Rec'd via e-mail ~~Feb 17/03~~ Feb 17/03

From:	Dahl,Mark [Yel] [Mark.Dahl@EC.GC.CA]
Sent:	Monday, February 17, 2003 10:56 AM
To:	'Glenda Fratton'; EA-SnapLake
Cc:	dbevington@auroranet.nt.ca; colleen.english@ca.debeersgroup.com; John.McConnell@ca.debeersgroup.com; judy.langford@ca.debeersgroup.com; kevin.ledrew@ca.debeersgroup.com; robin.johnstone@ca.debeersgroup.com; letha@canada.com; BalintD@DFO-MPO.GC.CA; DahlJ@DFO-MPO.GC.CA; LangeM@DFO-MPO.GC.CA; Wilson,Anne [Yel]; Dahl,Mark [Yel]; Fournier,Mike [Yel]; Harbicht,Stephen [Yel]; swilbur@entrix.com; byerses@escape.ca; ima.nwtmn@gardtal.com; Eric Denholm; Steve Morison; Dawn_Kelly@golder.com; hmachtans@golder.com; lgreen@golder.com; Gavin_More@gov.nt.ca; Jason_McNeill@gov.nt.ca; steven_matthews@gov.nt.ca; tpearse@gulfislands.com; Jagtar_Sandhu@hc-sc.gc.ca; Surinder_Grewal@hc-sc.gc.ca; Adelinca@hotmail.com; Keith_Jen@hotmail.com; watershedwriting@hotmail.com; benderm@inac.gc.ca; FairmanF@inac.gc.ca; HamiltonT@inac.gc.ca; tapsellm@inac.gc.ca; williamsb@inac.gc.ca; ellis@internorth.com; nlawson@jacqueswhitford.com; ARLaboucan@lutselke.com; Ritac@lutselke.com; wildlife@lutselke.com; wwfnwt@mailmarinenet.net; Alan Ehrlich; Bridgette Larocque; EA-SnapLake; Roland Semjanovs; Vern Christensen, Executive Director; kristyn@mvlwb.com; mvlwbpermit@mvlwb.com; jramsey@NRCan.gc.ca; bobz@nsma.net; garth@nt.sympatico.ca; jhutchison@nucleus.com; Chuck.Blyth@pc.gc.ca; SBriscoe@polarnet.ca; jfreeman@rfi.on.ca; SLDF@SierraLegal.org; ATgovt@ssimicro.com; denenationcp@ssimicro.com; econorth@ssimicro.com; mvaydik@ssimicro.com; Ravencom@ssimicro.com; SOLOWAD@tc.gc.ca; donihee@telusplanet.net; galson@telusplanet.net; carc@theedge.ca; cpawsnwt@theedge.ca; geonorth@theedge.ca; donihee@ucalgary.ca; laura@whatidene.org; Pewins@wwfcanada.org; tiacobelli@wwfcanada.org; execdir@ykchamber.com; rachelc@ykdene.com
Subject:	Environment Canada's Snap Lake Technical Report

plain language Summary of Outs... Snap EC Technical Report Final...

Please find Environment Canada's Technical Report for the Snap Lake review attached.

Mark Dahl
(867)669-4734 | facsimile/télécopieur (867) 873-8185
mark.dahl@ec.gc.ca
Contaminants Biologist | Biologiste, Contaminants
Environmental Protection Branch |Service de la protection de l'environnement
Prairie and Northern Region | Région des Prairie et du Nord
Environment Canada | 301-5204 50th Ave, Yellowknife, NT, X1A 1E2
Environnement Canada | 301-5204 50e Ave, Yellowknife, T.N.-O, X1A 1E2
Government of Canada | Gouvernement du Canada

<<plain language Summary of Outstanding EC Issues final.doc>> <<Snap EC Technical Report Final.doc>>

647

Summary of Outstanding Environment Canada Issues

As a Responsible Minister Environment Canada (EC) has reviewed the Snap Lake Environmental Assessment Report prepared by De Beers Canada and the documents supporting it. The mandate of Environment Canada includes responsibilities for the enforcement of the *Canadian Environmental Protection Act* (CEPA), Section 36(3) of the *Fisheries Act*, the *Canadian Wildlife Act*, and the *Migratory Birds Convention Act*. The EC review of this project has focused on topics related to water and air quality, ground water, geochemistry, climate, and hydrology. EC and De Beers have resolved many of the concerns raised by Environment Canada but the issues listed below remained unresolved at the time of submission. It should be noted that the proponent has indicated that all efforts will be made to address Environment Canada's outstanding concerns before the Public Hearings.

Issue #4 Water Quality - Phosphorus Modeling
EC identified concerns (rather than concerns you could say "uncertainty")with water quality modeling results that predicted a decrease in total phosphorus levels, when loadings were increasing as a result of project inputs.
EC was also noted that only one form of phosphorus was included in eutrophication modeling, and that this may have lead to an underestimation of available phosphorus; De Beers was asked to re-run the phosphorus model to include other forms of phosphorus.
Reference TOR line # EAR section # 9.4.2.2.4
Why is this an issue? Phosphorus is generally the limiting nutrient in lakes so any addition of phosphorus to a lake can result in changes in the productivity. However it should be noted that only some forms of phosphorus are readily available for use. De Beers used a model to predict the impact of the addition of phosphorus to Snap Lake but they only modeled the impact of the readily available portion of the phosphorus in their discharge. Environment Canada is concerned that by excluding the less available forms De Beers is underestimating the impact of their discharge on lake productivity.

Issue #5 Water Quality - Ground water impacts on Snap Lake
EC is concerned that the De Beers may have underestimated the impact of introducing ground water from underground mine workings to Snap Lake.
Reference TOR lines 344-355, 381, EAR section 9.4, Appendix IX.
Why is this an issue? Ground water forms a large part of the mine discharge water but it's constituents are not well understood. In order to understand how the mine discharge is going to affect Snap Lake it is necessary that both upwelling ground water and infiltrating lake water be well characterized. Are we comfortable with the understanding of the ratio between infiltrated water and deep up welling ground water.

Issue #6 Water Quality - Total Dissolved Solids
De Beers estimates that mine discharges will increase the Total Dissolved Solids (TDS) concentrations in Snap Lake to ten times their present levels. EC seeks further information on the prediction that higher TDS levels would have little or no effect on biota.
Reference TOR line # TOR lines 344-355, 381, EAR section 9.4, Appendix IX.1

Why is this an issue? De Beers estimates that TDS concentrations in Snap Lake will likely increase by ten times as a result of project inputs. However, very little information was provided to support the position that increased TDS levels would not have impacts on aquatic ecosystems. EC recommends that the proponent verify ground water quality estimates and, if their findings are very different from previous estimates, remodel TDS impacts on Snap Lake

Issue #7 Air Quality Monitoring - $PM_{2.5}$ and PM_{10}

Air Quality Monitoring is necessary to demonstrate that Ambient Air Quality Standards for $PM_{2.5}$ and PM_{10} are being met.

Reference TOR lines 281-288, EAR section 2.6.1 Air Quality and Climate

Why is this an issue?:

The NWT has ratified the Canada-Wide Standards for Particulate Matter and Ozone (CWS). As part of the CWS many jurisdictions recognize that polluting "up to a limit" is not acceptable and that the best strategy to avoid future problems is to keep clean areas clean. EC concludes that De Beers needs to demonstrate, through monitoring, that the air quality impacts from the Snap Lake mine development comply with the NWT Ambient Air Quality Standards and Canada-Wide standards. In addition, ambient monitoring is essential to ensure that efforts are working to Keep Clean Areas Clean .

Environment Canada

Technical Report

De Beers Canada Snap Lake Project

February 14, 2003

INTRODUCTION

Environment Canada (EC) has reviewed the Snap Lake Environmental Assessment Report prepared by De Beers Canada and the documents supporting it. During this review Environment Canada has, and is, providing expert advice as a Responsible Minister acting in the role of a Directly Affected Party as defined by the Mackenzie Valley Environmental Impact Review Board.

The mandate of Environment Canada includes responsibilities for the enforcement of the *Canadian Environmental Protection Act* (CEPA), Section 36(3) of the *Fisheries Act*, the *Canadian Wildlife Act*, and the *Migratory Birds Convention Act*. The EC review focused on topics related to water and air quality, ground water, geochemistry, climate, and hydrology.

Throughout the course of the environmental assessment of the Snap Lake Project, a variety of issues/concerns have been raised by EC. In some cases these issues have been resolved to Environment Canada's satisfaction while other issues remain unresolved. In this report the issues are grouped as *resolved* and *outstanding* based on the information available at the time of writing. The position presented in this report is EC's position based on the information to date. It should be noted, that efforts will continue to be made to resolve issues in the period between submission of technical reports and the Public Hearings. New information will be incorporated into EC's submission to the pre conference hearing.

In the interest of brevity issues that were minor in nature are not listed here. The specifics of each issue are as follows:

RESOLVED ISSUES

Issue #1 Water management - Storage capacity

Water management facilities may be inadequate to deal with unexpectedly large mine water volumes combined with large runoff events or water treatment plant failures.

Reference: TOR Section 2.6.4, lines 344-355

Background

The quantity of mine water inflow was predicted using the MINEDW computer model, however the accuracy of the computed quantities of mine water flow are limited by a lack of field data to estimate input parameters and to calibrate the model. The weak calibration may result in an underestimate of mine water inflows and greater stress on the water management system. Examination of the hydrologic and precipitation data presented in the EA suggests that maximum runoff may also be underestimated. Environment Canada was concerned that the combination of high surface runoff, possibly exceeding 35000 m^3/d, combined with unexpectedly high mine water flows could overwhelm the water management system.

Developer's conclusions

Water management system capacity is not an issue because sufficient storage and treatment capacity will be available at all times. It should also be noted that increases in mine water inflow are expected to occur gradually as mining progresses, this will allow additional treatment capacity to be added as necessary. To ensure that sufficient water treatment capacity will be available to process the combined volume of natural runoff and mine water De Beers will maintain a 35000 m^3/d buffer of excess treatment capacity throughout the mine life. As well, De Beers has indicated that the Water Management Pond will be maintained in an empty, or near empty, state to provide the maximum possible capacity for containing the water from large runoff events or mine water generated during treatment plant failures. In addition De Beers reiterated that, should all available storage capacity be filled, they will flood the mine rather than allow the water management system to be overwhelmed resulting in an untreated discharge of water to Snap Lake.

Environment Canada's conclusions

The mitigation measures that De Beers has committed to should prevent the water management system from being overwhelmed and prevent untreated mine water from entering Snap Lake.

Rationale/Evidence

The proponent has committed to maintaining 35 000 m^3/d of excess treatment plant capacity and they have further committed to maximising the storage capacity available in the Water Management Pond and to flooding the mine in order to prevent untreated mine water from being released into Snap Lake.

Environment Canada's position: This issue has been resolved to the satisfaction of Environment Canada's reviewers.

Issue #2 Ground Water - Impacts on North and Northeast Lakes

The possible contamination of the North and Northeast Lakes by ground water that has been in contact with the mine workings.

Reference: TOR lines 374-376, De Beers Oct 2002 North Lakes Technical Memorandum

Background

The long-term discharge of contaminated ground water from the mine workings to the North and Northeast Lakes represents a potential uncontrolled release of contaminated water from the site. The supplemental studies completed by De Beers in 2002 and reported in a technical memorandum released in October 2002 provide further insight regarding potential ground water flow from the decommissioned mine workings to the northern lakes following mine closure. In this study the ground water flow into the North and Northeast Lakes was computed using mass balance calculations and using an updated and recalibrated numerical model.

Developer's conclusion

Mass balance calculations and remodeling of ground water flows indicate that the quantity of mine impacted ground water reaching the lakes to the north of the site will be 25% of what was originally anticipated. Refinement of the horizontal and vertical hydraulic conductivities have improved the predictive abilities of the model which now indicates that ground water that has contacted the mine workings will not intersect the basin of the North Lake. The ground water modeling does not incorporate the effects of adsorption and dispersion when predicting contaminant loads carried by the ground water to the North East Lake. However, in the unlikely event that there is no attenuation of these contaminants between the mine and the North East Lake, the developer has demonstrated that molecular diffusion in the lake bed sediments will reduce the predicted concentrations of parameters of concern to below CCME guidelines by the time the ground water leaves the sediments. Overall the results of remodeling indicate that the ground water impacts on the North and Northeast Lakes will be minimal.

Environment Canada's conclusions

Attenuation through adsorption and dispersion along the ground water flow path in the rock between the mine workings to the Northeast Lake and in the Northeast Lake sediments is likely to reduce metal concentrations below water quality guidelines even if mine-affected ground water flow is greater than predicted by the mass balance calculations and modeling.

Environment Canada's Rationale/Evidence

The mass balance calculations using the sodium, chloride and strontium ions are based solely on lake inputs and outputs and do not consider losses of chemical mass to the sediments in the lake. Although Na, Cl and Sr are considered to be conservative ions (i.e. they are not readily removed from the water column by biotic and abiotic processes) their removal is not completely absent since these elements are found in routine analyses of lake sediments. Ignoring this sequestration of elements when computing ground water inputs from mass balances, results in underestimation of ground water inputs. Therefore, the quantities of mine-affected ground water entering Northeast Lake could be higher than estimated by the mass balance calculations given in the technical memorandum.

Revisions to the numerical model have removed inconsistencies in horizontal and vertical hydraulic conductivities and have improved the capability of the model to simulate regional ground water flow between Snap Lake and the northern lakes. Overall, values for hydraulic conductivity are higher than those used in the environmental assessment report and tend to be on the high end of ranges expected for fractured rock. Estimates of ground water flow to the northern lakes computed by the model are, therefore, about an order of magnitude greater than those from mass balance calculations. Due to the inherent uncertainties in the numerical model De Beers, has used the results from the mass balance calculations to quantify ground water flow to the northern lakes. Although the maximum flow of mine-affected ground water to the Northeast Lake is predicted to be about 25% of the value originally estimated in the environmental assessment report, uncertainties in the computation of this value limit its reliability.

In section 6.2.2.4 of the technical memorandum, a qualitative discussion of ground water quality changes along the flow path from Snap Lake through the mine workings to the northeast lake is presented to demonstrate that high pH and high concentrations of aluminum, copper and chromium will likely be attenuated prior to the ground water reaching northeast lake. These discussions are based on well known principles of ground water geochemistry and, therefore, provide strong support for the argument that mine-affected ground water will have a negligible effect on Northeast Lake. The processes of adsorption and dispersion along the subsurface flow path are expected to reduce the contaminant load in the mine-affected ground water to such a large extent that any variability inherent in the volume estimates based on mass balance calculations and modeling will not be significant.

Environment Canada's position: This issue has been resolved to the satisfaction of Environment Canada's reviewers.

Issue # 3 Water Quality - Treatment options

The proponent did not demonstrate how they came to the conclusion that the selected water treatment option is the best one available and that it minimized project impacts on Snap Lake.

Reference: TOR line # 337-341, November 2002 Technical Sessions Day #3

Background

EC requested that De Beers elaborate on the treatment method(s) to be employed for treating mine water, specifically with respect to dissolved metals. During the technical sessions several treatment options were discussed, and EC sought clarification on which options will be employed and how incorporation of these options would affect the size of the impact area in Snap Lake. EC requested a commitment from De Beers that they would optimize treatment for metals as well as the specifics of how and when treatment would be implemented.

EC also requested that De Beers provide a discussion of all the water treatment options examined in the search for optimal treatment of "parameters of concern". The requested discussion was to include options considered, effectiveness of each option, criteria used to select the preferred option and reasons for rejecting treatment options. Treatment options examined for nitrate were also requested.

Developer's conclusions:

Options for treatment were screened and refined using testing of bulk sample mine water to identify the most effective processes. Details of the treatment options examined and the process used to compare them are provided in the technical memorandum dated Feb. 13, 2003 from Tom Higgs of AMEC. The water treatment process that has been selected involves solids removal using a thickener and flocculant, with provision for the addition of lime and ferric sulfate followed by further flocculation and filtration. Testing of other reagent combinations and additional treatment through use of a high-density sludge circuit did not demonstrate consistent improvements in effluent quality.

In the evaluation process the use of ion exchange or reverse osmosis technology was rejected because the large mine water flow rates would result in a large brine waste stream. The system was also rejected because of extremely high life cycle costs. This is documented in the De Beers submission on TDS Removal Technology dated Feb. 10, 2003.

The water treatment plant optimization and operating strategy outlines monitoring activities and will be adaptive to dynamic process conditions to attain best treatment. This strategy will formalized in a long-term monitoring and optimization plan.

Unfortunately no feasible treatment options for nitrate are available.

Environment Canada's conclusion

EC is satisfied that treatment alternatives have been adequately explored and that the work done to identify and select the best available process was sufficient. EC accepts that the size of the area in Snap Lake impacted by mine effluent is being minimized.

Our Rationale/Evidence

The treatment process selected employs proven technology that is presently in use in the north and across Canada, and is expected to provide acceptable treatment for suspended solids and metals. De Beers has indicated that if necessary ferric sulfate and lime will be added to the treatment process to precipitate dissolved metals.

De Beers developed their impact assessment for Snap Lake water quality using aquatic community-level benchmarks based on literature-derived hazard concentrations for each parameter. Effects were evaluated and assessed as negligible because concentrations of parameters of concern exceeded benchmarks in less than 1% of the lake. The initial question was whether affecting 1% of the lake was acceptable, and if that area could be reduced through improvements in water treatment. Concern lay with using a mixing zone to attenuate effluent effects rather than treating with best available technology. Environment Canada accepts the confirmation from De Beers that a range of treatment options were examined and pilot tested to select the best configuration of available technology.

Recommendation

EC recommends that De Beers periodically re-evaluate available treatment technologies with a view to maintaining optimal effluent treatment and quality.

Environment Canada's position:

This issue has been resolved to the satisfaction of Environment Canada's reviewers.

OUTSTANDING ISSUES

Issue #4 Water Quality - Phosphorus

EC identified concerns with water quality modeling results that predicted a decrease in total phosphorus levels, when loadings were increasing as a result of project inputs. EC was also concerned that ortho-phosphorus was the only form included in eutrophication modeling, and that this may have lead to an underestimation of available phosphorus; De Beers was asked to re-run the phosphorus model to include other forms of phosphorus.

Reference: TOR line # EAR section # 9.4.2.2.4

Background

Total phosphorus (P) includes all the P that is in dissolved, particulate, and organic forms, and is sampled from within the water column. The model used predicted changes in the lake productivity and showed that the addition of P to the lake would increase algal growth somewhat, but at the same time predicted that total P concentrations would drop, as a result of rapid algal die-off and settling combined with a slow rate of release from sediment. EC felt this was unlikely.

Because phosphorus accumulates in the top layer of the sediments, and may become available for uptake or chemical release, loadings of P to a lake are often considered rather than discharge concentrations.

Ortho-phosphorus is the form of phosphorus which is readily utilized by aquatic organisms, and will be released in the effluent along with particulate and dissolved forms of phosphorus. These latter forms can become bio-available (ortho-phosphorus) under some conditions (e.g. by bacterial action during decomposition, or under anoxic conditions), and therefore should not have been ignored as completely unavailable to contribute to eutrophication.

Developer's Conclusions

De Beers re-ran the eutrophication model using a lower settling rate and negligible rate of P release from the sediments (recalibrated to observed conditions). This yielded a predicted P concentration of 12 ug/L in Snap Lake an increase of 4 ug/L from baseline conditions and an increase in chlorophyll *a* levels to 1.5 ug/L. This information was provided in a presentation made to stakeholders Feb. 10, 2003.

In discussions with reviewers, De Beers agreed to do further modeling, in which various amounts of dissolved phosphorus would be added as available phosphorus, in addition to the orthophosphate.

Environment Canada's Conclusion

EC finds the results of the re-calibrated modeling to be more credible. EC notes that the total phosphorus value predicted is likely to be associated with slightly increased productivity, but the phosphorus concentration would still fall within the range found in oligotrophic lakes (3.0 - 17.7 ug/L) as defined by Wetzel 2001[1]. Predicted chlorophyll *a* concentrations remain below the mean for oligotrophic lakes under this classification system.

Model results may change appreciably when dissolved phosphorus is added to the available P. EC will review results of further modeling and bring forward comments or concerns to the pre-hearing conference if necessary.

Environment Canada's Rationale/Evidence

Environment Canada concurs with proponent that the model inputs used to re-run total phosphorus concentration model are more realistic. To ensure model outputs were realistic, inputs to the model were calibrated to baseline observations for water quality and chlorophyll *a* concentrations.

Recommendation

EC recommends that De Beers continue to refine their model calibration by monitoring the parameters which are used as model inputs. EC further recommends that this monitoring be carried out in the first years of mine operation to improve confidence in model predictions with respect to P loading over time. This will confirm whether the sediments act as a phosphorus sink (as predicted).

Modeling of a portion of the dissolved phosphorus as "available phosphorus" is being run, and results will be reviewed by stakeholders to evaluate the effects of more phosphorus being available for uptake by the aquatic ecosystem.

Environment Canada's position: This issue remains outstanding.

Issue # 5 Water Quality - Ground water impacts on Snap Lake

EC is concerned that impacts to Snap Lake water chemistry as a result of the introduction of ground water from underground mine workings have been underestimated.

Reference TOR lines 344-355, 381, EAR section 9.4, Appendix IX.1

Developer's Conclusion:

When mixing of the water treatment plant discharge (at maximum predicted concentrations) with a volume of 1% of Snap Lake, cadmium, copper and hexavalent chromium would still be above the water quality guideline. These parameters were carried forward for a detailed water quality assessment along with Phosphorus, chlorophyll a and Total Dissolved solids (TDS) were also carried forward for detailed assessment (p. 9-224).

The maximum impact of the discharge on Snap Lake water quality was classified as low based on the predicted chronic toxicity from hexavalent chromium in Snap Lake. The predicted impacts for copper and cadmium were negligible (p. 9-227). The TDS concentrations are predicted to increase from the median baseline of 15 mg/L to a maximum average concentration of about 330 mg/L in Snap Lake. The major constituents would be chloride, calcium, sodium, magnesium and sulphate. However, the impact on water quality could not be classified because there are no established general water quality guidelines or site-specific benchmarks for TDS and major ions (p. 9-229).

Environment Canada's Conclusion

Mine water discharge could have concentrations of TDS, chloride and other dissolved constituents higher than predicted in Table IX.1-12. Therefore, impacts of the treated discharge on Snap Lake could be greater than predicted. This conclusion is based on: uncertainty with the baseline characterization of the connate water; the failure to fully include the effects of saline water upwelling in the water management modeling; and uncertainty about the effects of density flow from the water treatment plant discharge on mine water recharge under ice-covered conditions.

Environment Canada's Rationale/Evidence

Mine water constitutes about 98.9% of the total water discharged from the site (p. 9-209). The mine water discharge is a combination of connate (naturally occurring) water found in the subsurface and lake water infiltration induced from Snap Lake by dewatering the mine workings. The mine working also makes a minor contribution to mine water discharge due to grout and cement use, cemented paste backfill consolidation, etc. also As operations progress, the proportion of lake water increases and the proportion of connate water decreases. Near the end of the mine operations, most of the mine water discharge is composed of lake water infiltration. The GoldSim model calculates the overall estimates of mine water quality from flows computed by hydrogeological modeling and geochemical concentrations measured in the lake water, ground water, backfill leachates, etc.

The baseline estimate of connate ground water quality is based on the average of nine samples collected from underground boreholes in the granite during the advanced exploration program. It is evident that many of these samples were contaminated by mining activities. Two of the ground water analyses for the granite had nitrate values of 20.1 and 22.2 mg N/L. Concentrations of naturally occurring nitrate in granite should be less than 1 mg N/L. Four other samples ranged from 1.27 to 8.15 mg N/L and two of these samples had pH values of 11 and 11.8 indicating probable contamination by cement grout. Furthermore, the average values for TDS and chloride of 1265 mg/L and 477 mg/L respectively for ground water samples from the north lakes field program are significantly higher than the TDS and chloride values of 902 mg/L and 330 mg/L used for the connate ground water (Table 9.2-5) in the GoldSim modelling.

The upwelling of saline ground water was modeled using FEFLOW. The model predicted that, after five years of mining, the chloride concentrations in connate ground water would increase from the baseline average of approximately 300 mg/L to 480 mg/L and remain at approximately 480 mg/L for the life of the mine (EAR section 9.2.2.2). The modelling of the saline water upwelling was not coupled to the GoldSim modelling when determining the quality of the mine water discharge. The composition of the connate water was assumed to remain constant in the GoldSim model (p. IX.1-29). However, the effect of the saline water upwelling on overall mine water quality was examined in model variability run R2d (Table IX.1-13). The results shown on Figure IX.1-14 indicate that upwelling of saline ground water would increase chloride in the mine water discharge by about 45%.

Figure IX.1-14 also includes the time variant chloride concentration in the mine water that was carried forward for assessment of impacts on Snap Lake. The "assessed chloride" reflects the concentrations that are developed when mass is added to the primary concentrations in the connate water and the lake water infiltration in the working areas. The assessed value is higher than the increased concentrations due to saline water upwelling but the assessed value does not make provision for the addition of chloride from the working areas in combination with saline water upwelling. Upwelling of saline water would also be expected to increase TDS concentrations and presumably other constituents in the mine water. However, the time variant concentrations of the other mine water constituents assessed in the environmental assessment do not include increased concentrations due to upwelling saline water.

The quality of the lake water infiltration to the mine workings is assumed to be the same as Snap Lake water quality, i.e. there is no change as water infiltrates from the lake to the mine workings. The initial recharge water from Snap Lake is assigned the median water quality observed from the Snap Lake baseline data (Table IX.1-3). After the first time step in the GoldSim model, the recharge water from Snap Lake is assigned the concentration for the "Effective Lake Volume" calculated by the previous time step in the model (p. IX.1-28). For the purposes of modelling, the "Effective Lake Volume" of Snap Lake refers to that portion of the lake that mixes with the treated discharge and site drainage prior to recharging the fractured rock and mine workings. The Effective Lake Volume is estimated to be about 10% of the total lake volume (p. IX.1-17).

The RMA suite of hydrodynamic and water quality models were used to simulate two-dimensional, depth-averaged circulation and water quality in Snap Lake. This modelling was done independently of the site water management modelling using GoldSim but incorporated results from the GoldSim modelling. It is recognized that the RMA models do not provide a good representation of mixing conditions in Snap Lake under ice-covered conditions (p. 9-218). During ice-covered conditions, mixing would only occur within the initial turbulent mixing area created by the multi-port diffuser, beyond which there would be essentially no turbulence in Snap Lake. After initial mixing, the denser discharge water will move beyond the turbulent mixing zone and will sink back down to the bottom of the lake and flow downstream in a direction dictated by the topography of the lake bottom. The maximum ice-covered concentrations after initial mixing are presented for selected parameters in Table 9.4-19. These concentrations likely represent the concentrations that would move by density flow to the bottom of the lake and recharge the ground water flowing to the mine. Maximum concentrations in the "Effective Lake Volume" are not given in the environmental assessment but these should be compared to the concentrations given in Table 9.4-19 to ensure that conservative values have been used in the GoldSim modelling to account for the deterioration of Snap Lake water quality due to wastewater discharge. The timing of these water quality changes should also be considered. The highest concentrations in the water treatment plant discharge are expected early in the mine life when density contrasts between the WTP discharge and the lake water are greatest whereas concentrations in the "Effective Lake Volume" will gradually increase to their maximum values near the end of the mine life.

De Beers has not considered the possibility of poorer than expected water quality from several of the components of the mine water discharge. It is impossible to quantitatively or even qualitatively evaluate the magnitude of these variations in mine water quality without modeling. In addition to changes in the quality of the individual components, the proportion that each component contributes to total mine water discharge will change as mining progresses.

Recommendation

It is recommended that additional modelling be done to evaluate potential variability in all components of mine water discharge and to ensure that potentially higher concentrations of TDS and other dissolved constituents do not have an unacceptable impact on Snap Lake.

Environment Canada's Position: This issue remains outstanding.

Issue # 6 Water Quality - Total Dissolved Solids

De Beers estimates that TDS concentrations in Snap Lake will likely increase by an order-of-magnitude as a result of project inputs. EC seeks substantiation of the prediction that higher TDS levels would have negligible to low effects on biota.

Reference: TOR line # TOR lines 344-355, 381, EAR section 9.4, Appendix IX.1

Background

Very little information was provided to support the prediction that increased TDS levels do not have impacts on aquatic ecosystems. EC has requested scientific support for this position.

As discussed under Issue # 5 connate water forms a substantial part of the mine water discharge from the De Beers project. Therefore, any change in the predicted connate water quality will impact predictions of Snap Lake Water Quality. Though still unresolved, the characterization of the connate water quality is the subject of ongoing discussions between De Beers and groundwater experts from DIAND and EC.

Developer's Conclusions

De Beers concludes that effects on phytoplankton would be negligible, and those on zooplankton and benthic invertebrates would be of negligible to low magnitude. (EAR 9.5.2.2.3). This conclusion was substantiated through a comprehensive literature review presented in the technical memo dated Feb. 10, 2003 titled "Report on potential effects of increased total dissolved solids on aquatic communities in Snap Lake".

De Beers feels that connate water quality predictions are accurate, but have agreed to examine estimated chloride levels. De Beers has agreed to run an additional GoldSim simulation using increased concentrations of TDS and chloride in the connate ground water due to saline water upwelling.

Environment Canada's conclusion

Biological effects at the predicted levels of TDS (340ppm) would not be of high magnitude. EC anticipates that there may be minor species shifts within invertebrate communities and potentially a slight enhancement in productivity. However, because predicted concentrations of some TDS constituents approach values at which impacts may occur, acceptance of the developer's findings of negligible effects from TDS is based on the accuracy of their predictions.

Our Rationale/Evidence

This issue is linked to Issue #5 which is unresolved. If, rather than being at the predicted concentration of 340 ppm, TDS concentrations rise as high as 900 ppm, some effects would be expected. For example, optimum TDS levels for diatoms would be exceeded threefold, and effects on zooplankton may occur above 600 mg/l of TDS.

Recommendation

EC requests that De Beers, in conjunction with ground water experts, verify the expected TDS in the connate water. If connate water TDS concentrations are materially higher than predicted, the concentrations of Snap Lake water quality parameters associated with the connate water should be remodeled. Special attention should be paid to those parameters that are not susceptible to water treatment processes.

Environment Canada's position: This issue remains outstanding.

Issue # 7 Air Quality Monitoring - $PM_{2.5}$ and PM_{10}

Air Quality Monitoring is necessary to demonstrate attainment of $PM_{2.5}$ and PM_{10} Ambient Air Quality Standards

Reference: TOR lines 281-288 EAR section 2.6.1 Air Quality and Climate

Developer's Conclusion

In the Information Request Response 2.3.2, De Beers stated it would not implement PM monitoring because, at the time of writing the response, there were no NWT Ambient Air Quality Standards for $PM_{2.5}$ or PM_{10}. The NWT Ambient Air Quality Standards have been recently updated, December 2002, to include standards for $PM_{2.5}$. The following is an excerpt from the Information Request Response 2.3.2:

> *Future air quality monitoring at Snap Lake will not include PM10 and $PM_{2.5}$ monitoring. While De Beers acknowledges that the NWT is a signatory to the Harmonization Accord and has agreed to the recent Canada-Wide Standards for $PM_{2.5}$, these Canada-Wide Standards do not have any legal standing. Each jurisdiction participating in the Harmonization Accord will implement the standards under existing legislation, or by drafting new legislation. To date, the NWT has not implemented air quality regulations for $PM_{2.5}$. There are currently no Canada-Wide Standards and no NWT legislation for PM_{10}.*

During the MVEIRB Technical Sessions for Air Quality, Day 8, December 4, 2002, De Beers was again questioned about implementing $PM_{2.5}$ and PM_{10} monitoring. De Beers stated that it is committed to operating within existing standards and laws and would consider the suggestion of adding $PM_{2.5}$ and PM_{10} to its ambient air quality program. Below is response from De Beers (taken from the Technical Sessions transcripts).

> *De Beers is committed to operating within existing standards and laws. We are also committed to conducting consultations and developing resulting monitoring programs with the goal of confirming impact predictions. Basically you have highlighted your interest and we will consider the suggestion.*

Environment Canada's Conclusion

The NWT has Ambient Air Quality Guidelines for $PM_{2.5}$ and has ratified the Canada-Wide Standards (CWS) for PM and Ozone. Ambient Air Quality Standards for PM_{10} from other jurisdictions, such as British Columbia, should be considered in absence of NWT standards. As part of the CWS development process the scientific review of PM_{10} has been completed and a report will be forwarded to the CCME in 2003. The report will present the findings of PM and ozone environmental and health science review, including recommendations on a PM_{10} CWS.

As part of the CWS, jurisdictions recognize that polluting "up to a limit" is not acceptable and that the best strategy to avoid future problems is keeping clean areas clean. The Keeping Clean Areas Clean (KCAC) commitment is aimed at minimizing the degradation of air quality in areas that currently have relatively clean air. The pollutants that should be included in the Snap Lake KCAC program in the ambient environment are $PM_{2.5}$ and PM_{10}.

EC concludes that De Beers needs to demonstrate through ambient monitoring that the air quality impacts from the Snap Lake mine development are in compliance of the NWT Ambient Air Quality Standards and Canada-Wide standards. In addition, ambient monitoring is essential to ensure that mitigation efforts are working to fulfill the KCAC commitment of minimizing the degradation of air quality.

Environment Canada's Rationale/Evidence

Air quality modeling results presented in the Snap Lake Diamond Mine Environmental Assessment Report indicate that the impact from mine emission of particulate matter will degrade regional air quality. Specifically, the model predicts that ambient air quality standards for total suspended particulate, PM_{10} and $PM_{2.5}$ will be exceeded.

Emissions from the BHP and Diavik diamonds will also impact regional air quality. Since Snap Lake shares a common airshed with the other mines, a cooperative regional air quality monitoring program may provide economic efficiencies and increase the understanding of environmental impacts.

Recommendation

EC recommends that De Beers include PM_{10} and $PM_{2.5}$ in the Snap Lake monitoring program to demonstrate they are meeting the Ambient Air Quality Guidelines.

EC encourages De Beers to investigate potential partnerships with BHP and Diavik in establishing a regional air quality monitoring program.

Summary of Recommendations

Issue #3 Water Quality - Treatment Options
Recommendation

EC recommends that De Beers periodically re-evaluate available treatment technologies with a view to maintaining optimal effluent treatment and quality.

Issue #4: Water Quality - Phosphorus
Recommendation

EC recommends that De Beers continue to refine their model calibration by monitoring the parameters, which are used as model inputs. EC further recommends that this monitoring be carried out in the first years of mine operation to improve confidence in model predictions with respect to P loading over time. This will confirm whether the sediments act as a phosphorus sink (as predicted).

Modeling of a portion of the dissolved phosphorus as "available phosphorus" is being run, and results will be reviewed by stakeholders to evaluate the effects of more phosphorus being available for uptake by the aquatic ecosystem.

Issue # 5: Water Quality - Ground water impacts on Snap Lake
Recommendation

It is recommended that additional modeling be done to evaluate potential variability in all components of mine water discharge and to ensure that potentially higher concentrations of TDS and other dissolved constituents do not have an unacceptable impact on Snap Lake.

Issue # 6: Water Quality - Total Dissolved Solids
Recommendation

EC requests that De Beers, in conjunction with groundwater experts, verify the expected TDS in the connate water. If connate water TDS concentrations are materially higher than predicted the concentrations of Snap Lake water quality parameters associated with the connate water should be remodeled. Special attention should be paid to those parameters that are not susceptible to water treatment processes.

Issue # 7: Air Quality Monitoring - $PM_{2.5}$ and PM_{10}
Recommendation

EC recommends that De Beers include PM_{10} and $PM_{2.5}$ to its Snap Lake monitoring program to demonstrate they are meeting the Ambient Air Quality Guidelines.

[1] Wetzel, R.G. 2001. Limnology Lake and River Ecosystems. Third Edition. Academic Press. 1006 pp.