September 26, 2006

Patty Ewaschuk, Regulatory Officer, Diavik Diamond Mine
Wek’eezhii Land and Water Board
Yellowknife, NT
via email: pewaschuk@wlwb.com

Dear Patty:

Re: Diavik Diamond Mine – Fate of Ammonia Study and Special Effects Study No. 2
(Record of Agreement Items 12 and 15)

Introduction

This letter provides our executive review of the Plume Delineation Report that was submitted by Diavik Diamond Mines Inc. (DDMI) dated November 24, 2005. The report was submitted to satisfy two requirements of the Water Licence and Record of Agreement (RoA):

1. Part H, Item 26, Fate of Ammonia Study (RoA Item 12); and
2. Part K, Item 7(i)(ii), Special Effects Study No. 2 – Plume Delineation (RoA Item 15).

This letter provides an overview comment on the thoroughness of the report as compared to the study requirements.

Background

A brief, chronological summary of some key documents that led to this submission from DDMI is as follows:

- The Water Licence and RoA required DDMI to submit, for approval, a Terms of Reference for a study on the fate of ammonia entering Lac de Gras by September 1, 2004.
- The Water Licence and RoA required DDMI to submit, for independent technical review, within one month after issuance of the Water Licence Amendment a status report on the nine required Special Effects Studies that are described in Part K, Item 7(i) of the Water Licence.
July 28, 2004: DDMI submitted the required status report on Special Effects Studies. For study no. 2 (plume delineation), DDMI provided a schedule for completion of the work in fall 2005.

August 27, 2004: DDMI submitted the required Terms of Reference for the Fate of Ammonia Study. The Terms of Reference made reference to Special Effects Study no. 2 (plume delineation) as providing some of the required information.

January 18, 2005: Gartner Lee reviewed the Terms of Reference for the Fate of Ammonia Study and provided six recommendations to the MVLWB. Gartner Lee’s recommendation no. 5 recommended that an open-water delineation be conducted as well as the proposed under ice delineation. Gartner Lee’s recommendation no. 6 recommended that certain biological monitoring information be incorporated into the study in addition to the proposed water chemistry.

February 1, 2006: A tele-conference call was held that included Gartner Lee, DDMI and Board staff.

February 2, 2005: DDMI provided a response to the Gartner Lee review of Jan 18/05 and a revised Terms of Reference for the Fate of Ammonia Study. As re. Gartner Lee recommendation no. 5 (above), DDMI stated that the requested open-water delineation was to be conducted as Special Effects Study no. 2 (plume delineation). As re. Gartner Lee recommendation no. 6 (above), DDMI stated that the requested biological information was already reported in the annual reports on the Aquatic Effects Monitoring Program (AEMP) and that it was beyond the scope of the Fate of Ammonia Study to re-issue this information.

February 8, 2005: Gartner Lee reviewed DDMI’s response and the revised Terms of Reference for the Fate of Ammonia Study of Feb 2/05. Gartner Lee concluded that all recommendations had been adequately responded to except no. 6 (biological information), which GLL continued to recommend.

February 25, 2005: The Mackenzie Valley Land and Water Board (MVLWB) approved the revised Terms of Reference for the Fate of Ammonia Study provided that DDMI submit an addendum to the Terms of Reference that stated where in the AEMP annual reports the biological information requested by Gartner Lee (recommendation no. 6) could be located.

July 10, 2005: Gartner Lee reviewed the status report on Special Effects Studies. As re. Special Effects Study no. 2 (plume delineation), Gartner Lee stated that the Fate of Ammonia Study could be prepared to also satisfy the requirements for Special Effects Study no. 2.

July 25, 2005: DDMI provided a response to the Gartner Lee review of Jul 10/05. Re. Special Effects Study no. 2 (plume delineation), DDMI comment that it is unlikely that the results of the en-water program could be available for inclusion into the Oct/05 Ammonia Discussion Paper.
- November 24, 2005: DDMI submitted the *Plume Delineation Report*, to satisfy the approved Terms of Reference for the Fate of Ammonia Study and the requirements for Special Effects Study no. 2 (plume delineation).
- July 18, 2006: DDMI submitted the required Addendum to the Terms of Reference for the Fate of Ammonia Study, with an apology for the oversight and delay in this submission.
- September 25, 2006: Gartner Lee provided an executive review of the *Plume Delineation Report* against the study requirements.

**Study Requirements**

The combined (Fate of Ammonia Study and Special Effects Study no. 2) study requirements were taken from several sources:

1. The Terms of Reference for the Fate of Ammonia Study as submitted by DDMI on February 2, 2005 and approved by the MVLWB on February 25, 2005;
2. The Water Licence description of Special Effects Study no. 2 (plume delineation) per Part K, Item 7(i)(ii); and
3. Relevant commitments or comments from the documents previously summarized (above).

Four study objectives were identified:

1. Evaluate the environmental fate of ammonia upon release to Lac de Gras;
2. Assess the effects of ammonia releases on ambient water quality conditions;
3. Assess water quality conditions under ice-cover conditions in spring; and
4. Delineate any plume(s) from the main effluent discharge.

The general approach provided in the Terms of Reference for the Fate of Ammonia Study was to conduct a two-phase field program followed by reporting. This was initially focused only on an under-ice program as per the Water Licence requirements for the Fate of Ammonia study. Subsequent correspondence documented that the study was also to include an open-water program as required for Special Effects Study no. 2.

The Phase 1 field program was to roughly define the 1% plume boundary using barium concentrations at multiple locations and depths as a natural tracer. Gartner Lee has previously commented on and accepted the use of barium as a natural tracer element for this study.
The Phase 2 field program was to follow as quickly as practical on Phase 1 and was to provide water samples from three depths (near surface, mid-depth, and 2 m off bottom) at 25 grid locations that would encompass and extend just beyond the 1% effluent boundary. The SNP sample locations at the mixing zone boundary (1645-19 A,B,C), AEMP sample locations, and the effluent (1645-18) were also to be sampled. The grid samples were to be analysed for nitrate, nitrite, ammonia, total Kjeldahl nitrogen, and barium on a progressive basis that would provide the desired plume gradient. The SNP samples were to be collected and analysed according to the SNP requirements and the AEMP locations according to the AEMP requirements. Field profiles for temperature, turbidity, pH and conductivity were to be collected at each site.

Results were to be reported in graphical and tabular form with a focus on concentration isopleths for surface and depth for each of the nitrogen compounds. The ratios of nitrogen form to barium were to be presented graphically and used to test the degree of nitrogen transformation or uptake.

The under-ice field program was to be conducted in late winter (around the end of April) 2005 when the plume would be expected to be at its maximum extent. The open-water field program was to be conducted in late summer (mid-August) 2005.

The Terms of Reference for the Fate of Ammonia Study provided for a final report by September 2005. This commitment was based, however, on only the late-winter field program since, at that time, the Fate of Ammonia Study was considered separate from Special Effects Study no. 2 (plume delineation). In their correspondence of July 25, 2005, DDMI committed to conducting the open-water field program required for Special Effects Study no. 2 in August 2005 but stated that a report encompassing the open-water program would not be available to be included in the October 2005 Ammonia Discussion Paper.

**Review of the Study Report with Respect to the Requirements**

The objectives stated in Section 1 of the study report (DDMI, November 2005) are not precisely the same as the study objectives provided in the Water Licence and the approved Terms of Reference. Section 1 of the report appears to re-state the objectives in a more specific manner. This does not appear to affect the intent or implementation of the study and is not a concern, in our view.

The timing of the field programs was as planned. The under-ice program was conducted in March/April 2005 and the open-water program was conducted in August 2005. The study report was provided to the MVLWB in November 2005, an acceptable timeframe following completion of the late-summer field program.
During execution of the first (April 2005) Phase 1 field program for under-ice conditions, the initial 25 samples over an 800 m X 800 m area did not extend to the 1% effluent boundary and, therefore, an additional 15 samples were collected. This approach was appropriate to the study. For the second (August 2005) Phase 1 field program for open-water conditions, all 40 samples were collected.

For the Phase 2 programs, samples were collected at consistent locations, 11 samples within the Phase 1 grid area and 14 samples beyond. The UTM coordinates, distance from the effluent discharge point and depth to bottom at all sample stations are provided in the report. There appears to be a typo error in the header to “Table 2.2-1” on the top of page 5. This appears to be a simple continuation of Table 2.1-1 and the header should read “2005” and not “2004”. The sample locations are illustrated on a map of suitable scale for this purpose.

There are no results reported for the SNP Stations, as required in the Requirements. The report states that SNP stations 1645-18 (effluent) and 1645-19 A,B,C (60 m from diffuser) were sampled on their normal schedules which did not exactly correspond to this study’s sampling dates and that the SNP results, therefore, could not be used in the generation of isopleths. Vertical profiles at the 1645-19 SNP locations were compared to the study results to check consistency.

The report does not provide results for the AEMP stations, as required in the Requirements. The report states that the 10 AEMP stations were sampled on their normal schedule (April and August) and that the results from the farthest three stations (LDG-46, 48 and 50) were used to represent ambient lake concentrations. Vertical profiles at the four closest AEMP locations (LDG 40, 42, 43 and 45 but excluding SNP 1645-19) were compared to the study results to check consistency.

Field measurements of temperature, dissolved oxygen, pH and conductivity were collected at 2 m depth intervals through the water column at each sampling location using a datasonde instrument. Water samples were collected 2 m above bottom, 2m below ice/surface and at mid-depth using a vertical beta-bottle. The “Detailed Field Procedures” provided in Appendix A of the report states that the datasonde water chemistry profiling instrument was to be calibrated to 0 to 10 NTU for turbidity measurement, per the Requirements. However, no measurements of turbidity are reported in Appendix B and turbidity is not discussed elsewhere in the report, as required in the Requirements.

Samples were analysed at Enviro-Test Laboratories in Edmonton. Total metals (including barium and excepting iron) were analysed for all Phase 1 and Phase 2 samples to “ultra-low” detection limits, which is appropriate for this study. Iron was analysed in dissolved form for all Phase 1 and Phase 2 samples. The report does not state where the sample was filtered for iron analysis.
and we assume that this was done at the laboratory in Edmonton, which is not ideal. The report also does not state why iron was analysed in dissolved form. The Phase 2 samples were also analysed for conventional variables, major ions and nutrients, including those per the Requirements, as listed in Table 2.1-2 of the report.

The “Detailed Field Procedures” provided in Appendix A of the report states that 25% of the sample size was to be collected as duplicates and blanks for qa/qc purposes. However, Section 2.2 of the report states that 10% of the sample size was collected as duplicates and blanks for qa/qc purposes with no explanation of why this differed from the prescribed procedures.

The threshold for flagging poor qa/qc results for duplicates was a difference of >20% where concentrations were >5 times the MDL. For blanks, the threshold was a concentration of >5 times the MDL. The qa/qc data were assessed in the report and deemed to be acceptable.

The laboratory and field data for the Phase 1 and Phase 2 samples are tabularized in Appendix B of the report. Graphs of conductivity profiles over depth and along eight transects are also provided in Appendix B. Maps were provided in the report that illustrated isopleths of barium, conductivity, percent effluent, ammonia and nitrate at the three sample depths or maximum value. Isopleths were developed by computer software that applied a simple kriging method.

The percent effluent at each sampling location was calculated from ambient lake concentrations of barium (estimated from the farthest three AEMP sample locations, LDG 46, 48 and 50) and average effluent concentrations (average of 2 or 3 of the routine 6-day samples at SNP 1645-18 during the two sampling periods, April and August 2005).

Barium and conductivity data were used to delineate the vertical and lateral characteristics of the effluent plume (including the 1% boundary), which is consistent with the Requirements. Because the SNP results at 60 m from the diffuser (1645-19 A,B,C) were considered to not be appropriate for use in the data analysis for generation of isopleths, lake concentrations there and at the diffuser itself were extrapolated from the measured data. However, depth profiles for barium and conductivity were plotted at these three SNP stations and at the four closest AEMP stations (LDG 40, 42, 43 and 45) using their own data. These vertical profiles were compared to the Phase 2 samples to check for consistency between data sets.

Ammonia, nitrate and barium data were primarily used to assess the degree of nitrification within the plume, which is consistent with the Requirements. Nitrite concentrations were below detection in all samples and were not used in the assessment of nitrification. The concentrations of ammonia, nitrate and barium were converted to percent effluent for the assessment to correct for differences in background concentrations. The degree of nitrification was assessed by
comparing the isopleth maps for barium (as the “standard”) to ammonia and nitrate. Dissolved oxygen levels were reviewed to assess if the nitrification process might be oxygen limited and were found to be adequate (>2.0 mg/L minimum).

The fundamental results of the study were as follows:

1. The effluent plume was effectively delineated vertically and laterally for the under-ice and open-water conditions in April and August 2005;
2. There appears to be nitrification of ammonia to nitrate within the plume under ice-cover in April 2005; and
3. Nitrification could not be assessed for the open-water condition in August 2005 because rapid mixing and low effluent concentrations of ammonia reduced most of the in-lake ammonia concentrations to less than detection.

**Conclusions and Recommendations**

Based on this executive review of the report and our understanding of the study requirements, we find that the report does not contain any substantive flaws or omissions of a magnitude that would call into question the overall study results. Nonetheless, there were several inconsistencies that we suggest be resolved in the interest of:

1. increasing confidence and understanding of the results of this study, and
2. working towards ensuring that any future similar studies avoid such inconsistencies.

We suggest that DDMI be requested to provide, clarify or comment on the following items, drawn from this review:

1. why the study objectives are not stated in the report as they are in the Requirements and a comment on what implications this may have on the study results;
2. the apparent typo. error in the header of Table 2.1-1/2.2-1;
3. the SNP data for 1645-18 and 1645-19A/B/C and the AEMP data for the four “near” stations (LDG-40, 42, 43, 45);
4. an expanded comment on why the SNP and AEMP data was not collected in a manner where it could be integrated with the grid samples for the generation of isopleths and other analyses;
5. the turbidity data or an explanation of why it was not collected and a comment on what implications its absence may have on the study results;
6. an explanation of why iron was analysed in dissolved rather than total form and where the filtering took place; and
7. an explanation of the apparent discrepancy between the requirement for 25% qa/qc samples in the detailed field procedures versus the 10% stated in the report and actually collected.

In summary, we find that the study was conducted largely according to the requirements and that there appear to be no “fatal flaws” that would prevent the study results from being used in other work. However, we recommend that the design of any future plume delineation studies be updated with consideration of the comments provided herein and any other relevant comments that may be put forward by others. As described above, this is an executive review and it is possible that further review might identify additional questions or points of clarification.

Closing

Thank you for the opportunity to contribute to this interesting project. Please contact the undersigned if you have any questions in this regard.

Yours very truly,
GARTNER LEE LIMITED

Eric Denholm, P. Eng.
Senior Mining Consultant
February 1, 2006

Mr. Mark Anderson, President
Diavik Diamond Mines Inc.
PO Box 2498, 5007-50 Avenue
YELLOWKNIFE, NT X1A 2P8

Fax: (867) 669-9058

Dear Mr. Anderson:

Plume Delineation Report
Diavik Diamond Mine – Lac de Gras

The Mackenzie Valley Land and Water Board acknowledges the receipt of your letter dated November 24, 2005 with the attached Plume Delineation Report Annual Report as per Part H, Item 26 and Part K, item 7 (i)(ii).

This report will be reviewed and you will be contacted should additional information or clarification be required. If you have any questions, contact me at (867) 669-0506 or email mvlwbpermit@mvlwb.com.

Yours sincerely,

[Signature]

Peter Lennie-Misgeld
Regulatory Officer

Copied to: Ed Hornby, South Mackenzie District, DIAND
Kathleen Racher, Water Resources Division, DIAND
FILE NUMBER: N7L2-1645

Date: February 2, 2006

To: Mr. Mark Anderson, President

Organization: Diavik Diamond Mines Inc.

Fax Number: (867) 669-9058

Copied To: Ed Homby, SMD, DIAND
            Kathleen Racher, Water Resources, DIAND

From: Janna for Peter Lennie-Miguel, Senior Regulatory Officer

Number of pages including cover 2

Remarks:

Plume Delineation Report – Diavik Diamond Mine, Lac de Gras

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☒ For your information

☐ For your comment

☐ For your approval

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**FILE NUMBER: N7L2-1645**

**Date:** February 2, 2006  
**To:** Mr. Mark Anderson, President  
**Organization:** Diavik Diamond Mines Inc.  
**Fax Number:** (867) 669-9058  
**Copied To:** Ed Hornby, SMD, DIAND  
**From:** Kathleen Racher, Water Resources, DIAND  
**Number of pages including cover:** 2

**Remarks:**  
Plume Delineation Report – Diavik Diamond Mine, Lac des Gras

- Enclosures  
- As requested  
- For your information  
- For your comment  
- For your approval  

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Unsuccessful nrs.
Sharon Debler

From: Wilson, Anne [Yel] [Anne.Wilson@EC.GC.CA]
Sent: Monday, November 28, 2005 10:10 AM
To: Jalil Mustafa; Tony Pearse; blaisb@inac-ainc.gc.ca; balintd@dfo-mpo.gc.ca; MESL@island.net; Cotk@dfo-mpo.gc.ca; wildlife@lutselke.com; mvlwbpermit@mvlwb.com; leen@inac.gc.ca; richean@inac.gc.ca; rachelc@ykdene.com; lands&res@nsma.net; sanablak@polarnet.ca; byerses@escape.ca; lands@tlicho.com; Peter Lennie-Misgeld

Subject: RE: DDMI Plume Delineation Report

Spam: 1.85375834165391E-04

Good morning Jalil,
There must be a lag time for the report to be available? I couldn't see it on the website just now. At any rate, I wanted to let you know that a nine-day turnaround for comments not workable given the workload at this time, and EC will need more like 3 weeks to review this report (I'll have a better idea once I see size and complexity).
Thanks,
Anne

-----Original Message-----
From: Jalil Mustafa [mailto:jmustafa@mvlwb.com]
Sent: November 28, 2005 9:50 AM
To: 'Tony Pearse'; Wilson, Anne [Yel]; blaisb@inac-ainc.gc.ca; balintd@dfo-mpo.gc.ca; MESL@island.net; Cotk@dfo-mpo.gc.ca; wildlife@lutselke.com; mvlwbpermit@mvlwb.com; leen@inac.gc.ca; richean@inac.gc.ca; rachelc@ykdene.com; lands&res@nsma.net; sanablak@polarnet.ca; byerses@escape.ca; lands@tlicho.com; 'Peter Lennie-Misgeld'
Subject: DDMI Plume Delineation Report

Hi everyone;

The Plume Delineation Report for Diavik is now posted on the MVLWB website. The report is too big to be sent out via email, so please submit your comments as soon as possible before our next board meeting on December 7th. Some suggestions were made that it will be good to review this report in conjunction with ammonia discussion paper before deciding on how to proceed with the ammonia management for Diavik.

Regards;
Jalil

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