January 19, 1996

M. M. Dillon Ltd.
201, 5102 - 51 Street
Yellowknife, NT X1A 1S7

Dillon File: 95-2832
EBA File: 0701-96-12130

Attention: Mr. Gary Strong, P. Eng.
Project Manager

Dear Sir:

Subject: **Geotechnical Review for Proposed Grise Fiord Sewage Lagoon**

EBA Engineering Consultants Ltd. (EBA) has completed a review of the design drawings and geotechnical information for a proposed new sewage lagoon at Grise Fiord, N.W.T. This letter presents our comments. This is in response to a request received from M. M. Dillon Ltd. (Dillon) in a memorandum dated January 8, 1996. The design drawings, geotechnical investigation report and some correspondence were provided to EBA for review.

The design indicates that the lagoon will be constructed partially in cut (of up to about 3.5 m) and partially with an embankment, with excavated soil being used to construct the embankment. The design upstream (interior) slopes are 3H:1V in both fill and cut. The design downstream slopes of embankments are 4H:1V. The existing soil, observed in three test pits up to 1.4 m deep, is reported to range between:

- Coarse gravel with many cobbles and small boulders with a matrix of coarse sand; and
- Generally silty sand with varying amounts of these constituents and gravel, cobbles and boulders.

The coarse soil was considered to prevail over about the western one-third of the proposed lagoon site and the finer soil was considered to prevail below a depth of 0.6 m over the eastern two-thirds of the site.

The design shows the embankment being constructed with a core of the finer soil and a shell of the coarser soil. The cut slopes show no provision for erosion protection. Dillon identified this as a concern in an earlier review completed on behalf of the Northwest Territories Water Board. EBA has been requested to specifically comment on the requirement for erosion protection on the cut slopes.

EBA is of the opinion that some form of erosion protection should also be constructed on the cut slopes. This is particularly important in the portion of the lagoon excavated in the finer soil. Silty sand at the waterline is not expected to stand at a 3H:1V slope. The erosion protection should extend from the top of the slope to some distance below the minimum anticipated water level.

Recognizing that the previous comments are opinion, an attempt was made to find more authoritative direction. The subject of erosion protection is not given much attention in the references examined, particularly in cut slopes. However, typical cross-sections of northern dams are provided in Johnston (1981) and Sayles (1987). In all cases riprap, rock fill or gravel is indicated on the entire upstream face of the dam. Precedent suggests erosion protection is called for.

The foregoing comments deal with the possibility of the physical erosion of soil by water. Thermal erosion of permafrost by impounded water can also be expected. It is presumed that the designers have considered this and that the natural soils adjacent to the lagoon are considered to be thaw stable.

Other concerns were identified during this review. These are briefly discussed in the following:

- The depth of seasonal thaw in the embankment was predicted to be on the order of 0.7 m. Accordingly, a minimum freeboard of 1.0 m was recommended. However, two test pits excavated in the zone of finer soil on July 6, 1994, reportedly encountered frozen soil at depths of 0.6 m and 0.8 m. The test pits were excavated relatively early in the thaw season. It is expected that the depths to frozen soil would have been greater in late August. Thaw penetration in an embankment can be expected to be greater than in original ground. It seems as if the depth of seasonal thaw may have been underestimated.

- The description of the thermal analysis does not indicate that warm years were accounted for. The mean thawing index for Resolute is 252 degree (C) days. The maximum recorded is 441 degrees (C) days and the 1:100 return is 435 degree (C) days. Warm years should be considered in design.

- The spillway is shown to be 0.3 m deep. The predicted 0.7 m of thaw will penetrate, below the spillway, to the design water level in the lagoon. This would provide an opportunity for seepage, beneath the spillway, out of the lagoon. The seepage could initiate thermal erosion of the frozen core of the embankment and increased seepage. Sayles (1987) describes five cases where dams on permafrost have had problems because of thawing and seepage at spillways and outlet works. This is an area that requires careful attention in design.

- The design requires 0.3 m of subexcavation and backfill below the embankment. If the active layer is 0.7 m thick, this suggests that there might be a zone of unsaturated soil below subexcavation level. The unsaturated soil might provide a seepage path.

- Has the porewater salinity of the embankment construction material been investigated? If porewater salinity is present in the embankment fill, the freezing point of the porewater will be depressed. This could allow seepage at ground temperature below 0°C.

EBA was not provided with information on the proposed construction methodology or scheduling. The successful construction of frozen core dams or embankments is dependant on methodology and schedule. It is presumed that these considerations have been addressed to the satisfaction of other reviewers.

We trust that these comments satisfy your present requirements. Please contact the undersigned if you have any questions or comments.

Yours truly,

EBA ENGINEERING CONSULTANTS LTD.

REGISTERED PROFESSIONAL ENGINEER
JAN 19/96
T. E. HOEVE
N.W.T.

THE ASSOCIATION OF PROFESSIONAL ENGINEERS, GEOLOGISTS and GEOPHYSICISTS OF THE NORTHWEST TERRITORIES
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T. E. Hoeve, P. Eng.
Project Director, N.W.T.

Reviewed by:

W. T. Horne, P. Eng.
Review Engineer

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REFERENCES

Johnston, G. H. (editor), 1981. Permafrost Engineering Design and Construction; Chapter 9; Dams and Reservoirs. John Wiley & Sons, Toronto.

Sayles, F. H., 1987. Embankment Dams on Permafrost. U.S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory (CRREL), Special Report 87 - 11.