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MEMORANDUM

To: SLEMA

Subject: **Review of 2004 Adaptive Management Plan -- Snap Lake Project**

Date: April 28, 2005, 2005

Overview

1. DeBeers' 2004 *Adaptive Management Plan (AMP)* has two parts: [1] description of the principles of adaptive management; and [2] description of how adaptive management will be applied at Snap Lake with reference to 4 components stipulated in the *Water Licence*:
 - a. mixing in Snap Lake of several water quality parameters (TDS, chloride, calcium);
 - b. geotechnical performance of North Pile;
 - c. nutrient enrichment in Snap Lake; and,
 - d. increasing concentrations of TSS in Snap Lake.

For each of the four issues above, the discussion in the *AMP* follows the following outline:

- e. description of monitoring program to be used;
 - f. description of thresholds for triggering a management response (action levels);
 - g. description of the adaptive management process; and,
 - h. description of mitigation measures taken when action is triggered.
2. Despite the title, this document is not truly an 'adaptive' environmental management plan as the scientific literature defines 'adaptive environmental management'. However, notwithstanding this, the key point is whether this plan (however it is labeled) is up to the task of describing effective actions that will be taken when critical thresholds, as defined by monitoring, are exceeded.

3. The conclusion of this review is that this document is not adequate as a 'stand alone' management tool to achieve the conditions set out in the *Water Licence*. The problem is that the *AMP* is conceptual only, and lacks details in the following areas of any environmental management plan that is to be approved by regulatory authorities and implemented by managers:
 - a. stated objectives (including hypotheses or predictions to guide monitoring)
 - b. sampling and data collection programs
 - c. methods of analyzing the data, including QA/QC, statistical analysis
 - d. adequacy of existing baseline data
 - e. indicators for monitoring
 - f. thresholds for triggering action
 - g. specific management responses
 - h. specific mitigation measures that will be implemented
 - i. who is responsible for implementing management & mitigation.

Issue 1 – Mixing in the Lake

1. The monitoring program for the identified parameters (TDS, calcium and chloride) has been described in a *TDS Sampling Plan* (submitted to the MVLWB in July 2004) and is not described further in the *AMP*.
2. According to the *AMP*, the action levels proposed 'should be based on identifying when increasing trends could adversely impact aquatic populations in Snap Lake.' The *Water Licence* criterion for TDS is 350 mg/L, and the *Environmental Assessment Report (EAR)* defined 600 mg/L TDS and 110 mg/L calcium as effects thresholds in Snap Lake. Action is to be taken if any of the following are predicted, with a reasonable degree of certainty, to occur in Snap Lake:
 - increases in TDS, calcium or chloride that exceed *EAR* predictions;
 - whole lake concentration of TDS exceeds 350 mg/L
 - effects threshold for TDS or calcium is exceeded beyond the diffuser mixing zone
 - BC water quality guideline for chloride (not stated) is exceeded beyond the mixing zone.

Comment The analytical method of predicting these exceedances is not described. The 'reasonable degree of certainty' referred to is not described. How is the 'whole lake concentration' defined? A review of the *TDS Sampling Plan* is required to verify adequacy.

3. The following mitigative actions to be taken are described for forecast exceedances of 600 mg/L (TDS), 160 mg/L (chloride), and 110 mg/L (calcium):
 - review the forecasts to confirm potential to exceed these levels;

- if so, undertake studies to ‘determine actual effects thresholds in Snap Lake’;
- if studies show that actual effects thresholds will be exceeded by forecast concentrations then undertake aquatic risk assessment.

Comment These proposed actions do not constitute mitigation of the problem.

Issue 2 – Geotechnical Performance of North Rock Pile

The *Water Licence* identifies three issues related to the long-term performance of the North Pile that need to be covered in the *AMP*: [1] stability; [2] thermal behaviour; and [3] seepage effects on water quality.

Stability

1. The purposes of the program are stated as: [1] to identify potential changes in physical conditions that may lead to containment instability so that ‘these conditions can be mitigated prior to the occurrence of any instabilities’; and [2] to ‘mitigate the potential instability conditions prior to the development of any major change in ground conditions or instabilities’.

Comment The distinction between objectives [1] and [2] is not clear.

2. It is stated that analysis of this issue will be based ‘on monthly survey measurement of the berm crests and downstream slopes in comparison to original baseline data. Conventional land survey data will be used to assess settlement, heave, or lateral movement.’

Comment No further details of the monitoring program are provided.

3. The *AMP* states only that ‘action levels are based on unacceptable movement trends, such as settlement, heave or lateral movement that could lead to surface cracking, ground instability, containment overtopping, ditch blockage, ground erosion, or ditch breach.’

Comment Action levels are not identified. The *AMP* becomes useless without specified triggers or thresholds for action.

4. Mitigation actions proposed are conceptual, and include ‘visual inspection and immediate re-survey’, and ‘assessing trends in data, followed by investigation of any movements in the toe.’ In the event of ‘an increasing monthly trend at a downward slope, an investigation and examination of causes and corrective actions will be triggered to ensure that ground stability remains within design specifications.’ Also, ‘if additional data confirms unacceptable movement, then corrective action will be taken to remedy the observed movements.’ This could include ‘implementation of corrective measures by operations’, which may

require repair or modification, construction of additional berms, modifications to existing placement operations.

Comment There are no specific proposed mitigation measures, without which the *AMP* becomes useless.

Temperature

1. Monitoring is proposed to test predictions of thermal conditions within the North Pile by monitoring ground temperature, ice formation, and freezing rates. Monthly thermal data will be reviewed for trends in the status of thermal conditions, particularly ground thaw.

Comment No details of the monitoring program are provided.

2. With respect to action levels, the *Plan* states only that they ‘will include changes in thermal conditions in pile foundation, containment berms, reclamation materials, perimeter drainage berm, and natural drainage courses to Snap Lake.’

Comment No further details are provided. Without identified thresholds for action, the *AMP* is useless.

3. Mitigation measures are not specified. It is stated only that ‘if inadequate conditions are identified by the thermal monitoring, corrective measures will be triggered to ensure that groundwater seepage and collection remains within design specifications.’

Comment There are no specific proposed mitigation measures, without which the *AMP* becomes useless.

Seepage

1. Monitoring water levels in piezometers is proposed for estimating rates of seepage from the North Pile and, along with visual and thermal monitoring, will be used to assess the amount of seepage reporting to the collection ditches and the amount seeping past the containment structures to Snap Lake. Trends in pH will also be monitored for presence of acid generation.

Comment No details of the monitoring program are provided.

2. Action levels correspond to seepage rates exceeding those predicted in the EAR (not identified here), or if the direction of seepage flow is unanticipated. Also, if anomalous pH (not specified) is noted for more than four consecutive months in any monitoring year, then follow-up action will be triggered.

Comment No further details are provided. Without identified thresholds for action, the *AMP* is useless.

3. Response action will consist of ‘a re-evaluation of the potential impacts of seepage... If the re-evaluation of potential impacts shows unanticipated impacts to Snap Lake, correction actions will be designed and implemented.’ Expanding the permafrost barrier down gradient of the collection ditch is cited as an example of potential mitigation. For increasing acidity in seepage water, further investigation of the extent, rates, and volume of flow are triggered, followed by an evaluation of options for control or diversion if there appears to be risk posed to surface water or plants growing on the PK. Other mitigation measures ‘may include excavation and relocation of the acid generating materials to a more stable location, covering the acid generating materials and/or freezing the acid generating materials using mechanically active or passive freezing systems.’

Comment There are no specific proposed mitigation measures. A re-evaluation of potential impacts will not mitigate any adverse effects. Evaluating options for control or diversion are conditional on whether a risk ‘appears to be posed’ to surface water or plants growing on the PK. There are no details on how the risk is to be determined.

Issue 3 – Nutrient Enrichment of Snap Lake

The *Water Licence* requires monitoring of total phosphorus (P), dissolved P, ortho-P, nitrate, nitrite, ammonia, and K-nitrogen as indicators of nutrient enrichment in Snap Lake, as well as in connate water and mine effluent. Dissolved oxygen is also to be monitored.

1. Monitoring will occur at 10 stations within Snap Lake, with samples collected over four seasons each year. Stations will encompass ‘a range of depths’. ‘Once a sufficiently long data record has been collected, trend analysis will be undertaken annually at all water column and sediment sampling locations to determine both the magnitude and potential significance of apparent temporal trends observed in the data.’ Data will also be used to update the Snap Lake water quality model for forecasting purposes.

Comment Description of the monitoring program is inadequate. Details may be provided in the *AEMP*; need to confirm this.

2. Action levels will ‘be based on comparison to three criteria:
 - rates of increases of WQ parameters predicted in the EAR;
 - WQ guidelines for protection of aquatic life;
 - thresholds that would impact aquatic populations in Snap Lake.’

Comment No specific action levels are identified.

3. Proposed mitigation includes nutrient abatement programs (for nitrogen; good management practices and removal at the water treatment plant: for phosphorus; removal of particulate form in TSS and precipitation of dissolved form using

ferric sulphate addition in treatment plant), as well as a performance review for the sewage treatment plant, and artificial aeration for Snap Lake to deal with any trends of declining dissolved oxygen. ‘Should mitigation be required, the optimum method would be selected from the many options available and assessed as part of adaptive management.’

Comment There are no specific proposed mitigation measures, without which the *AMP* becomes useless.

Issue 4. Increase in Total Suspended Solids

The *Water Licence* requires that the *AMP* includes actions to prevent discharge of waters containing high TSS levels to Snap Lake. Three potential sources identified include final discharge (combined water treatment plan and sewage plant effluent), shoreline construction activities, and site run-off.

1. The *AMP* will use data collected by the SNP monitoring program (TSS sampling every 6 days and monthly) to monitor the final discharge as well as site run-off. TSS from shoreline construction activities (short-term) will be monitored according to the specifications identified in the *Fisheries Authorization*. Further description of the TSS monitoring activities is provided in the *AEMP*.

Comment Description of the monitoring program is inadequate. Details may be provided in the *AEMP* and the *Fisheries Authorization*, but these should be repeated here if this is to be a useable document.

2. The *AMP* states that the *Water Licence* limits (14 mg/L max; 7 mg/L average) and *Fisheries Authorization* conditions will form the action levels for effluent discharge and shoreline construction activities. For site run-off during construction the *Water Licence* limits are 100 mg/L maximum and 50 mg/L average.
3. Mitigation measures are only conceptually described. For triggered action levels of TSS in effluent, the following measures are identified:
 - short-term measures include increasing residence time of water discharged into the settling pond by using a sediment curtain or moving the location of the discharge point. Flocculants and coagulants could also be added to the effluent prior to discharge into the settling pond or within the water treatment plant.
 - long-term measures include ‘optimizing’ the performance of the water treatment plant by adjusting operating parameters, or increasing filtration capacity. In the event of a mechanical problem in the treatment plant, a contingency measure would be to divert mine water to the wastewater management pond where coagulant and flocculant could be added if required.

For shoreline construction, a silt curtain will be used which will be ‘closely monitored to verify its success and improvements will be made where necessary through the adaptive management cycle.’

For uncontrolled runoff, options include ‘diverting flow to settling pond areas, or using silt fences or other materials to intercept and remove sediment.’ For construction of the airstrip, mitigation measures also include ‘a change in construction practices; additional mitigation; or, a pause in construction until weather conditions are more favourable.’

Comment Much more detail is needed about the measures proposed, including details about capacity and contingencies. How much can residency time in the settling pond be increased? How quickly can the operations or water treatment plant be modified to effect the required changes?