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PROJECT MEMORANDUM

To:	**Nunavut Water Board**	**Fax No.:**	**Via e-mail**
Attention:	**Joe Murdock**	**CC:**	**Philippe di Pizzo** **John Grainger**
From:	**Holger Hartmaier (Ext. 113)**	**Date:**	**October 5, 2006**
Subject:	**Cape Dorset Sewage Lagoon Licence Amendment Technical Meeting September 19, 2006- Notes**		
No. of Pages (including this page): 9 Pages		**Project No:**	**0308-003-01**

1.0 INTRODUCTION

A technical meeting was convened by the Nunavut Water Board (Board) in Cape Dorset on September 19, 2006 to allow Dillon Consulting Limited (DCL) to provide additional information regarding the design of the proposed sewage lagoon. The documentation provided by DCL to the Board for the water licence application was previously reviewed by BGC and other interveners. As a result of these reviews, and subsequent responses by DCL, the Board arranged for this technical meeting to give all parties a forum to clarify outstanding issues.

The meeting was attended by representatives of various interested parties including:

- Hamlet of Cape Dorset
- Government of Nunavut (CGS and DOE)
- Indian and Northern Affairs Canada
- Environment Canada
- Fisheries and Oceans

Mr. Gary Strong, P.Eng., representing DCL was accompanied by Mr. Paul Cavanagh, P.Eng. of AMEC.

Board representatives present included the following individuals;

- Philippe di Pizzo, Executive Director
- Joe Murdock, P.Eng., Director of Technical Services
- Zhong Liu, Licensee Trainee
- John Grainger, P.Eng. (Associated Engineering Ltd.- Board Consultant)
- Holger Hartmaier, P.Eng.(BGC Engineering Inc.- Board Consultant)

The technical meeting comprised two parts:

- A site tour of the proposed sewage lagoon site in the morning led by Mr. Gary Strong of DCL.
- A meeting, open to the public, in the afternoon during which DCL presented their information, followed by questioning and discussion by the various parties as well as members of the public present.

This memorandum summarizes pertinent details related to the geotechnical concerns raised during the meeting to allow the Board to draft a suitable response to Dillon with respect to the next steps in securing approval of the proposed water licence amendment. It is not meant to be an exhaustive minutes of the entire proceedings.

2.0 TECHNICAL MEETING NOTES

2.1 Site Visit

The Board had arranged a charter flight to Cape Dorset from Iqaluit on the morning of September 19, 2006. The following individuals were included in this group:

- Philippe di Pizzo, Nunavut Water Board
- Joe Murdock, Nunavut Water Board
- Zhong Liu, Nunavut Water Board
- Colette Spagnuolo, Environment Canada
- Tanya Gordanier, Fisheries and Oceans Canada
- Jim Rogers, INAC
- David Abernethy, INAC
- John Grainger, Associated Engineering Ltd.
- Holger Hartmaier, BGC Engineering Inc.

A separate charter carried the representatives from DCL, AMEC and the Government of Nunavut.

Upon arrival at Cape Dorset, transportation and meeting facilities were provided by the Hamlet staff, including:

- Fred Schell, Mayor of Cape Dorset.
- Art Stewart, Senior Administrative Officer.

The site visit took place in the morning between about 9:30 AM to 12:30 PM. Weather during the site visit varied from overcast to scattered clouds with a temperature of about 7^{o} C. Site photos were taken during the inspection tour, however, due to a technical problem with the camera, none of the site photos turned out.

Access to the site was by road, using vehicles provided by the Hamlet. Kudlik Construction, the contractor for the sewage lagoon, was in the process of constructing the sewage lagoon access road. The road had been built almost to the crest of the saddle where the berm along the northeast side of the lagoon would be located.

Rock cuts exposed along the newly constructed lagoon access road provided an opportunity to assess the potential depth of frost affected bedrock at the site. The exposed bedrock along the rock cuts is granitic gneiss with a well-developed set of orthogonal joints. A prominent sub-horizontal to shallow dipping joint set pervades the rock mass, intersected by sub-vertical joints forming a blocky to tabular rock mass fabric. The spacing of the sub-horizontal joints is less than 1 m, whereas the spacing on the sub-vertical joints averages to about 1 m or more. The depth of dilated joints due to seasonal thaw was limited to the upper 1-2 m of the rock mass. In general most of the rock mass appeared massive and tight, with dilation evident only locally along the edges of outcrops or cliffs.

The lagoon site is located within a broad valley bounded on all sides by bedrock outcrops. At the north end, the access road traverses a topographic saddle at about elevation 121 m above sea level (asl) at the truck turnaround pad. The bedrock in this area is covered by a raised marine beach deposit consisting of gravel and cobbles, visually estimated to be less than 1 m thick. The lagoon berm in this area is called the “East Berm” and is aligned in an east-southeast direction across the saddle, with a crest length of about 100 m and a maximum height of about 5 m. The west, or left abutment is located along the foot of a steep bedrock ridge that rises to above elevation 205 m asl. This area is covered by a mixture of talus and raised marine beach deposits. The east, or right abutment, is mainly exposed bedrock composed of rhombic-blocky jointed granitic gneiss with a prominent sub-horizontal joint set, intersected by orthogonal joint sets. Based on visual observation, frost jacked bedrock in this area appears to be limited to less than 1.5 m depth below bedrock surface, with tight joints below, although local variations in depth are expected to occur.

The lagoon access road traverses around the east and south sides of the valley to provide access to the “West Berm” which separates the lagoon area from P Lake.

The area forming the proposed lagoon base is covered by relatively thin organics on alluvium/raised marine beach deposits comprising cobbles and boulders. The area is poorly drained, with standing water noted between boulders and saturating the thin organic soil cover. Frost wedge polygons were noted, with cobbles being preferentially sorted into the margins of the polygons and the finer gravel, sand and silt fractions in the centre.

The West Berm is aligned in a north-northwest direction and spans the entire base of the valley of about 200 m, with a maximum height of about 7 m. The north (left abutment) will be on exposed bedrock for about one-third of the length of the berm. The north abutment rises steeply to form a bedrock cliff above the crest of the berm. Talus will have to be removed from the berm foundation at the north end.

The central third of the West Berm is founded on poorly drained organics, underlain by boulders, likely of glacio-fluvial origin and polygonally patterned ground, indicative of seasonal freeze-thaw activity within the active zone.

The south abutment is composed of granitic bedrock overlain by raised marine beach gravel and cobbles. The overburden unit may be several metres deep, based on observations of bedrock slope and the presence of larger scale frost-wedge cracks on the surface.

During the site visit, DCL indicated that AMEC would be carrying out a drilling program that week using the air track drill available from the road construction contractor. BGC discussed the details of the drilling program with Mr. Paul Cavanagh, P.Eng. of AMEC during the site tour. The probe holes are intended to determine the extent of frost affected bedrock and provide information on the depth of the cut-off trench required. BGC noted that this method of exploration would not yield the information to determine the extent of the frost affected bedrock required for the design of the cutoff trench as it would be difficult to identify zones of ground ice content and to distinguish bedrock from large boulders.

AMEC intended on installing thermistors into the hole on a temporary basis to measure ground temperatures. BGC raised a concern that the thermistors may not be measuring the true ambient ground temperatures due to the effects of drilling disturbance. BGC's experience is that at least one month, and likely several months are required to obtain stabilized temperature readings in boreholes drilled into permafrost affected ground. BGC suggested that dedicated thermistors should be installed in each hole. It should be noted that the depth of the active zone is at its greatest at this time of year. The cut-off trench should penetrate below the active zone to ensure that the liner is tied into permanently frozen ground.

The site tour continued downstream of the West Berm, along the south side of P Lake to the outlet of P Lake. The south shoreline of P Lake is composed primarily of raised marine beach gravels and cobbles overlying bedrock. The outlet of P Lake discharges into a small wetland area located at the head of a narrow bedrock gulley filled with talus that slopes down to the ocean. DCL reported that the maximum depth of P Lake was about 2.75 m. This would indicate that the lake likely freezes to the bottom over much of the lake area during the winter. As such, it would be unlikely that there is a talik under the lake.

Construction materials for the lagoon berms were being processed by the contractor using waste rock excavated from the access road construction. Stockpiles of screened material were noted adjacent to the contractor's lay down area. The main berm construction material will be a -3/4'" material, with processed sand used as bedding and cover for the geosynthetic liner.

The site tour was completed at approximately 12:00 noon. The group broke for lunch and reconvened at 1:30 PM at the Community Centre for the public meeting and technical presentation by DCL/AMEC.

2.2 Technical Presentation

A public meeting was arranged by Board and Hamlet representatives to provide an opportunity for DCL/AMEC to address the issues raised by various interveners from the review of the documents submitted for the water licence application.

Mr. Gary Strong, P.Eng. of DCL provided a summary of the project history and the work that was carried out to select the site, treatment options and general design criteria. Mr. Paul Cavanagh, P.Eng. of AMEC provided a point by point response to the issues raised by interveners, primarily with respect to permafrost and geotechnical aspects.

During these presentations, the attendees were free to ask questions at any time. With respect to the Board, Mr. John Grainger, P.Eng., of Associated Engineering questioned DCL regarding the effluent quality and treatment aspects. Mr. Holger Hartmaier, P.Eng. of BGC questioned AMEC and DCL on the geotechnical issues. It is understood that Mr. Grainger will be preparing a separate summary of the technical meeting (in parallel with this one) with respect to the sewage treatment issues.

The following pertinent geotechnical issues were noted by BGC during the technical presentations by DCL and AMEC:

1. AMEC will be collecting site specific stratigraphy and thermal data to finalize the design. As noted previously, BGC has concerns regarding the use of the air track to gather this information.
2. The configuration of the GCL liner has been changed. Instead of being a vertically oriented liner in the middle of the berm, the GCL will now be inclined on the upstream side of the berm down to foundation grade, then horizontally along the foundation into the cut-off trench. The exact position within the embankment is still being finalized. The details of the liner connection to the sub-grade will be required as well.
3. AMEC does not believe seepage analysis is necessary as the liner will extend down to the permafrost.

4. The depth of the cut-off trench will be determined from the probe holes being done the week of the meeting. BGC does not think that the air track holes will provide the appropriate information to determine that depth. Further, construction monitoring will be required to confirm that the cutoff trench is located in good quality frozen rock.
5. AMEC has reviewed the construction drawings prepared by DCL. Both companies are now in agreement as to the final design requirements.
6. A liner was added to the East Berm.
7. Additional thermal modelling will be carried out by AMEC based on the information received from the construction site investigations to finalize the configuration of the liner and other details. An assessment of global warming will be carried out to demonstrate that the lagoon will remain contained over the life of the facility. BGC noted that accurate temperatures will be required to support the thermal modelling. BGC indicated that use of temporary thermistors in the air track holes would likely not result in accurate ground temperature readings.
8. BGC expressed concern that the revised liner configuration would now expose the sewage discharge pipe going through the embankment to freezing upstream of the manhole where the shutoff valve is located. This could lead to potential rupture of the pipe due to expansion of the water, leading to an uncontrolled discharge of the lagoon contents and potential breach of the dam. BGC suggested moving the shutoff valve to the upstream side of the pipe. AMEC will review this design detail.
9. BGC expressed concern regarding the spillway across the crest of the West Berm. DCL noted that the berm would be constructed of a -¾" material. BGC was concerned that this material would be unable to withstand erosion if the spillway were subject to a flood event. DCL considers that the 0.5 m of freeboard would be sufficient to store any runoff from a flood event. BGC requested that DCL justify this in their design report, as the details of the flood handling have not been included in the submitted documents.
10. DCL/AMEC must provide details on the Quality Assurance/Quality Control (QA/QC) plan for construction inspection, and provide as-built drawings.

Since the 2006 construction season has now come to an end at this site, no further work will be carried out this year on lagoon construction. This delay in the schedule provides time for DCL and AMEC to conduct additional site investigations and refinements to the design to address the issues raised by the interveners.

3.0 DISCUSSION

Based on the site inspection and the technical presentation, BGC is encouraged that DCL and AMEC are now proceeding with the gathering of additional site specific geotechnical information. The proposed probe holes using the air track drill supplied by the lagoon construction contractor, should however be supplemented by core drilling. BGC recommended in the meeting that core drilling using a chilled brine drilling fluid be used in the winter to recover intact frozen samples of the overburden and frost affected bedrock along the berm foundations. This will provide relatively undisturbed samples of overburden and rock to determine the minimum depth of the cut-off trench. A suggested minimum depth of exploration is 3 times the maximum height of the berm, or 20-25 m.

Thermistors should be installed in the abutments and valley bottom of the West Berm and left in place with data loggers to record daily temperature readings so that stabilized temperature readings are obtained. It may already be too late to capture the maximum depth of the active zone, as cooler weather will now affect shallow thermistor readings during the period when the boreholes are recovering from drill induced thermal disturbances.

The configuration of the GCL liner presented at the hearing is improved from that shown in the previous documentation, however BGC recommended that the liner not be installed in a vertical configuration in the cut-off trench as shown by DCL. The sides of the cut-off trench should be sloped at 45^{o}, and the liner placed on the sloping surface on the upstream side of the trench into the base of the core trench. This will ensure that the overlaps of the individual liner panels are positively sealed by the weight of the embankment fill placed on top.
The water retention capability of the lagoon depends on the berm liner being integrated with the permafrost, as the lagoon base is unlined. As such, the depth of the cut-off trench must meet the following criteria:

- Extend below the zone of frost affected bedrock associated with the active zone.
- Penetrate into the permafrost to depth greater than the maximum predicted depth of thaw associated with the impoundment of the lagoon, over the life of the facility (including the effects of global warming).

AMEC should carry out additional thermal analysis to finalize the design of the liner and depth of cut-off trench, using the information gathered from the geotechnical investigations. With the revised liner configuration, the sewage discharge pipe through the berm may be subject to freezing upstream of the manhole. BGC recommended that AMEC consider another option to move the shutoff valve to the upstream end of the pipe, so that the portion of the pipe through the embankment remains dry. AMEC will review this design detail.

4.0 RECOMMENDATIONS

DCL and AMEC should re-submit a complete set of documentation for the water licence application. The design report, contract drawings and specifications should be consistent and reflect the final design details. From a geotechnical perspective, the long-term water retention capability must be demonstrated. Since the proposed lagoon design does not incorporate a fully lined lagoon, the design must, as a minimum, satisfy the following requirements:

- Geotechnical investigations that confirm the depth of the frost affected bedrock and the integrity of the rock mass at the proposed base of the cut-off trench.
- Stabilized ground temperature measurements to show that the liner is tied into permafrost.
- Geothermal modelling demonstrating that the long-term thawing of the permafrost under the lagoon does not affect the core trench and the liner tie-in.
- The cut-off trench must extend far enough into the abutments to prevent seepage around the end of the liner through the active zone.
- Re-design of the configuration of the discharge pipe through the embankment to ensure that the pipe remains dry on the downstream side of the liner to prevent freezing between discharge periods. Locating the shutoff valve at the upstream end of the pipe also eliminates having a pipe pressurized with the head of water in the lagoon within the body of the dam.
- Details on selection of extreme flood event, freeboard and lagoon operating levels, spillway design and flood handling.

From the Board perspective, the documentation must provide assurance of the long-term water retention capability of the lagoon, as well as meeting the effluent quality criteria.

5.0 CLOSURE

DCL and AMEC are the engineering consultants for the noted design. BGC's review provided herein does not constitute an assumption of liability for their responsible works.

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Yours truly,
BGC Engineering Inc.

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