effluent that settles in the deep areas of the lake will likely have negative effects on the aquatic community. Lake trout and other bottom dwelling fish may suffer greater impacts than predicted since higher concentrations may occur than presented in the EAR.

**DFO's Conclusion and Recommendation**

DFO's conclusion has not changed from its original technical report whereby modeling of the density plume should be revised to account for a reduced lake volume for mixing under ice conditions.

## 2.6 EFFECTS OF TDS ON LAKE TROUT, OTHER FISH SPECIES AND AQUATIC INVERTEBRATES

Reference: ToR line # 395-397, 406-408 EA Report Section 9.5.2.4, *Potential Effects of Increased Total Dissolved Solids on Aquatic Communities in Snap Lake, Potential Overall Effects of the Changes in Water and Sediment on the Aquatic Communities of Snap Lake.*

TDS concentrations are predicted to be considerably higher than the baseline concentrations in Snap Lake: the primary toxicological concern of TDS being an increase in osmotic stress on aquatic biota.

**DeBeers' Conclusion**

The EAR predicted that concentrations of TDS that would occur in Snap Lake were below harmful effect levels for fish. There are no TDS water quality criteria, but the EAR cites concentrations of 3000 mg/l TDS as a threshold level before freshwater biota begin to disappear.

**DFO's Position and Rationale**

The EAR made comparisons to coolwater fishes such as sticklebacks and members of the Percidae and Catostomidae families and reported that members of the Salmonidae are able to withstand high levels of salinity or TDS. Comparisons and projections of the effects of TDS on biota were also based on data obtained from saline lakes.

The comparisons made may not be valid. Snap Lake is much different from the referenced lakes in that it is an oligotrophic lake having an average TDS level of only 15 mg/L. The aquatic biota and especially lake trout that occur in this headwater lake have adapted to these low salinity conditions for many thousands of years. A large proportion of this local population or stock of fish could suffer increased mortality since it is adapted to low salinity conditions.

Of all the salmonids, lake trout exhibit the most sensitivity to ion concentrations in the water. The preferred requirement of < 50 mg/l TDS (Kerr and Lasenby, 2001) will be greatly exceeded causing stress and increasing the likelihood of mortality. Within Snap Lake, effluent discharge is predicted to result in increases in TDS levels from the average baseline of 15mg/l to 330 mg/l in 10 to 20% of the lake and 444 mg/l in 1 % of Snap Lake (p 9-306, 9-357).

Since the effluent will have an elevated concentration of TDS and will therefore, be more dense than the lake water, it will settle into deeper areas, potentially impacting lake trout. Since mixing of the lake will not occur instantaneously at "ice out" especially at the depths where TDS will be increased, the preferred fish habitat of lake trout, and other benthic dwelling fish such as whitefish and burbot will suffer greater impacts than predicted in the EAR. Benthic invertebrates will also be particularly susceptible since they complete their life cycle requirements in the substrate during this time. They will not be able to avoid the high TDS areas and hence may suffer mortality. The memorandum *Potential Effects of Increased Total Dissolved Solids on Aquatic Communities in Snap Lake* states that there were no effects on a benthic invertebrate community of a lake in Northern Saskatchewan receiving effluent with elevated TDS, but then reports that species richness declined with fewer oligochaetes, Hirudinea, and amphipods (page 16). Comparisons and data are also presented to show that Chironomids inhabit freshwater with high TDS. However the study cited and genera listed in Table 4.9 are from the San Joaquin River in California. The species in Snap Lake are most likely very different and comparisons are questionable.

Data presented in DeBeers' technical memorandum entitled *Potential Effects of Increased Total Dissolved Solids on Aquatic Communities in Snap Lake* indicates that lake trout inhabit lakes that exceed the 350 mg/L concentration predicted for Snap Lake. The prediction that lake trout will adapt to the increase in dissolved solids over the lifetime of the mine will be difficult to verify.

**DFO's Conclusion and recommendation**

Although it appears that lake trout could tolerate increased levels of TDS, the prediction of effects to the benthic invertebrate community as discussed earlier in this report is based on comparisons in non-arctic environments. As such, the company should be required monitor TDS so that adaptive management approaches can be implemented to prevent negative impacts to the aquatic community.

## 2.7 BIOACCUMULATION OF METALS

Reference: ToR line # 406-408 EA Report Section 9.5.2.3, *Cemented Paste PK Kinetic Test Results.*

Selenium and cadmium are metals that have the potential to bioaccumulate in biological tissues.

**De Beers' Conclusion**

No metals will bioaccumulate in biota.

**DFO's Position and Rationale**

Selenium levels predicted in the mine water discharge were reported to be in excess of water quality guidelines (Table 9.4-18), but the results were dismissed due to analytical interference. Follow-up analysis resulted in selenium values below the detection limit and selenium was, therefore, not carried forward for assessment. Cadmium was however predicted to be discharged at levels above water quality guidelines.

Cadmium was identified as a metal that will be discharged in the effluent at levels that will cause chronic effects to the aquatic community in a portion of the water in Snap Lake. Cadmium has an affinity for particulate matter and readily settles and hence will accumulate in the sediments potentially affecting the benthic organisms living in that environment. Cadmium may accumulate in these organisms and then increase in higher trophic levels, such as fish, as the benthos is consumed, thereby having food chain effects. Increasing cadmium levels in fish may have implications to human health if the fish are consumed.

The concern that human health could be compromised was addressed in IR 4. As a result of information requests and information presented at technical sessions the concern that cadmium would bioaccumulate and cause human health effects is alleviated.

DFO, through IR 2.1.2 asked for more detailed information on the trophic feeding relationships of aquatic organisms in reference to a biomagnification or bioaccumulation perspective. DeBeers' response indicated that these relationships were noted in section 9.5.2.4.3 of the EAR. However, feeding relationships are not presented in this section of the report. The biomagnification issue is partially addressed in this section by the measurement and use of bioconcentration factors (BCFs) which represent the concentration of the substance in the tissue (ug/kg) relative to the concentration of the substance in water (ug/l).

A response to IR 3.8.8 was also reviewed and the response stated: "overall, the impact prediction is low as reliable data linking fish tissue to exposure concentrations is scarce." Since the confidence is low, monitoring should occur to verify the impact prediction.

**DFO's Conclusion and Recommendation**

Potential impacts of metal bioaccumulation on fish and benthic invertebrates need to be monitored to verify DeBeers' impact prediction.

## 2.8 NUTRIENTS AND EFFECTS ON FISH HABITAT

Reference: ToR line # 370-371, 406-408 EA Report Section 9.4.2.2.4, *Potential Effects of Phosphorus Enrichment on the Productivity of Snap Lake, Potential Overall Effects of the Changes in Water and Sediment on the Aquatic Communities of Snap Lake* and *Dissolved Oxygen Baseline for Snap Lake – 2003 Program.*

The supply of both phosphorus and nitrogen to Snap Lake, will increase as a result of mining activities. Phosphorus will originate from groundwater pumped from underground, mine workings and from treated sewage effluent. Nitrogen will increase primarily as ammonia which is a result of blasting residue. The increase in nutrients will increase the productivity of lower trophic levels in Snap Lake, and cause changes in biomass and species diversity in the aquatic community.

**DeBeers' Conclusion**

Snap Lake is an oligo-mesotrophic lake. Elevated phosphorus or nutrient levels in Snap Lake during mine construction and operations are expected to have a low or negligible impact on resident aquatic communities. A major shift in community structure is unlikely to occur. An increase in the deposition of organic matter may reduce winter dissolved oxygen (DO) in a small portion of available fish and benthic invertebrate habitat (less that 10 % of surface area).

**DFO's Position and Rationale**

The mine effluent will have greater amounts of bioavailable phosphorus (IR 4.1.8) than current natural inputs into Snap Lake. Linkages and interactions among trophic levels in response to nutrients have been poorly defined in the EAR, however the aquatic community in Snap Lake will likely change in response to increased levels of bioavailable phosphorus.

These concerns were presented by Information Request and were discussed during the technical sessions. The response to IR 4.1.8 indicated that phytoplankton biomass would increase in the water column and therefore that phosphorus levels would also increase in the sediments as phytoplankton die-off and settle to the lake sediments.

There could also be effects to zooplankton communities. Biomass of zooplankton could also change in response to changes in the phytoplankton community. However, the trophic level response of the zooplankton was not discussed, nor was possible effects to the invertebrate or fish community included in the EAR.

Increases in phytoplankton biomass reporting to the sediments due to die-off and settling, and the decomposition of these organisms can create a biological oxygen demand and cause decreases in dissolved oxygen levels at depth. Projections in the EAR have indicated that certain areas of Snap Lake will be inhabitable to fish due to low oxygen. The addition of more nutrients will result in greater areas inhabitable to fish which could have greater impacts than predicted.

**DFO'S Conclusion and Recommendation**

DFO has considered the technical memoranda submitted by DeBeers and agrees that the modeling projections indicate that a major shift in community structure is unlikely to occur.

However, DeBeers states that species richness of benthic invertebrates could decrease in areas of low DO. Community composition and biomass of each trophic level will need to be monitored to verify the predictions. DeBeers will need to continue to characterize the natural variability of DO in order to effectively monitor to verify predictions to facilitate appropriate adaptive management approaches.

## 2.9 METALS FROM NON-POINT SOURCES: EFFECTS ON FISH HABITAT

Reference: ToR line # 319-320,337-341,391,392, 543-545 EA Report Section 3.5.1 and *Snap Lake North Pile Seepage Collection*

### 2.9.1 Leaching of metals from potential acid generating rock (PAG)

Metals can leach from acid generating rock in waste rock storages and runoff or seep into groundwater or surface water systems. Section 3.5.1 of the EAR states that PAG rock will be mined during the pre-development stage and is to be stockpiled. Concern was expressed that this rock had the potential to cause increased mobilization of metals that would runoff and contaminate the surrounding aquatic ecosystem.

**DeBeers' Conclusion**

De Beers originally proposed to use a collection ditch and pond system to intercept approximately 90% of the seepage and runoff.

**DFO's Position and Rationale**

Discussions presented during the technical sessions indicated that some water will leak from the rock pile. Although 90% will be captured by diversion ditches, some of the water is predicted to flow to Snap Lake. There are potential impacts on near-shore fish habitat which have not been assessed or quantified by DeBeers.

**DFO's Conclusion and Recommendations**

The memorandum submitted by DeBeers addresses DFO's concerns. The seepage collection system will have to be monitored to ensure the proposed mitigation measures identified in the memorandum are performing as identified.