Technical Memorandum C

To: Nunavut Water Board	Date: July 15, 2011
From: Shear Diamonds Ltd.	cc:
Ref: Jericho Diamond Mine: 2AM-JER0410	

2AM-JER Renewal Application Technical Meeting June 20-21, 2011

List of Commitments: Proposed Changes to the Aquatic Effects Monitoring Plan – Jericho Diamond Mine, Nunavut

This technical memorandum is being submitted in response to the questions raised with regard to the proposed changes to the Aquatic Effects Monitoring Plan (AEMP) submitted by Shear Diamonds Ltd (Shear) in support of the Type A Water Licence renewal application filed on February 28, 2011.

The AEMP is designed to provide a detailed biotic and abiotic assessment of direct and indirect project effects, along with a comparative assessment to control systems within and beyond the project effects area. The program includes the monitoring of these effects within the Jericho River, O-Lake and Lynne Lake groups, upstream and downstream far field controls within the Jericho lake group, and two control lakes located disparate distances from the mine site.

In preparing the Type A water licence renewal application, Shear conducted a compliance audit of NWB1JER0410. The compliance report was filed with the water licence assignment application on November 16, 2010. During the audit and review of the AEMP previously submitted by Tahera Diamond Corporation (TDC), Shear determined that there were a number of deficiencies and that previous comments provided by interveners had not been addressed. Shear updated the AEMP along with the following proposed changes:

Reference Sites Evaluation

The lake known as Control Lake, selected to be a "control" for the AEMP filed by TDC is within the zone of influence identified by the air dispersion model within the Air Quality Monitoring Plan. For this reason, Shear is proposing to select a new "control" lake. The previous Control Lake will remain part of the AEMP; however it will be monitored as a far-field potential effects lake rather than as a "control". The new "control" lake selection will involve desktop and field investigations.

Evaluation criteria will include:

- Size and Shape – basin morphology directly influences water, limnology, sedimentation, and food web structure.
- Watershed and Lake Area Ratio – the ratio of watershed to surface area directly correlates with hydrologic, chemical, and sediment influx into lake systems.
- Existing or Potential Development – development or watershed disturbances can greatly alter a lake system.
- Shoreline Development – the degree to which a shoreline is irregular, or departs from a circular shape. The higher the degree of development, the higher the degree of direct interface with terrestrial influences.
- Geology – watershed and benthic geology shapes the nature and amounts of dissolved solids, nutrients, metals, etc., that are naturally found within the system, along with influx potential from adjacent watershed areas.
- Proximity and Practicality – providing reliable data in an economical and logistically feasible manner is essential for insuring comparative data.
- Existing Data – previous baseline and monitoring data can prove useful for establishing the baseline criteria for future monitoring efforts.
- Abiotic Parameters – existing water chemistry, limnology, bathymetry, water retention period, substrate character, morpho-edaphic index, and seasonal temperature profile are important for establishing criteria for comparative evaluations of baselines and potential effects.
- Biotic Parameters – the precise nature of the existing biotic assemblages along with the seasonal fluctuations within the food web are important for defining existing baseline biotic variability and evaluating potential future effects.

Once a site has been identified, the location will be provided as an addendum to the AEMP for review and approval.

Sample Locations General Principles

Rationale for site selection under the previous AEMP is incomplete and sparse. The sampling program for this AEMP provides substantial expansion and coverage with respect to biotic component assessment and number of sites. Each sampling site is chosen to provide assessment of identified direct and indirect projects effects or to provide a control for assessment of these effects. The specific rationale for site selection, location, sampling methodology, and frequency used for the AEMP are described in detail within the specific description sections for each identified indicator within the AEMP. In general, sampling locations were based on the following general principles:

- Areas of potential direct impact will be sampled. For sites with a direct interaction of watercourses or waterbodies, near-field and far-field sites will be established to provide for future dispersion evaluations.
- New sites will be incorporated to provide more extensive coverage of indirect project effects and enhance controls.
- Efforts will be made to incorporate as many previous sites as possible to maintain consistency with past studies and monitoring programs and to extend monitoring data for trends analysis.
- Where practical, a suite of abiotic and biotic sampling will be employed at each site.
- Where practical, the sampling schedule will incorporate a seasonal element to enable assessment of seasonal variability.

Water Quality
The following stations are being proposed as additional water quality sampling locations:

- New reference lake, JER-AEM-02
- Lake O1, JER-AEM-19
- Lake O2, JER-AEM-20
- Lake O4, JER-AEM-21
- Contwoyto Lake (at the outlet of Lynn Lake), JER-AEM-25

Sediment Quality
The following stations are being proposed as additional sediment quality sampling locations:

- New reference lake, JER-AEM-02
- Lake C4, JER-AEM-13
- Lake O1, JER-AEM-19
- Lake O2, JER-AEM-20
- Key Lake, JER-AEM-23
- Lynne Lake, JER-AEM-24

Sediment Deposition
The following stations are being proposed as additional sediment deposition quality sampling locations:

- New reference lake, JER-AEM-02
- Key Lake, JER-AEM-23

Dissolved Oxygen
The following stations are being proposed as additional dissolved oxygen sampling locations:

- Lake O2, JER-AEM-20
- Carat Lake Outlet, JER-AEM-16
- Key Lake, JER-AEM-23

Aquatic Biota
The sampling site selection and rationale for the biotic component of the AEMP was based on enhancing the previous program with respect to the following key goals:

- Increase sample sites and frequency to provide better coverage of near-field and far-field conditions.
- Provide linear sample site arrays for ascertaining potential effect gradients associated with known direct impact pathways.
- Increase sampling effort on potential direct effects and reduced efforts on far-field sites in order to reduce overall potential for data variability while providing greater capacity for early detection of potential changes in biotic components.
- Introduce a pilot periphyton program to assess its viability in enhancing current efforts.
- Removal of redundant sites that increase potential data variability, reduce data interpretation, and do not provide defensible data for indirect, direct, or control conditions.

Based on these goals the following changes were made to the previous sampling program sites, with respect to each biotic component.

- Phytoplankton and Zooplankton
    - Sampling sites were increased from 5 to 6.
    - Sampling frequency for several sites has been increased to provide a seasonal representation. Results will be used to help define the natural variability within the system.
    - Previous sampling sites at Control Lake and Jericho Lake were removed. The Control Lake site was removed as a control due to acknowledgment that it experiences indirect effects. These effects will be ascertained with the retention of the Reference Lake site. The Jericho Lake site was

removed in order to increase sampling efforts on new indirect and direct sites along with reducing overall potential data variability.
- Sites at the Reference Lake, Lake C3 and Carat Lake were retained to provide data for continuation of long term trends analysis, and for comparison with results from historic reports.
- Three new sites are established. One at Lake O2 to provide data for the O Lakes system. One at Key Lake to provide data for the Lynne Lakes system. An additional site within the northern basin of Carat Lake was established to assess for inter basin differences and potential effects from stream C2.

- Fisheries and Fish Tissue
  - Currently a fisheries program and fish tissue sampling program is not included in the proposed AEMP. Slimy Sculpin fish tissue work was included in the previous AEMP.

- Periphyton
  - A pilot periphyton program has been incorporated into the new AEMP. The original AEMP did not include such a program.
  - A total of four sampling sites are included and are designed to ascertain possible dispersion effects near the confluence of stream C3 and Lake C3, and stream C1 and Carat Lake.

- Macroinvertebrates
  - The new AEMP will expand the previous program by increasing the total sampling sites from 5 to 15 (not including 3 new sites at a control lake to be determined).
  - Sampling frequency for several sites has been increased to provide a seasonal representation. Results will be used to help define the natural variability within the system.
  - Historic sampling sites at Control and Reference Lakes were eliminated as they did not fit the requirements of a true reference or control lake. Control samples will be obtained at a new control lake site.
  - Previous single sampling points have been changed to linear arrays of three sampling sites to better assess potential dispersion effects along gradients that include stream, confluence, and lake habitats for each of the identified direct impact pathways (streams C1, C2, and C3).
  - The new program include implementation of linear sampling arrays for the O and Lynne Lakes systems, which were not include in the previous AEMP program.
  - Previous sampling sites between Lake C3 and Carat Lake, and the Jericho Lake site have been removed in order to focus efforts on direct impact areas and reduce the introduction of data variability.

Additional Sites in Response to Fine Processed Kimberlite Dispersal

During the under-ice sampling for the AEMP in April, 2011, Shear noted that fine processed kimberlite (FPK) has become airborne and deposited outside of the PKCA. In response, Shear has proposed these additional sampling locations to the AEMP:

- Lynn Lake and Key Lake have been added to the under-ice sampling (April) of the AEMP.
- Two previously unnamed lakes (Southeast Lake and Shine Lake) have been added to the open water AEMP sampling program. Both of these lakes were frozen to the bottom when sampled in April of this year.
- Ash Lake was frozen to the bottom and thus will remain an open water sampling station.

Additional Commitments Made at the Technical Meeting

In addition to the proposed changes already discussed in this technical memorandum, Shear made the following commitments during the Technical Meeting and Pre-Hearing Conference held in Cambridge Bay on June 20th and 21st, 2011.

- Shear will include core sampling.
- Shear will include a minimum of one duplicated sediment deposition trap at designated sediment sampling location, starting with the 2012 AEMP.
- If issues are identified through the AEMP sampling program that suggest that parameters or other factors may be affecting fish health, Shear will reinstate the fish studies.
- In 2012, Shear will conduct seasonal sampling of phytoplankton and zooplankton in Carat Lake and the newly established “control” lake.
- Shear has agreed to perform annual zooplankton and phytoplankton sampling in Lake C3, Carat, Key Lake, Lake 02, Control and Lynne.

Shear distributed a number of hand-outs at the Technical Meeting, those that are applicable to this technical memorandum are provided as:

- Attachment A – Core Sampling Materials and Methods, Jericho Diamond Mine, Nunavut
- Attachment B – Statistical Analyses, Data and Outliers, Jericho Diamond Mine, Nunavut
- Attachment C – Figures 3 through 9, inclusive.

If you, or any interveners, have any questions, or require further clarification, please do not hesitate to contact me.

Sincerely,

Julie Lassonde
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ATTACHMENT A

Core Sampling Materials and Methods (Field), Jericho Diamond Mine, Nunavut

Introduction

Core samplers penetrate the sediment more deeply than grab samplers. Consequently, they provide a cross-sectional slice of sediment layers and thus, information about the sediment deposition. There are many types of core samplers for specific applications. For the proposed application of obtaining a small sediment sample for chemical analysis, it is recommended that a Kajak-Brinkhurst (KB) sampler be used.

A picture of a modified KB sampler and related sampling equipment is provided below. A core sample is obtained by lowering the sampler into the sediments and sending a messenger weight to trip the spring-loaded suction cup, sealing the top of the core tube. This coring device uses suction to hold the sediment sample inside the core tube during retrieval. The depth of the sample is controlled by the distance the device is allowed to fall before entering the sediments.

The corer is a portable sampling device, deployed and recovered by hand. The KB corer is best suited for studies that do not require large amounts of sediments. The modified KB corer is not a good sampler choice for soupy or very soft sediments because the suction force cannot hold in the sample. It also may be difficult to obtain a core sample in extremely firm substrates, such as clay.

Equipment Requirements

In addition to all necessary equipment required for a safe and organized field outing, the following will be needed specifically for sediment core collection:

1. Core tubes
2. Extruder
3. Sectioning apparatus
4. Stage
5. Rubber stopper
6. Spatula
7. Screwdriver
8. Large plastic tub
9. Siphon tubing
10. Measuring device
11. Non-talc, disposable nitrile gloves
12. Cleaning brush
13. Deionized water
14. Sample cooler and ice packs
15. Field logs (on Rite-in Rain paper)

16. Plastic bags (Ziploc, garbage)
17. Preprinted sample container labels, with extra blank labels
18. Chain of Custody tags and forms
19. Pencils, indelible ink pens (fine and regular)
20. Camera
21. Depth finder
22. Maps, charts, aerial photographs
23. GPS unit
24. Cell phone
25. Sediment Sample Containers – appropriate containers for project-specific analyses

Decontamination/ pre-field preparation

Pre-clean the core tubes, core slicers, and any other devices coming into contact with sediments before use in the field. The following cleaning procedure is suggested (Blakley 2008) for sediment sampling. However, individual projects may require additional or different decontamination procedures depending on the analytes of interest.

- Wash using Liquinox detergent.
- Rinse three times with tap water.
- Wash with 10% nitric acid (for metals analyses).
- Rinse with deionized water.
- In fume hood, rinse with acetone, then hexane (for organics analyses).This step is intended to remove trace organics from the sampling equipment, although

EPA (2001) also recommends it for field samples of "unknown composition". Many sources, including EPA (2001), recommend only an acetone rinse. Because the acetone molecule has both polar and non-polar components it is a good solvent for a broad range of chemicals. It is miscible in water and readily evaporates, serving as a drying agent. Hexane is also a good solvent for organic compounds and is recommended here for thoroughness, particularly for analyses of dioxins and PCBs.

Air dry in fume hood and wrap with aluminum foil (shiny side of foil facing out)

Sample Collection

Deployment

Determine the water column depth of the sampling location using a depth finder or weighted line. Place the core tube inside the sampling housing apparatus and tighten the hose clamps around the tube. Make sure the tube is held tightly in the housing apparatus. While keeping the messenger weight on board, lower the corer through the water column. Keep track of the depth of the corer by counting the meters on the calibrated line. When the bottom of the corer reaches approximately 0.5 m above the substrate, let the line drop quickly and allow the corer to settle into the sediments. To prevent the corer from tilting and disturbing the sample, keep a slight tension on the line when the corer is settling into the sediment. Release the messenger weight down the line.

Retrieval

Once the messenger hits the corer, slowly lift the corer up through the water column until the core tube and rubber seal are just below the water surface. One crew member should hold the corer while another reaches under the water surface to plug the core tube with the rubber stopper. Make sure to keep the core tube and rubber seal under the water surface while plugging the bottom of the tube. It may be necessary to tilt the corer slightly to reach the bottom of the tube. In order to keep the sample intact, do not tilt the corer more than 45 degrees when placing the rubber stopper at the bottom of the corer.

Once the bottom of the liner is plugged, slowly lift the corer into the boat and place in a large tub. While the housing apparatus is still on the core tube, check to make sure that sufficient depth was achieved and that the sediment water interface is undisturbed. Loosen the hose clamps and lift the sampling housing apparatus off of the core tube. One person should hold the core tube while another crew member takes the housing apparatus off.

Tips for sample collection:

- Adjust the line release height to attain different core depths. For firmer substrates it may be necessary to release the line at a height greater than 0.5m above the sediment in order to allow deeper penetration.
- Keep spare rubber stoppers on board. They are easily dropped when plugging the core tube.

Collecting Sediment from the Sampler

After retrieving the core sample, check the sample for acceptability. A sample is considered acceptable if it is not over-filled with sediment, overlying water is present and not excessively turbid, the sediment surface is relatively flat, and the desired core length has been retrieved. It is important that the sediment-water interface remains intact while processing the sample. Unacceptable samples should be dumped overboard at a location away from the station.

Acceptable samples should be sub-sampled using the following techniques:

- Begin by measuring the penetration depth of the coring device and length of the core. For penetration depth, measure from the bottom of the corer to the highest point on the outside of the device where sediments exist. To measure core length record the length of the sediment core inside the liner. These two measurements can be used to estimate core shortening.

- Position the extruder under the rubber stopper at the bottom of the core tube and extrude the water into the large tub by gently pressing down on the core tube. Siphon off the rest of the water without disturbing the sediment and place the stage and sectioning apparatus on top of the core tube. Hold the extruder in place and gently press down on the core tube so that the core sample is extruded up into the sectioning apparatus. For 1 cm sections, extrude the sediment core up to the 1 cm calibration on the sampling apparatus. Slide the sampling apparatus onto the adjacent surface of the stage and transfer to the appropriate sample container using a spatula.
- **Note:** It is recommended that pictures be taken of each core sample prior to extrusion. The photo should show the full length of the core and the appropriately labeled sampled container it will go into.

Field Decontamination

For most sampling applications, rinsing the equipment between grabs with site water is normally sufficient (PSEP, 1997a), using a scrub brush to remove any sediment that does not rinse off easily. Rinsing can be performed by dipping the grab in the water or using pumped water. When changing waterbodies or sampling in severely contaminated sediments decontaminate with acid washes described in pre-sampling preparation.

Records Management

Complete the field log for each station sampled. Include a visually descriptive assessment of each acceptable sample (sediment interval), together with any unusual characteristics such as odor, debris, color. Other items to note include:

waterbody name, water conditions, weather conditions, time of day, crew, core length, sampling depth, corer penetration, location, sample size (cm), type of analysis, field ID, sample number, sampling program, etc.

ATTACHMENT B

Statistical Analyses, Data and Outliers, Jericho Diamond Mine, Nunavut

Outliers will be identified as part of the overall data QA/QC process. This process will include the assessment of all data prior to statistical processing to identify any potential bad data. For example, data that may have been coded incorrectly or subject to improper laboratory techniques or equipment malfunctions.

If the data is found to be erroneous, then it will be corrected, if possible, or documented and removed from the dataset. If it is not possible to determine if the outlier is bad data, depending on the number and nature of the outliers encountered, outlier significance will be determined or consideration of use of robust statistical techniques. The main aim of the outlier identification process is to identify, correct, or remove erroneous data. Data that is not proven erroneous will not be removed from the data sets.

Identifying of potential oultiers will initially be performed using graphical representations. Proposed techniques will include application of normal probability plots, scatterplots, standard deviation plots (significance at 2.5 STD from Mean), histograms and box plots. These tests will be performed for each dataset, and where warranted for each component or variable. The distribution of data will be assessed and presence, number, or trend of potential outliers noted.

Depending on the findings of the initial outlier assessments, either single or multiple outliers identification statistical tests will be performed. For multiple outliers measures will also be taken to ensure masking or swamping are avoided with supplemental graphical assessments. Statistical identification of possible outliers will be performed using a Z-Scores test or for small sample sets a modified Z-Scores test (Iglewicz and Hoaglin) with outliers identified as those with an absolute value greater than 3.5.

Following identification of outliers (graphically and statistically), measures will be taken to identify, fix or remove identified erroneous data. All remaining outliers will be subjected to formal testing. If only a single outlier is noted a Grubb's Test will be used. If multiple outliers are identified and the exact number is known a Tietjen-Moore Test will be applied. If multiple outliers are identified and the exact number is not known a Generalized Extreme Studentized Deviate Test will be run.

Appropriate tests will also be conducted prior to formal statistical analysis using techniques to correct and identify potential outliers. The chosen method of identification, assessment of significance, and diagnostics of effect will vary depending on the type of analysis being performed and the properties of the dataset.

ATTACHMENT C

Figures 3 through 9