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April 23, 2003

Fisheries and Oceans Canada
101, 5204 - 50th Avenue
Yellowknife, Northwest Territories X1A 1E2

Attention: Dave Balint, Fish Habitat Biologist

Dear: Dave

SUBJECT: Clarification of Issues Discussed During April 14th and 17th Conference Calls

Two conference calls (April 14th and 17th, 2003) were organized by De Beers Canada Mining Inc. (De Beers) in order to address outstanding issues concerning the dispersion pattern of the total dissolved solids (TDS) plume in Snap Lake, chromium and cadmium concentrations near the point of discharge into Snap Lake, interpretation of the HC5 value, and the potential effects of TDS on deep water benthic invertebrates. De Beers would like to respond to questions and concerns raised by Elaine Blais and yourself of Fisheries and Oceans Canada (DFO) during the conference calls of April 14th and 17th, 2003. It should be noted that other participants of the April 14th conference call included:

- Sven Bohnet – INAC;
- Mark Dahl – Environment Canada;
- Marlene Evans – Environment Canada;
- Anne Wilson – Environment Canada;
- Tom Higgs – AMEC;
- Rick Schryer – Golder Associates Ltd.;
- Mark Digel – Golder Associates Ltd.; and,
- Robin Johnstone – De Beers Canada Mining Inc.

Total Dissolved Solids Dispersion Pattern

Questions were raised regarding mixing of the treated mine water discharge (discharge) in Snap Lake. There were two main questions discussed:

1. *Did modelling predictions exclude the northwest arm and other areas not available for mixing under ice covered conditions?*



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2. Would the density stratification predicted to develop during the winter persist into the open water period?

In response to question 1, Mark Digel of Golder Associates started the discussion with a general description of how mixing was modelled under ice covered and open water conditions. The discussion that followed clarified what is expected to occur in Snap Lake and how it was modelled in the environmental assessment. The following is a summary of the discussion.

The diffuser outfall will provide a high degree of initial mixing of the discharge with lake water. The initial mixing model (Cormix) predicted a minimum of 34:1 mixing ratio during the winter within approximately 120 m of the outfall. This means that one part of discharge would mix with 34 parts of lake water. The initial mixing ratio would be greater during open water conditions.

In order to account for the reduced volume of water in Snap Lake available for mixing during the winter, and to exclude the volume of the northwest arm of Snap Lake and other smaller bays, the initial mixing ratio for ice-covered conditions was lowered to 12:1. An example was provided to show the difference associated with this conservative assessment of initial mixing. The numbers used in the example are different from what was discussed, in order to make them consistent with the environmental assessment, so as to avoid confusion. With a lake TDS concentration of 300 mg/L and a discharge concentration of 930 mg/L, an initial mixing ratio of 34:1 results in a concentration of 318 mg/L, and a initial mixing ratio of 12:1 results in a concentration of 348 mg/L.

In response to question 2, Mark Digel provided the following discussion. Under ice-covered conditions, the initial mixing model predicted that density differences between the lake and the initial mixed water, though small, would be sufficient such that the mixed water would sink to the bottom as it moves away from the discharge. Although some mixing will occur under the ice, it will be much slower than under open water conditions. To be conservative it was assumed that under ice covered conditions no additional mixing would occur beyond the initial mixing from the diffuser.

The density differences between the initially mixed concentrations and the remainder of Snap Lake are small and stratified conditions would not persist during open water conditions. Wind driven currents would de-stratify the lake and full vertical mixing would be re-established. This pattern is identical to what occurs under baseline conditions; however, density differences during baseline conditions are driven solely by temperature differences between top and bottom waters.



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Chromium and Cadmium

Concentrations greater than the site-specific water quality benchmarks were predicted in the environmental assessment for a very small area near the discharge under open water conditions. These predictions are very conservative because they do not account for initial mixing from the diffuser. Maximum concentrations in Snap Lake after initial mixing (*i.e.*, within approximately 120 m of the diffuser outfall) will be below site-specific water quality benchmarks for chromium and cadmium.

Therefore, no chronic effects are expected for cadmium and chromium. The environmental assessment shows that even when very conservative assumptions are used and maximum concentrations are over-estimated, that the predicted effects were very small.

DFO asked how the sum of the maximum predicted concentrations of hexavalent chromium and trivalent chromium reported in the Environmental Assessment Report (EAR) Table 9.4-19 could be higher than the maximum treated discharge concentration of 7.5 mg/L. This occurs because the discharge is expected to consist primarily of hexavalent chromium, which will convert to trivalent chromium in Snap Lake. Conservative assumptions were used in predicting maximum concentrations of hexavalent and trivalent chromium that results in some double counting of total chromium concentrations. In other words, both maximum hexavalent and trivalent chromium concentrations in Snap Lake were overestimated, such that the sum of the two chromium forms is greater than the total.

DFO also mentioned that there were inconsistencies between the maximum chromium concentrations reported in Section 9.4 and concentrations used in Section 9.5. The chromium concentrations provided on page 9-306 of the EAR are discussed incorrectly. The concentration of 7.5 µg/L is not the predicted concentration in 1% of the lake, it is the maximum total chromium concentration released from the treated effluent discharge. Following mixing generated by the diffuser and dispersion in the lake, the concentrations of chromium are reduced to 2.5 µg/L within 230 m, which is equivalent to 1% of the lake. The statement made that the maximum predicted concentration of chromium will be 2.5 µg/L in less than 3% of the lake is correct; however, the interpretation of this is confusing. What this is stating is that although the HC5 value of 2.1 µg/L is exceeded within the 1% area, the concentration is below the HC5 value within 3% of the lake.

On page 9-357 of the EAR, a discussion on chromium concentrations relative to the 1% and 10% spatial extent and indirect effects to aquatic organisms is provided. As indicated by DFO's position,

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this discussion is not stated clearly. This section of the EAR was to place the elevated concentrations into context relative to potential indirect effects to fish through such pathways as reduced food availability. On page 9-357, the 2.5 µg/L concentrations that will extend beyond 1% of the lake but within 3% of the lake is compared to the chronic effect level for the three most sensitive invertebrate species. The chronic value for the most sensitive species is 3.32 µg/L which is greater than the predicted exposure concentration therefore the potential impact was deemed negligible.

HC5

The questions raised during the conference call regarding interpretation of the HC5 value were:

1. *Is the data used for generating the site-specific benchmark based on real toxicity data?*
2. *Does the HC5 value for the site-specific benchmarks cause a loss of any species?*

The short answer to these questions is that the site-specific benchmarks were developed based on real toxicity data using an accepted approach for interpreting the toxicity data, and that exposure to concentrations at an HC5 value would not cause the loss of any species in Snap Lake.

It is apparent that confusion with the impact assessment is related to the development and use of the water quality benchmarks (*i.e.*, HC5, HC10, and HC20). The water quality benchmarks were derived as a tool to identify the potential for environmental impacts for parameters that are elevated above the Canadian Council of Ministers of the Environment (CCME) guidelines within greater than 1% of the lake area. Parameters that exceeded the conservative HC5 benchmark beyond the 1% area were carried forward to the aquatic organisms section of the EAR for further assessment. These were considered to be parameters with the potential for an effect based on the HC5 screening benchmark. Chromium falls into this category and was carried forward, whereas copper and cadmium did not and were not considered further in the assessment process. Within the aquatic resources section of the EAR, the potential of impacts for parameters exceeding any threshold is assessed by comparing the concentration to the actual chronic effect values from the literature (*i.e.*, even if an HC5 is exceeded, the concentration may still be lower than the chronic effect threshold for the most sensitive species and thus potential for impact to aquatic organisms may be negligible). A more detailed answer is provided below.

The benchmarks are based on available toxicity literature generated through toxicity studies in peer-reviewed journals. The data used and the corresponding references are provided in Appendix IX-8 of the EAR. In this Appendix, the entire database of available toxicity literature on the specific parameters was provided. A detailed screening of this data was completed and species relevant to Canada and specifically northern Canada were included. Details on the decision rules used for including and excluding of data was provided in the methods section of Appendix IX-8.



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The data points shown on the figures in Appendix IX-8 are real data points. These values are generated either by actual chronic toxicity endpoints or adjusted from acute endpoints using the methods of acute:chronic ratios (a standard approach used by CCME and United States Environmental Protection Agency). A single value is generated for each test species by taking the geometric mean if more than one value is available. Using the geometric mean allows one to use all the available data for a species and thus control for extraneous values that may be over-conservative or under-protective.

The data provided in Appendix IX-8 of the EAR was used^{*} to generate the species sensitivity distributions shown for cadmium, hexavalent chromium, trivalent chromium, and copper. This information is plotted as a cumulative percentage, meaning that as the concentration increases the potential chronic effects to species increases. Once the data points are plotted a best fit line is calculated using a non-linear regression model. This is similar to plotting a length-weight relationship and fitting a linear regression that allows one to predict the weight of a fish at a given length. Whereas in this case we are using the non-linear regression to predict a potential effect level associated with a concentration.

What is important to consider in the development of the site-specific benchmarks is that the HC5 values calculated are based on the regression model created from the actual data points. By using the data to define the potential effect levels we account for uncertainty and do not have to use arbitrary application factors as is the case for the CCME guidelines. This is not to say that the CCME guidelines are not appropriate for intended purposes, they are however irrelevant for the prediction of potential environmental impacts.

An example as to where the HC5 values are located relative to the literature values is provided, based on chronic toxicity of cadmium at a hardness of 180 mg/L (Figure 1) and hexavalent chromium (Figure 2).

These figures (not to scale) provide a perspective on the relationship between the CCME guidelines, the HCx values, and the literature based chronic toxicity results. What is demonstrated here is that the HC5 is greater than the CCME guideline but is actually lower than the lowest chronic value used by CCME to generate the guideline by the use of an arbitrary application factor (*i.e.*, $0.55 \mu\text{g/L} * 0.1 \text{ application factor} = 0.055 \mu\text{g/L}$ CCME guideline). Considering that there is more than just the one study on the species used in the CCME guideline, the geometric mean concentration or lowest mean chronic value is slightly higher and takes into account that there is variability within species sensitivities. For hexavalent chromium, we find that all three HCx values are less than or equal to the lowest chronic effect concentration of $10 \mu\text{g/L}$ used by CCME to derive the hexavalent chromium guideline of $1.0 \mu\text{g/L}$ (*i.e.*, $10 \mu\text{g/L} * 0.1 \text{ application factor} = 1 \mu\text{g/L}$ CCME guideline). Consequently, no effect to the most sensitive species used to derive the benchmark will occur at the HC5 level.



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Figure 1: Cadmium

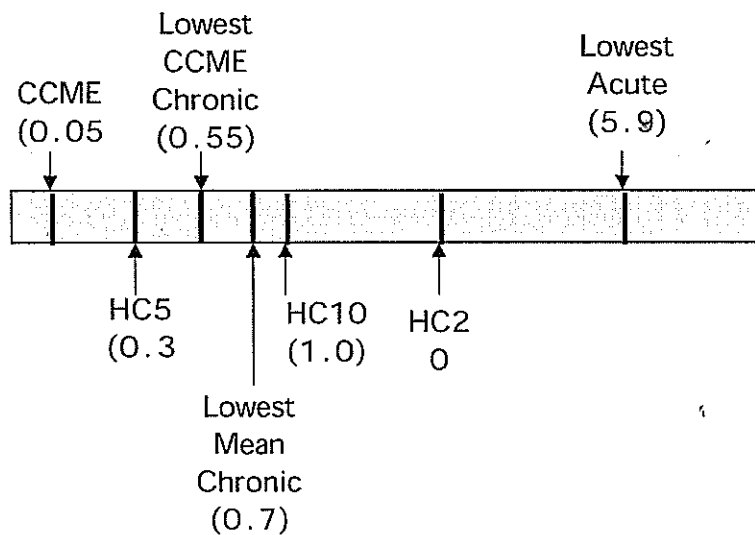
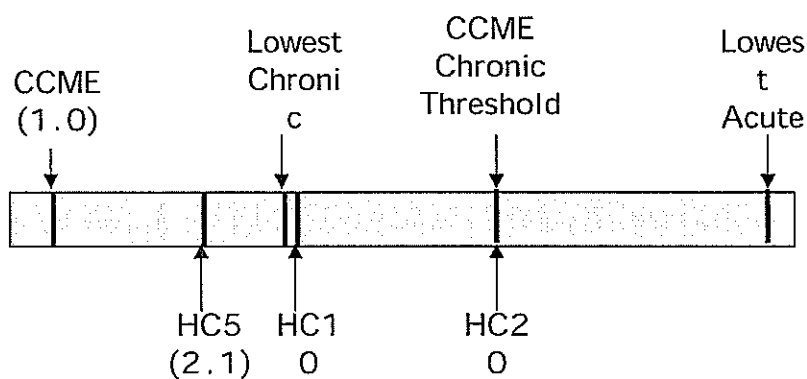


Figure 2: Hexavalent Chromium



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Potential Effects of Total Dissolved Solids on Deep Water Benthic Invertebrates

The potential effects of increased TDS on deep water benthic invertebrates were discussed, especially in terms of exposure during the winter period. As discussed in the TDS dispersion section above, elevated TDS water from the discharge may first settle to the bottom of the lake before slowly dispersing to the remainder of the lake. Concentrations are not expected to exceed 350 mg/L.

Dr. Marlene Evans stated that the most she expected to see occur in the deep water benthic community as a result of exposure to these TDS levels was a slight shift in relative species abundance. In other words, one species may have a small advantage over another and increase its numbers without harming the other species. Dr. Rick Schryer concurred and went on to explain that this species shift simply meant that one species of chironomid, the most abundant group of benthic invertebrates in this type of habitat, may be slightly favoured (e.g., stimulation of growth) over another due to differences in salinity preference. He also stated that no mortality of individuals or loss of species would occur. Dr. Evans agreed with these statements and cited her work at Kelly Lake in the Northwest Territories where a successful lake trout population exists at a TDS of over 400 mg/L as an example of the natural range for TDS in this species. DFO expressed concern over the change in forage for fish species such as round whitefish and the potential cascade effect to the forage base for lake trout. Both Dr. Evans and Rick Schryer agreed that this small shift in the relative numbers of benthic invertebrates would have little consequence to the foraging ability of fish species such as lake trout or round whitefish since the change would be very small and both species are opportunistic feeders. The net result will be a small increase in the total number of benthic invertebrates.

DFO also expressed a concern over the lack of baseline data on deep water benthic invertebrates since they felt there was no basis for comparison in future monitoring studies. De Beers acknowledges that specific data on this area is lacking and commits to collecting samples of benthic invertebrates in deep water habitats before operations begin. De Beers also commits to sampling these same habitats during operations so that impact predictions can be confirmed.

If you have any questions concerning the information presented in this letter, please contact me at your convenience.

Sincerely,
SNAP LAKE DIAMOND PROJECT

ORIGINAL SIGNED BY

Robin Johnstone
Senior Environmental Manager



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