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MEMORANDUM

TO Glenda Fratton, Environmental Assessment Coordinator
DIVISION Mackenzie Valley Environmental Impact Review Board (MVEIRB)

FROM Robin Johnstone, De Beers Canada Mining Inc.
DATE 28 February 2003

COPY Conference call participants, Public Registry

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**SUBJECT: Meeting Notes: Determination of Cryoconcentration Boundary Limits**

Below please find a summary of a conference call discussion held on 25 February 2003 at 1:00 pm MST to address a concern regarding boundary limits for cryoconcentration calculations raised by Indian and Northern Affairs Canada during the MVEIRB Technical Sessions. Conference call participants included: Peri Mehling (Mehling Environmental Management, consultant to INAC), John Brodie (Brodie Consulting Ltd, consultant to INAC), Chris Burn (consultant to INAC), Sevn Bohnet (INAC), Ken DeVos (Golder), Rens Verburg (Golder), Robin Johnstone (DBCMI) and Colleen English (DBCMI).

- Ken DeVos asked about model results from Terry's memos in an effort to determine if there was agreement on the mass loading predictions and unfrozen water content. John Brodie stated that this was how he and Chris saw it, and Chris asked if the relation between 0 and -0.4 (critical) is simply a straight line drawn between two points and not based on other data? (Ken stated that we would assumed this to be correct for the purposes of this call.) Chris Burn then asked if the water used in the paste during the lab tests was the mine process water. Ken replied that it was his understanding that the paste, with water was supplied to Golder by Mine Systems Design (MSD) along with any additives that were needed. Golder then supplied the water, materials and any additives that were needed to EBA for testing. Water in that sample is expected to be similar to process water. [To clarify: coarse material was shipped from site, dry, to MSD in Idaho where it was ground to the consistency of paste. It is assumed that the water was added by MSD. Although the water was not from site, the ultimate quality of the paste porewater would likely be similar to that of process water as it would have gone thought a similar grinding/ preparation process.]

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- Ken requested feedback on the possible cryoconcentration loadings that should be used for the North Pile paste. Chris provided a reference relating to loadings from cryoconcentration. According to Chris, a useful paper from a 1997 Journal of Earth Sciences was written by J.R. MacKay, pg. 17-33, Effect of permafrost aggradation into a saturated sandy material. Figure 13 and 14 of this report give porewater expulsion and cryoconcentration effects. He indicated that in the case provided in the paper, almost all water that has undergone cryoconcentration is expelled out. Terry's Figure 17 (Thermal Modeling Technical Memorandum) very closely resembles Figures 13 and 14 from this paper.

- Ken referred to the Frost Heave technical memo which shows that ice lenses up to 3mm thick formed in the North Pile. Does this not suggest the opposite of extruding water? Chris commented that depending on the nature of the frost heave test, there may be a very rapid freezing at the beginning of the tests leading to expulsion very early on. Then the freezing rate declines. Chris would need a more thorough description of the test before commenting (had not seen the memo). Ice lenses could more be a function of the freezing rate rather than the frost heave potential. The material content in this case would suggest that it is not susceptible to frost heave (steep gradient in Fig. 1).

- Ken stated that he would like to know what range and assumptions would be acceptable, and what boundaries Golder could put in the model. Chris referred to Fig. 17 (boundary conditions for the first 50 years). The time series shows a frost penetration curve near the surface 10 years post-deposition, from about 7m below the surface to about 25m below the surface. This is the freezing zone. The frost front proceeds downward with time. The freezing rate can be calculated from this information. You know how many layers of soil are frozen per year, so you then calculate the change in composition of the material. It is then assumed that the whole amount is ejected from the pile. This is conservative.

- Peri Mehling mentioned that close to zero temperatures do not necessarily mean that chemical reactions do not proceed. Materials at temperatures slightly below zero would still produce reaction products and could generate some sort of chemical load.

- Ken asked if Peri's Appendix A values from the DIAND report would be representative? Peri responded that they would likely be reasonable, but she would have to read the numbers again, as she was working with limited information at that time. Chris mentioned that this was a conservative estimate for two cases. Now

that we have simulated the potential rate of freezing, a better estimate can be made regarding the amount of ground frozen every year and the concentration of solute in that material. The temperature depression changing over time needs to be captured in some way. There is an IR response on how cryoconcentration happens that can be used as a basis for this work.

- Ken raised the recently proposed potential contingency measures from the North Pile Seepage Control technical memo. One proposed contingency is to reduce water levels in the ditch, reversing the gradient between the ditch and the lake so water flows from the lake is to the ditch, and discharge from the North Pile cannot escape via the ditch to Snap Lake. Coupled with this could be a frozen berm between the ditch and lake which would pull up the permafrost and capture runoff and force seepage from the North Pile upwards, into the ditch by acting as a hydraulic barrier. Are these contingency measures reasonable? If we were to look at loading rates in relation to contingencies, plus keeping in mind that we have a number of years to get "real time" information (including the starter cell), would this be sufficient? Chris noted that he would defer to John Brodie for an opinion on the effectiveness of ditches in controlling seepage getting to the lake. John asked if the flow of water due to drainage from the lake to the ditch would affect capacity as it relates to the water management system? Ken stated that it would not as it is the equivalent of less than 1% of the minewater inflows. John stated that the ditches intuitively sound reasonable. The elevation of the ditch remaining below that of the lake is the most attractive option. As long as the water management system can handle the flows, this would seem to be a reasonable contingency measure.

- Chris stated that literature information on cryoconcentration materials suggests you can learn a lot from the starter cell, but mostly during years 5-10 of operations. Functioning of the ditches, however, would be a much quicker learning process, within the first couple of years of operations. Monitoring of temperatures in the starter cell is key (John agreed with this).

- Peri tried to clarify that, generally speaking, if De Beers were to use the range of variables we identified, plus mitigation measures, we'd be happy with the work done on this?

- Chris added the following two points.
    - Rate of frost penetration into the pile is key. Use this as a basis to assess the rate of porewater expulsion or cryoconcentration from the North Pile.

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- Likely the pile is partly frozen and partly unfrozen. The TempW model that was used only operates by conduction and has layers added in. This provided the model of how the paste is deposited. Parts of the pile will follow this, while others will not. How much of the pile is not below zero degrees Celcius is not a profitable discussion. Instead, acknowledge the possibility of this and then estimate the percentage of the pile that is unfrozen (eg: our estimate of half being frozen at closure). Knowledge of how it actually operates will only be obtained from field observations. You learn as you go, but make conservative estimates based on what the consequences may be.

- Robin Johnstone asked how much of this information is critical given sound mitigation measures for the seepage issue? John responded that the model is a good first effort, but not conservative with respect to the layer thickness used. A thicker layer of paste will result in unfrozen zones. There would be some effect on the amount of frozen water, but nothing consequential. The assumption of half the pile being unfrozen at closure is reasonable (would more or less provide mitigation measures). You would be best to present this scenario coupled with contingency measures. Peri added that this is reasonable, though it might be more conservative to use three quarters of the pile as unfrozen. It is better to be more conservative as you do not know for certain the volume of material going to the treatment plant.

- Ken raised the issue of hydraulic conductivity (K) of the frozen soils. He mentioned that when determining the amount of seepage out of the North Pile, he assumed a high K in the model, but this was limited by the infiltration rates into the pile. Ken now thinks this was grossly overestimated and very conservative. John stated that he was not sure he would agree given the deep active layer and the conduit of flow within the rock fractures. He encouraged Ken to stick with the higher K. Chris also added that K for frozen soils is usually from published calculations of the K of freezing soil during frost heave – this is very different from seepage and gravity-driven flow. It is good to have stuck with these high K ranges when determining seepage rates.

It was agreed that De Beers would do whatever they could to incorporate the comments and suggestions from this conference call, given the timeline for submission of additional technical memos to the Public Registry.

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Should you have any questions, please feel free to contact the undersigned.

Sincerely,
SNAP LAKE DIAMOND PROJECT

ORIGINAL SIGNED BY

Robin Johnstone
Senior Environmental Manager

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