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August 21, 2007

Dillon Consulting Limited
P.O. Box 1409,
4920 47th Street
Yellowknife, NT X1A 2P1

Attn: Mr. Gary Strong, P. Eng., Project Officer

Dear Mr. Strong:

Re: Additional Geotechnical Analyses for P-Lake Sewage Lagoon, Cape Dorset, NU

1.0 INTRODUCTION

The Government of Nunavut is planning to construct a new sewage lagoon for the community of Cape Dorset, Nunavut. In 2005, AMEC Earth & Environmental, a division of AMEC Americas Limited (AMEC) was retained by Dillon Consulting Limited (Dillon) to provide geotechnical assessments for the proposed lagoon and, in July 2007, to undertake construction monitoring services during excavating the cut-off trench underneath the lagoon berms.

The 2005 geotechnical report ("Geotechnical Investigation for P- Lake Sewage Lagoon, Cape Dorset, NU") prepared by AMEC for Dillon included the following:

- description of inferred subsurface condition based on the field reconnaissance;
- geothermal modeling of the berm;
- assessment of available borrow sources in the nearby vicinity of the lagoon;
- recommendations on liner positioning with in the berm.

Field drilling and slope stability analyses were not carried out during preparation of the 2005 geotechnical report. A seepage analysis was also not performed, assuming that water seepage cannot occur through the frozen core berm with installation of a liner.

Berm construction was commenced in July 2007. AMEC personnel, Dmitry Dumsky, monitored excavation of the cut-off trench for two berms, located at the north and west sides of the lagoon. The construction monitoring report was completed in a separate letter-report and submitted to Dillon on August 20, 2007.

The present geotechnical report contains a review of the geothermal conditions for the berm based on as built information and in-situ subsurface conditions obtained during monitoring the cut-off trench construction. Also, the present geothermal analysis was based on a revised schedule of lagoon filling, and revised berm dimensions. Slope stability analyses were also undertaken for the berm and road sections. It is understood that a bentonite liner will be installed in the berm material and embedded at a minimum of 2 m into the native soil at location, shown in Dillon Drawing 111. The result of current geothermal analyses indicates that the native soil in this location will be frozen one year after berm construction is completed. Hence, seepage analysis was not considered to be necessary.

2.0 IN-SITU SOIL CONDITIONS AND BERM DIMENSIONS

The soil profile, observed during excavation of the cut-off trenches comprised mainly silt over clay. Bedrock was encountered at about 35% of trench length below silt or clay at shallow depth (less than 2 m) while no bedrock was encountered in about 65% of trench length to 2. 5 m below the ground surface ("Cut-off Trench Excavation, Sewage Lagoon Berms Construction Monitoring, Cape Dorset, NU", AMEC, 2007). The base of the trench was in frozen clay or bedrock over the entire length. It is expected that within such sections of the cut-off trench, the bedrock would be found at a depth of about 3 m below the ground surface. Thus, the soil profile and berm material, analyzed in the present report is summarised as follows:

- berm material – sand and gravel;
- native soil from ground surface to 3 m depth - silt and clay;
- native soil below 3 m depth - bedrock.

Berm dimensions, applied in the geothermal and slope stability analyses, were the following:

- Height of berm is 6 m.
- Width of crest is 4 m.
- Upstream and Downstream slope of berm are 2.5H:1V.

The typical road section in fill area has the side slope of 2H:1V and a maximum height of 8.5 m and be constructed on an existing slope.

3.0 GEOTHERMAL ANALYSES FOR BERM STRUCTURE

A geothermal analysis was carried out to assess the present and future thermal regime within the Cape Dorset sewage lagoon berm and the berm foundation soils based on the above described soil profile and berm dimensions. Additionally to that, the analysis assumed that the waterproof liner will be installed within the berm near the centre of the crest.

The geothermal modeling program SIMPTEMP, 2D version, (developed in-house by AMEC) was used to analyze geothermal regimes for the berm. The simulator uses the finite element method to compute a numerical solution of the heat transfer problem. Physical/mathematical algorithms used in the SIMPTEMP model have been published, and the simulation process has been verified: both against well-known analytical solutions of the heat transfer problem, and as compared with numerical solutions produced by other commercial/non-commercial geothermal software. AMEC has successfully used the SIMPTEMP program for a variety of geothermal applications over a ten years period.

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The following section briefly describes the boundary and initial conditions applied over the model grid, soil input parameters, model setup, and results of the analysis.

3.1 BOUNDARY AND INITIAL CONDITIONS

3.1.1 Boundary Conditions

The air temperature data and snow depth used for the present analysis were based on the Climate Normals for Cape Dorset weather station for period from 1970 to 2000. The mean monthly air temperatures and snow thicknesses used for the SIMPTEMP model are presented in Table 1.

Table 1: Mean Monthly Air Temperatures and Snow Thicknesses

Data	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temp., °C	-25.0	-26.0	-21.6	-14.1	-5.5	2.3	7.4	5.7	1.5	-3.9	-11.7	-20.2
Snow, m	0.48	0.47	0.55	0.58	0.41	---	---	---	---	0.13	0.25	0.40

Mean monthly surface temperatures were applied over the exposed berm surface, the ground surface downstream of the berm slope and over the water surfaces upstream of the berm slope. To obtain the mean monthly surface temperatures, various n-factor coefficients were used over the berm, ground surface downstream of the berm and water surface.

3.1.1.1 Berm Slopes and Crest

It was assumed that practically no snow would accumulate on the berm slopes and crest. Therefore, an n-factor of 0.9 was applied to the mean monthly air temperatures to obtain the mean monthly winter temperatures on the berm surface. An n-factor of 1.2 was applied to the mean monthly air temperatures to obtain the berm surface temperature in summertime.

3.1.1.2 Terrain Downstream of Berm

It was assumed that snow could accumulate beyond the toe of the berm. Based on 1D geothermal analysis, it was estimated that n-factors for the terrain type would be 0.65 and 0.83 for the winter and summer air temperatures, respectively. These n-factors represent the insulating/warming effect of snow cover in the winter, and the cooling effect of the moss/lichen vegetation in the summer.

3.1.1.3 Water Surface Upstream of Berm

It was assumed in the model that filling the lagoon with sewage will be gradual in a rate of about 0.45 m per month. Such rate will result in the water depth of 5.4 m after 12 months of the lagoon filling. It was further considered that the sewage will be discharged from the lagoon instantaneously at the end of each September after 12 months of the lagoon filling. The resulting fluid level will be about 0.45 m above the ground surface after the previous year discharge. This schedule was repeatedly applied in the model during the 30 years of the lagoon operation.

It was assumed that snow would accumulate on the lagoon surface in the winter. Similar to the downstream terrain area, an n-factor of 0.65 was applied to the mean monthly air temperatures for the winter months (October through May). From June through September, it was assumed that the water temperature over the entire depth of the water column was the same as the mean monthly air temperatures.

Table 2 provides data on the mean monthly surface temperatures that were applied over the upper boundary of the geothermal model.

Table 2: Mean Monthly Surface Temperatures on Model Mesh

Data	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dyke Crest and Slopes	-22.5	-23.4	-19.4	-12.7	-5.0	2.8	8.9	6.8	1.8	-3.5	-10.5	-18.2
Downstream Surface	-16.2	-16.9	-14.0	-9.2	-3.6	1.9	6.1	4.7	1.2	-2.5	-7.6	-13.1
Water	-16.2	-16.9	-14.0	-9.2	-3.6	Water temperature equals air temperature.				-2.5	-7.6	-13.1

3.1.2 Initial Temperatures

The initial berm and active layer temperatures were taken as 2 °C, corresponding to the berm material temperature and active layer temperature at the end of summer. The initial sewage temperature also in wintertime was assumed to be 5 °C. The initial soil temperature from the base of the active layer and to a depth of 12 m was taken to decrease linearly from 0 °C to -5 °C; the soil temperature then was warmed gradually down to the bottom of the grid with the geothermal gradient of 0.02 °C/m.

Zero heat flux was applied at lateral boundaries of the grid, while the heat flux at the mesh bottom corresponded to the geothermal gradient of 0.02 °C/m.

3.2 SOIL INPUT PARAMETERS

Estimates of physical properties for various typical soils encountered within the berm and berm foundation were based on published information and field observations during construction monitoring. Thermal properties of the materials (thermal conductivity and heat capacity) were selected based on available published data, and on previous experience with similar materials. Saturated and unsaturated berm materials were considered in the upstream portion and downstream portion of the berm section, respectively. The construction design drawing indicates that a 500 mm thick rip-rap will be placed on the upstream slope. This layer has

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insignificant influence on the results of geothermal analyses and therefore was not included in the model. Table 3 summarizes the material physical and thermal properties applied for the geothermal analyses.

Table 3: Physical and Thermal Soil Properties

Soil Type	Dry Density, kN/m^3	Moisture Content, %	Thermal Conductivity, W/m/°C		Heat Capacity, $MJ/m^3/°C$	
			Frozen	Unfrozen	Frozen	Unfrozen
Bedrock	28	2	2.90	2.90	2.58	2.58
Unsaturated berm - sand and gravel	20	7	2.90	2.73	2.26	2.68
Saturated berm - sand and gravel	19.6	15	2.61	2.26	2.26	2.51
Silt & Clay	17	20	1.69	1.57	2.14	2.49
Water	10	---	2.20	0.58	1.95	4.19

3.3 MODEL SETUP

The model grid in the native soil was 150 m deep and 54 m wide. The berm was 5.85 m high with the upstream and downstream slopes of 2.5H : 1V. The grid contained 5158 nodes and 8058 finite elements.

The water level in the impoundment increased at 0.45 m in the beginning of each month and, after 12 months of increase, the water level was instantaneously dropped down to an elevation of 0.45 m above the ground surface. These procedures were applied annually during 30 years of the lagoon operation. It was also assumed in the model, that the berm construction was completed on September 30, and the lagoon filling started on October 1, meaning that the model ran 30 years, beginning from October 1, 2007.

3.4 RESULTS OF GEOTHERMAL MODELING

The results of temperature contours at the end of winter and summer for various years after operation are presented in Figure 1 to 8, Appendix A. The maximum berm height was used for the thermal analyses to provide a general understanding of the ground temperature during various periods of the lagoon operation.

Figure 1 shows that at the end of the first winter, the lower portion of the active layer under the lagoon could be at temperature of about 0 °C. The active layer under the berm crest will be in an unfrozen state as well. Further downstream, the berm and active layer are frozen, having a temperature in a range from -2 °C to -4 °C.

Figure 2, shows that at the end of the first summer, the active layer under the lagoon could be about 1.8 m thick. Due to penetration of winter freezing into the berm, process of freezing commenced at the berm base where the sand temperature dropped down to -0 °C. Similar temperature was predicted in the majority of berm body. The upper portion of the active layer, about 1 m thick, is unfrozen under the berm crest at a temperature of about 0 °C.

The berm temperature will decrease considerably during the first years of the lagoon operation. Figure 3 demonstrates that at the end of the third winter, only a localized portion of the active layer (interval from 116 m to 115.5 m) under the lagoon will remain at temperature of -0 °C, while the majority of the active layer will have temperature – 0.5 °C to -1 °C. It is important to note that, due to the gradual filling of the lagoon, no formation of the talik will be observed under the lagoon. The berm base and underlying native soils will have temperature in a range of -3 °C to -4 °C.

The berm base temperature will remain frozen (temperature -2 °C to -3 °C) at the end of the third summer (Figure 4). The thickness of the active layer under the lagoon is 1.5 m, being slightly decreased from that at the end of the first summer.

During the following years of the lagoon operation, the berm temperature will be quasi-stabilized in winter and summer time. Figures 5 through 8 show that the berm base temperature will be in a range of -7 °C to -9 °C, while at the end of the summer the temperature will be at 2°C to 3 °C warmer. No talik will be created under the lagoon, if the described schedule of the lagoon filling is followed. The thickness of the active layer under the lagoon in summer time will be about 1 m.

The analysis did not include any component of climate warming over the expected life of the lagoon. Typical climate warming values could be in the range of 0.0.05 °C/year (0.5 °C/decade). Applying a climate warming scenario to the analysis would result in warmer berm temperatures at about 1 °C to 1.5 °C and a small but not significant increase of the active layer under the lagoon.

4.0 SLOPE STABILITY ANALYSES

4.1 BERM SLOPES

In order to determine the stability of the berm slopes, the most critical section was selected at the downstream slope of the west berm (construction drawing No. 109). The upstream slope and downstream slope of this section are at 2.5H:1V with the slope height of approximately 6 m.

Three failure mechanisms were assumed in stability analyses:
Case 1: A circular failure within the berm material during first several months of the operation when the berm is still in an unfrozen state.
Case 2: A planar failure of the active layer on the exterior slope of the berm with a frozen core during summer periods of the berm operation.
Case 3: Berm stability against sliding along the interface of the berm and the native material.

4.1.1 Case 1

This case considers the berm slope under construction or shortly after construction. A simplified geological profile was developed for the slope stability analyses, using available geotechnical information. The strength of the berm fill after compaction governs the stability of berm slopes. The pore water pressure within soil particles will reduce the effective overburden stress of soil and hence decrease the shear strength of soil at the failure slip. Considering that materials for the berm construction are granular soils, the pore water pressure within soil particles has been assumed to be zero.

Commercial computer software SLOPEW (Geostudio 2004) was applied for assessment of the slope stability. Due to various compositions of fill that may be used for construction, the applicable soil input parameters (unit weight, cohesion and friction angle ϕ) may vary over a wide range of values. In order to evaluate the impact of the soil input parameters on the slope stability, sensitivity analyses were conducted by varying these parameters. The potential failure surface with the lowest safety factor was initially determined using a circular search associated with the mean values of the strength parameters. The friction angle and cohesion were then kept at the mean values, and factors of safety were computed by varying the unit weight. Similar calculations were performed by varying the friction angle and cohesion. The estimated mean values, range of the input parameters and results of the analyses are summarized in Table 4.

Table 4: Input Parameters of Berm Fill and Results of Sensitivity Analyses

Input Parameters		Mean Value	Range	Factor of Safety
Compacted Sand & Gravel	Apparent Cohesion (kPa)	2	0 to 4	1.45 to 1.5
	Friction angle°	33°	31° to 35°	1.45 to 1.5
	Unit Weight (kN/m^3)	19	18 to 20	1.4 to 1.55
Native Silt & Clay	Apparent Cohesion (kPa)	25	20 to 30	1.25 to 1.7
	Friction angle°	0°	----	----
	Unit Weight (kN/m^3)	18.5	----	----

Figure 9 in Appendix A presents a sensitivity plot for the berm slope. The strength parameters and unit weight are normalized to values ranging between 0 and 1. Zero indicates the lowest value in the parameter range, and 1 indicates the highest value. The point where the sensitivity lines cross is known as the deterministic factor of safety at the mean values of the strength parameters. The potential failure surface and safety factor using the mean values is shown in Figure 10.

Figure 9 indicates that the safety factor against slope failure is generally close to 1.5 for various soil parameters. The safety factor of 1.4 to 1.5 is generally considered to be acceptable in geotechnical practice. The only exception is that if the undrained shear strength of the overburden soil (3 m thick silt & clay) reduces to the lower bound value (20 kPa), the safety factor will decrease to less than 1.3. However, this lower bound value of strength corresponds to soft material which is unlikely presents at the site, based on field observation during construction monitoring. The results of the geothermal analysis also suggest that the active layer thickness (silt/clay) beyond the downstream slope will be less than 1 m, i.e. the silt/clay below the 1 m depth will generally be frozen during the lagoon operation. Therefore, the risk of existence of soft material below the 1 m depth is low.

For the upstream slope, the active layer in the impoundment area may extend 2 m below the ground surface after 1 year of operation (end of summer). The slope stability analysis for the upstream slope has confirmed that the safety factor is above 1.4. During the following years, the active layer thickness will decrease to 1.5 m and 1 m after 3 and 5 years of operation, respectively, resulting in the increase of the safety factor.

4.1.2 Case 2

The stability of the active layer, overlying a frozen slope during summer periods was assessed. The thaw depth (thickness of the active layer) on the berm slope was obtained based on the results of geothermal analysis. The maximum thickness of the active layer, as was predicted by geothermal analysis, can reach 2 m to 2.5 m at the end of summertime.

The safety factor of the slopes was calculated using the limit equilibrium theory by comparing the total resistance force along a failure slip (interface between active layer and frozen soil) to the total driving force along the same failure slip. In addition to the base resistance along the slip, the side shear resistance of the active layer also contributes to the total resistance, hence increasing stability of the slope. Resistances along both lateral sides of the failure zone were considered, applying a side factor of 0.7. The limit equilibrium theory, applicable to the described application, was developed by Dr. E. McRoberts of AMEC.

The analyses were carried out for an assumed failure slope of 17 m long (along the berm slope) and 20 m wide. Similar to case 1, sensitivity analyses were carried out using the same mean values and ranges of the soil parameters as it was outlined in Table 1. The results of analyses for the active layer, 2 m and 2.5 m thick, are presented in Figure 11. The factors of safety against the failure within the active layer are greater than 1.5 which suggests that the berm slopes are in a stable condition.

Figure 11 indicates also that the factor of safety of the active layer generally decreases by 3 percent with increasing of the active layer thickness from 2 m to 2.5 m. It was also found that the factor of safety decreases by 5 percent with increasing of the slope width from 20 m to 190 m (the maximum length of berm on site).

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4.1.3 Case 3

Stability of the berm against sliding due to the hydrostatic pressure applied on the interior slope was assessed by assuming that the berm is a rigid retaining structure. The friction coefficient of 0.25 was used at the interface between the berm material and the native ground, as recommended by the Canadian Foundation Engineering Manual (2006, 4rd). The lateral pressure on the interior slope was estimated based on the fluid pressure with a unit weight of 10 kN/m^3. It was found that the factor of safety against the sliding along the interface is greater than 3.

4.2 TYPICAL ROAD SECTION

Analyses were performed on typical road section for the foregoing case 1 and case 2 described in Section 3.1. Based on current construction drawing (Drawing No. 109), the fill slope of this section is 2H:1V with a maximum slope height of approximately 8.5 m. The field observation has indicated that a shallow layer of the overburden (silt or clay) may be encountered near the lower portion of the existing slope. This material was included in the slope model. All input soil parameters are the same as for the berm section.

Figure 12 below presents a sensitivity plot for the fill slope stability. The results indicated that the overall safety factor is sensitive with the cohesion value of compacted fill material and will decrease to slightly less than 1.4 if the cohesion of fill was reduced to zero. However, it is understood that an apparent cohesion will exist (based on common results of laboratory shear tests) under a relatively low normal pressure, as is the case of a shallow failure surface. Hence, the fill slope is considered to be stable. The potential failure surface and safety factor using the mean values is shown in Figure 13.

No geothermal analysis was performed on road section. It is inferred that the thickness of active layer for fill slope would be similar to that of berm section. The results of stability analyses for the active layer thickness of 2 m and 2.5 m, and with an assumed failure width of 20 m are presented in Figure 14. The factors of safety against the failure within the active layer under the lower bound parameters (cohesion or friction angle) are less than 1.4. Based on visual observations of berm fill during cut-off trench construction, the fill should have a mean value of the cohesion and friction angle, and hence, the proposed fill slope is considered to be acceptably safe.

5.0 CONCLUSION

The geotechnical analyses presented herein are based on the AMEC Geotechnical Report (October 2005), field observations during construction of the cut-off trench, and the AMEC design experience for similar structures in permafrost areas.

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The results of the geothermal analysis indicate a very unlike occurrence of the seepage under the berm, if the liner will be installed in accordance with the drawing specifications, and the schedule for the lagoon filling will be as it was provided by Dillon.

The berm and road slopes will have the factor of safety in a range from 1.3 to 1.8 against circular and planar failure, while the factor of the safety is greater than 3 against sliding the berm along the interface between the berm and the native material.

It should be noted the actual berm temperatures may differ from the predicted values. AMEC recommends that a temperature monitoring program within the berm be implemented. Several monitoring thermistor strings should be installed in wells, drilled across the berm. AMEC can develop a monitoring program upon request. If the actual berm temperatures differ considerably from the predict values, then a contingency plan should be implemented.

This report has been prepared for the exclusive use of Dillon Consulting Limited and its agents and applicable for the lagoon design in Cape Dorset, NU. Any use of AMEC recommendations by a third party, is the sole responsibility of this party. It has been prepared in accordance with generally accepted permafrost and foundation engineering practices. No other warranty, expressed or implied, is made.

Respectfully submitted,
AMEC Earth & Environmental,
a division of AMEC Americas Limited

PERMIT TO PRACTICE
AMEC Earth & Environmental, a Division of AMEC Americas Limited
Signature
Date August 21, 2007
PERMIT NUMBER: P 047
The Association of Professional Engineers, Geologists and Geophysicists of the NWT / NU

En Tzu (Peter) Hsieh, M.Sc., P. Eng.
Geotechnical Engineer

Reviewed by:
Paul Cavanagh, M.Eng., P. Eng.,
Associate Geotechnical Engineer

REGISTERED PROFESSIONAL ENGINEER
A. TCHEKHOVSKI
LICENSEE
NWT/NU

August 21, 2007

Alexandre Tchekhovski, Ph.D., P.Eng.,
Associate Permafrost Engineer

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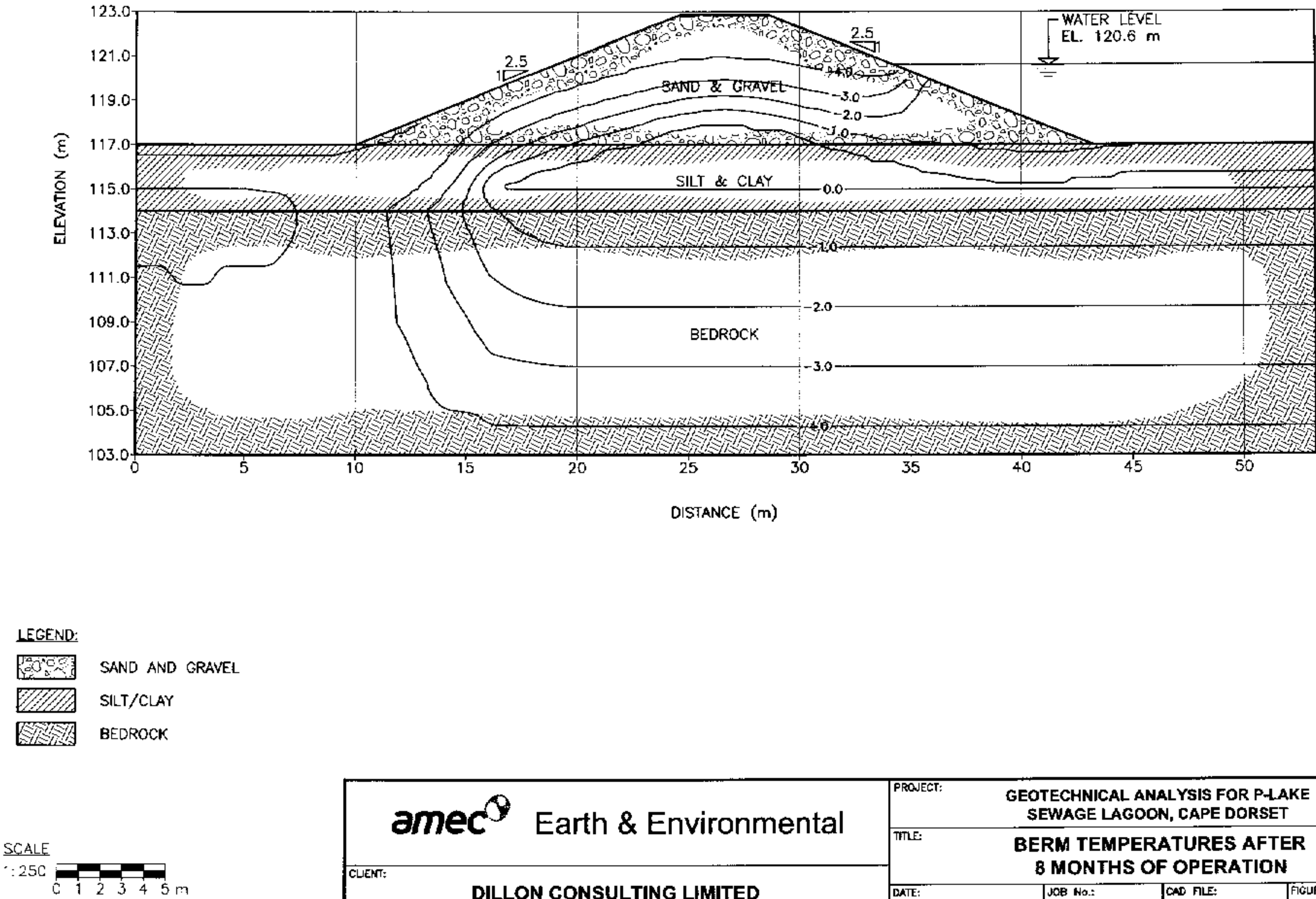
APPENDIX



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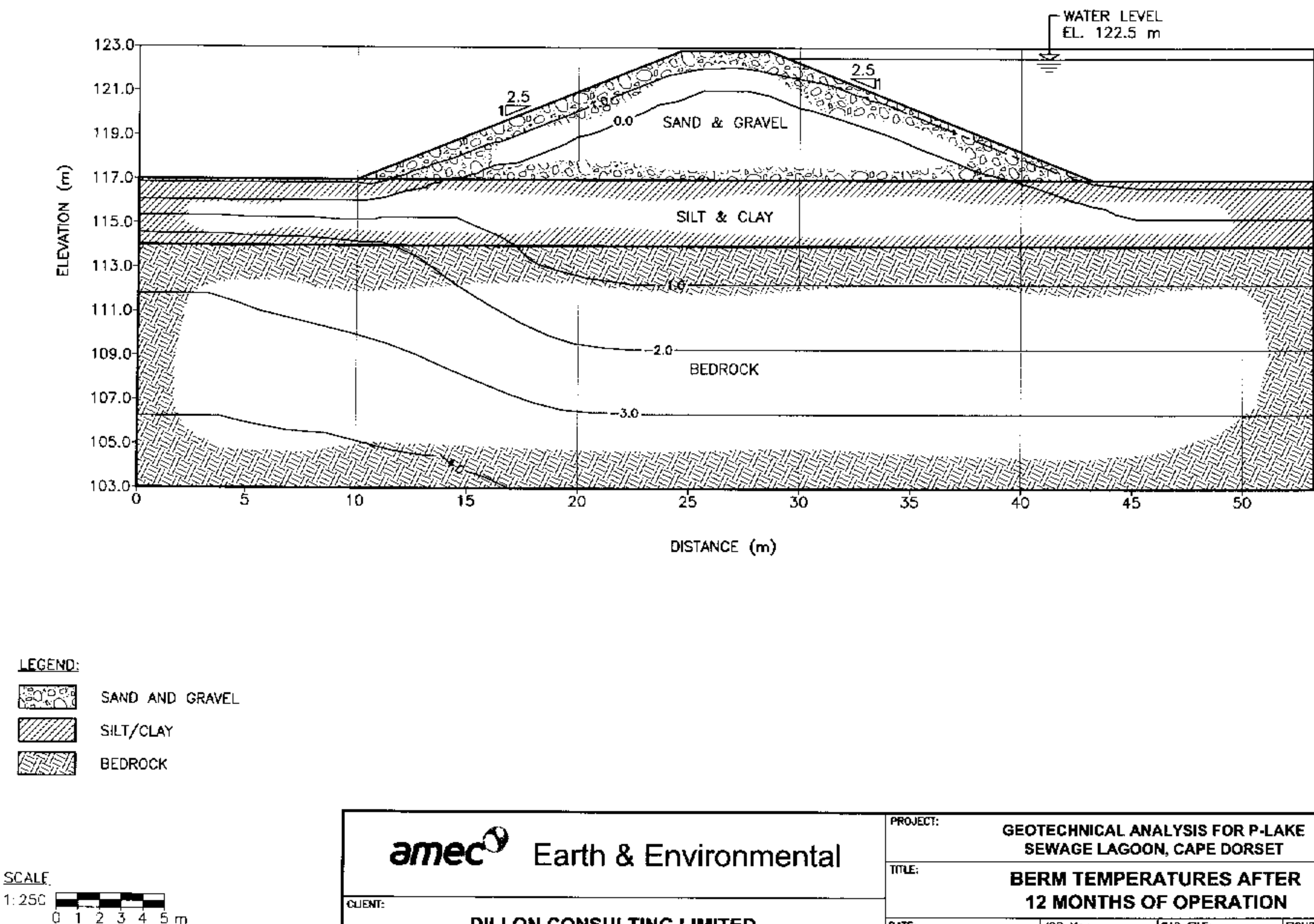
CLIENT: DILLON CONSULTING LIMITED

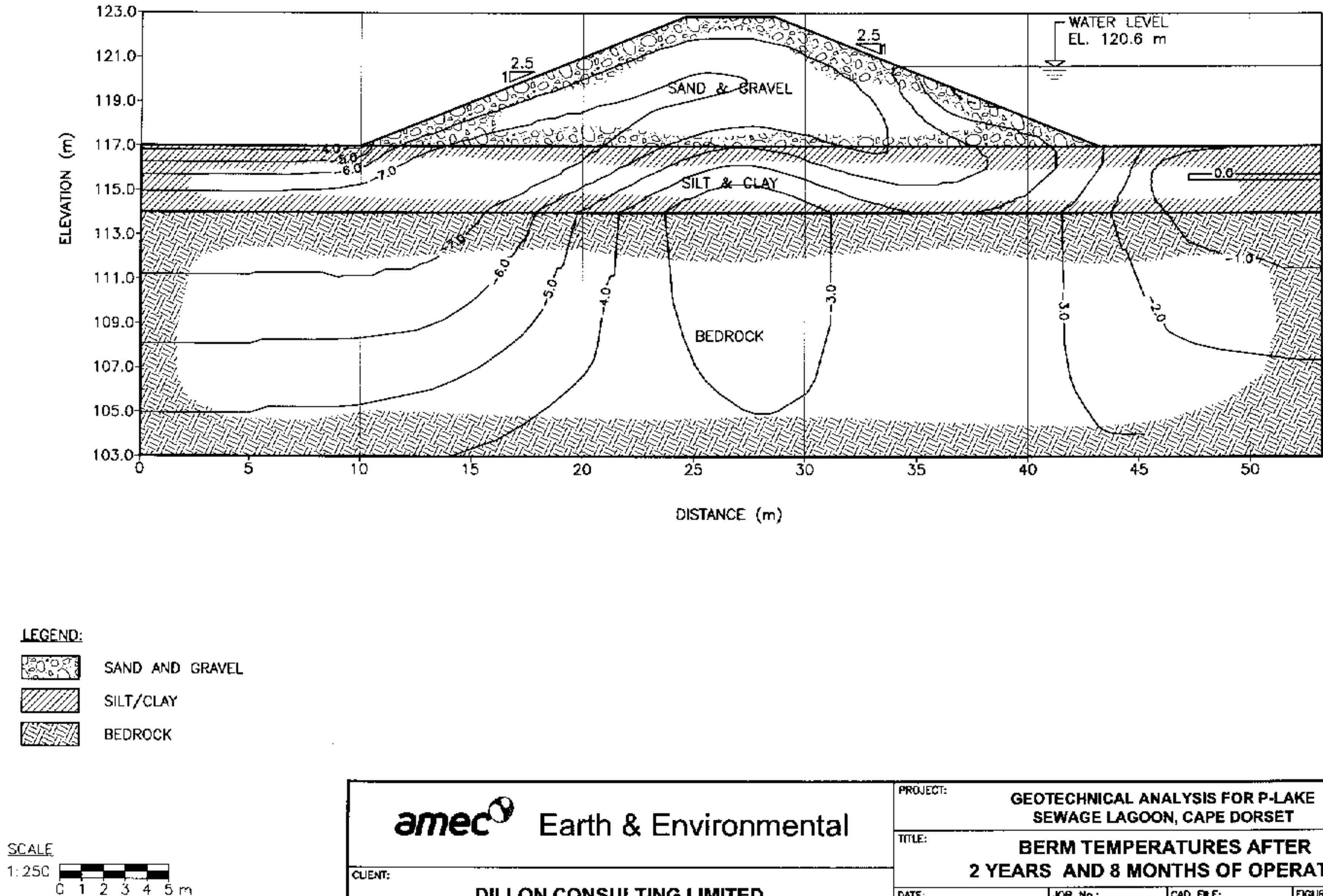
PROJECT: GEOTECHNICAL ANALYSIS FOR P-LAKE SEWAGE LAGOON, CAPE DORSET

TITLE: BERM TEMPERATURES AFTER 8 MONTHS OF OPERATION

DATE:	JOB No.:	CAD FILE:	FIGURE No.:	REV.
AUGUST 2007	YX00748	00748N00.dwg	FIGURE 1	A



amec Earth & Environmental	PROJECT: GEOTECHNICAL ANALYSIS FOR P-LAKE SEWAGE LAGOON, CAPE DORSET			
	TITLE: BERM TEMPERATURES AFTER 12 MONTHS OF OPERATION			
CLIENT: DILLON CONSULTING LIMITED	DATE: AUGUST 2007	JOB No.: YX00748	CAD FILE: 00748N00.dwg	FIGURE No.: FIGURE 2	REV. A



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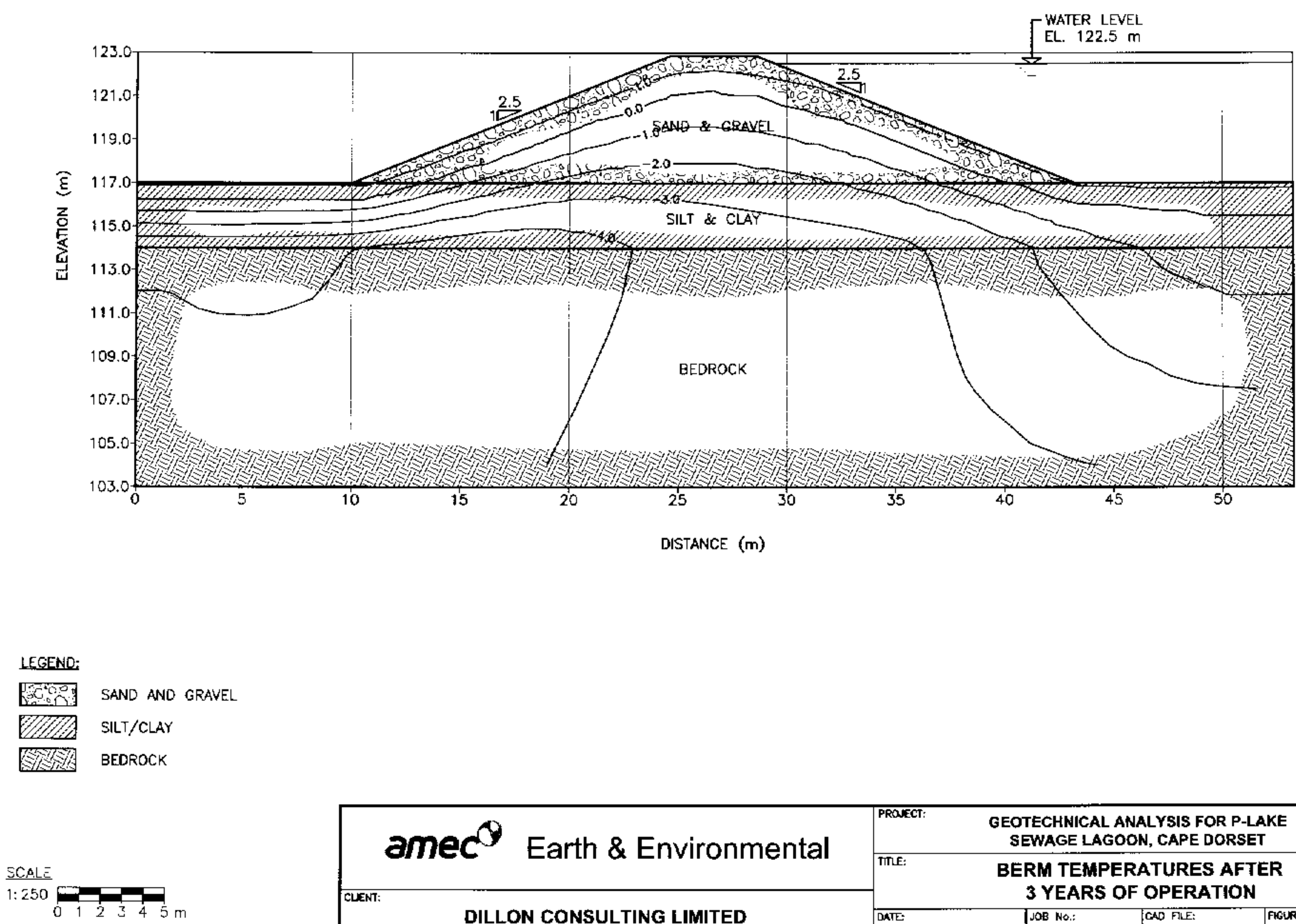
CLIENT: DILLON CONSULTING LIMITED

PROJECT: GEOTECHNICAL ANALYSIS FOR P-LAKE SEWAGE LAGOON, CAPE DORSET

TITLE: BERM TEMPERATURES AFTER 2 YEARS AND 8 MONTHS OF OPERATION

DATE:	JOB No.:	CAD FILE:	FIGURE No.:	REV.
AUGUST 2007	YX00748	00748N00.dwg	FIGURE 3	A



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CLIENT: DILLON CONSULTING LIMITED

PROJECT: GEOTECHNICAL ANALYSIS FOR P-LAKE SEWAGE LAGOON, CAPE DORSET

TITLE: BERM TEMPERATURES AFTER 3 YEARS OF OPERATION

DATE:	JOB No.:	CAD FILE:	FIGURE No.:	REV.
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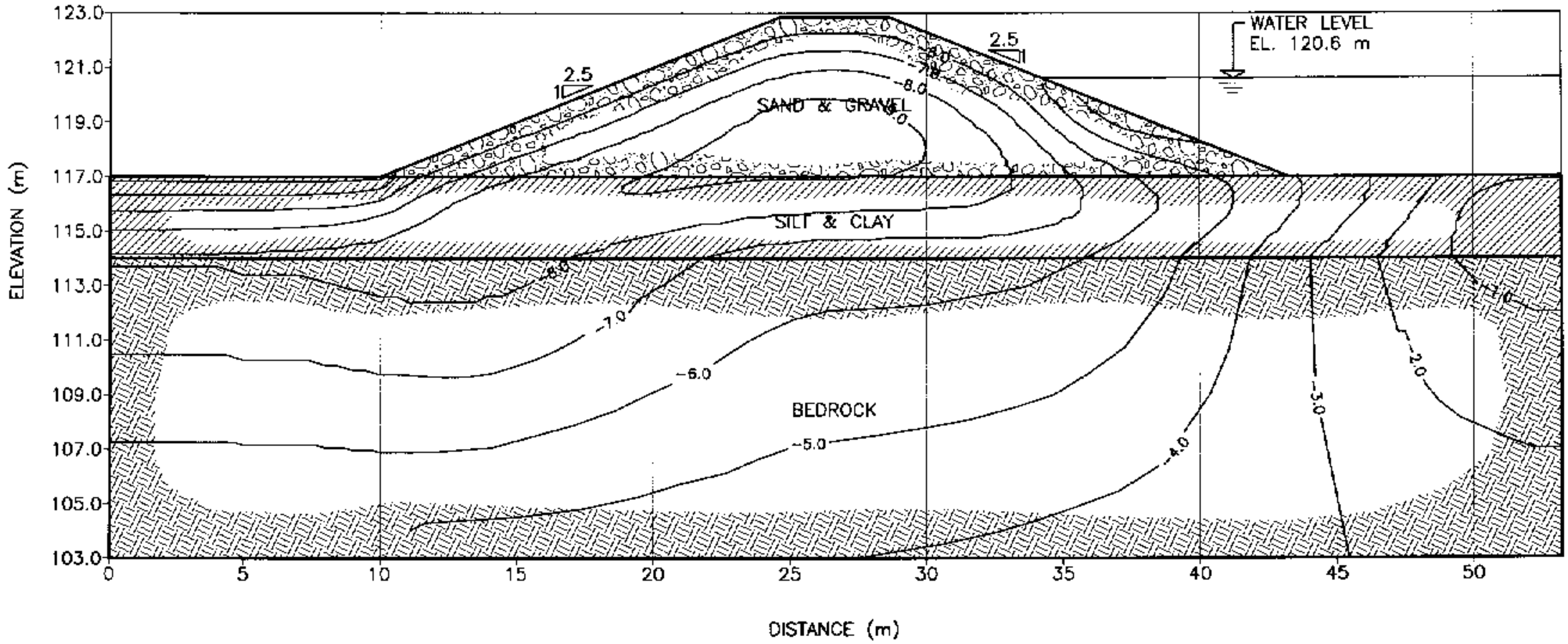

LEGEND:

SAND AND GRAVEL

SILT/CLAY

BEDROCK

SCALE
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0 1 2 3 4 5 m

amec Earth & Environmental	PROJECT:	GEOTECHNICAL ANALYSIS FOR P-LAKE SEWAGE LAGOON, CAPE DORSET
CLIENT: DILLON CONSULTING LIMITED	TITLE:	BERM TEMPERATURES AFTER 4 YEARS AND 8 MONTHS OF OPERATION

DATE:	JOB No.:	CAD FILE:	FIGURE No.:	REV.
AUGUST 2007	YX00748	00748N00.dwg	FIGURE 5	A

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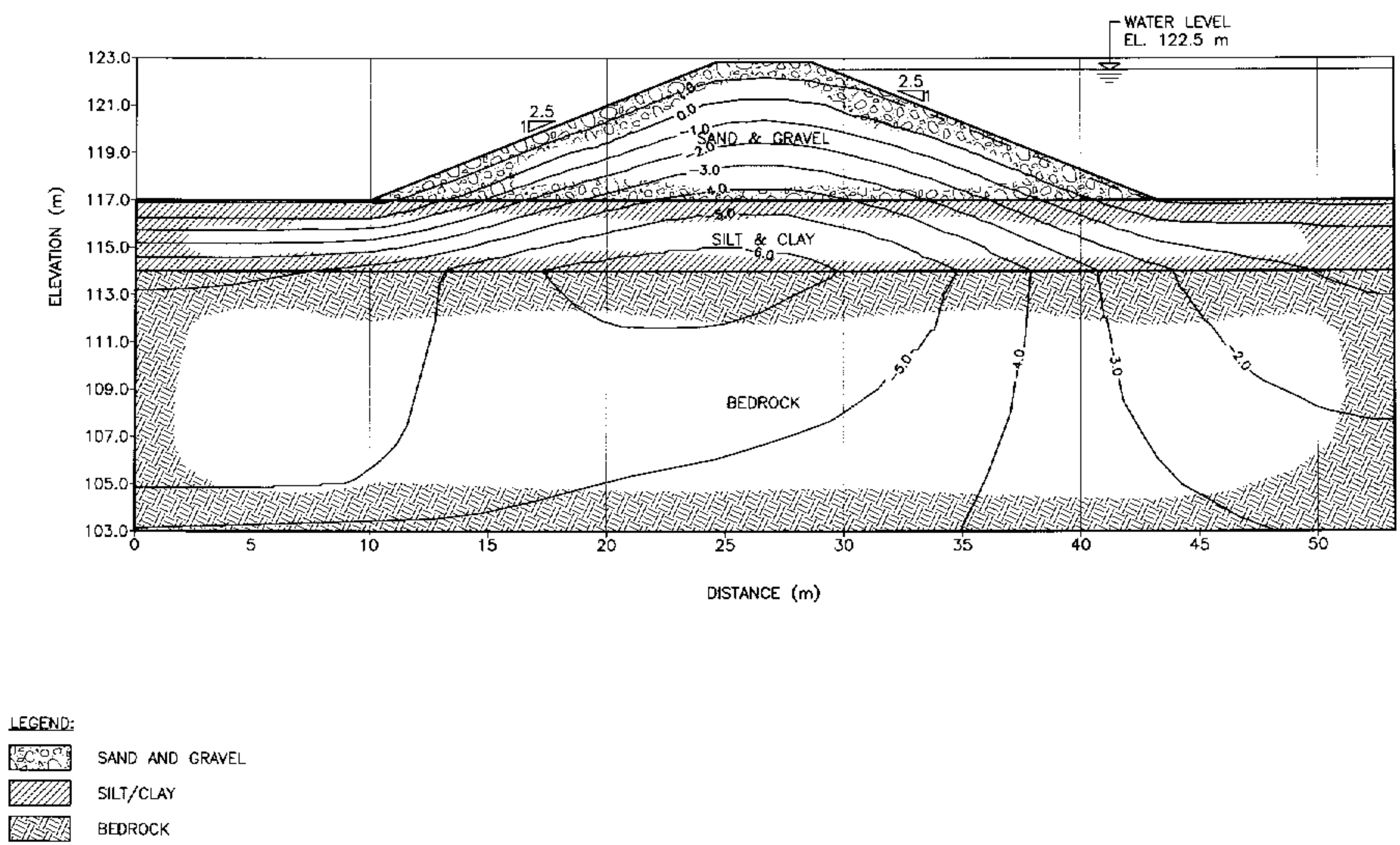
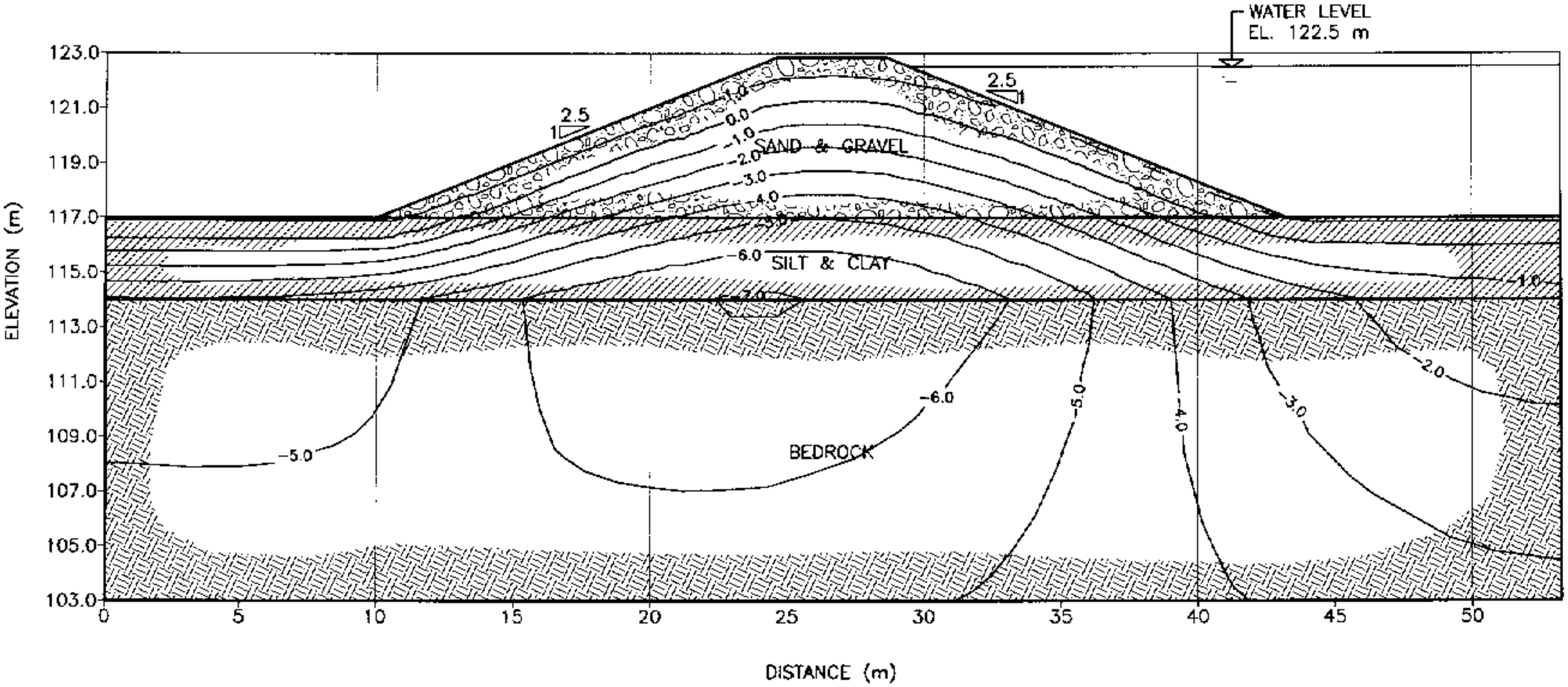


amec Earth & Environmental	PROJECT: GEOTECHNICAL ANALYSIS FOR P-LAKE SEWAGE LAGOON, CAPE DORSET				
	TITLE: BERM TEMPERATURES AFTER 5 YEARS OF OPERATION				
CLIENT: DILLON CONSULTING LIMITED	DATE: AUGUST 2007	JOB No.: YX00748	CAD FILE: 00748N00.dwg	FIGURE No.: FIGURE 6	REV. A



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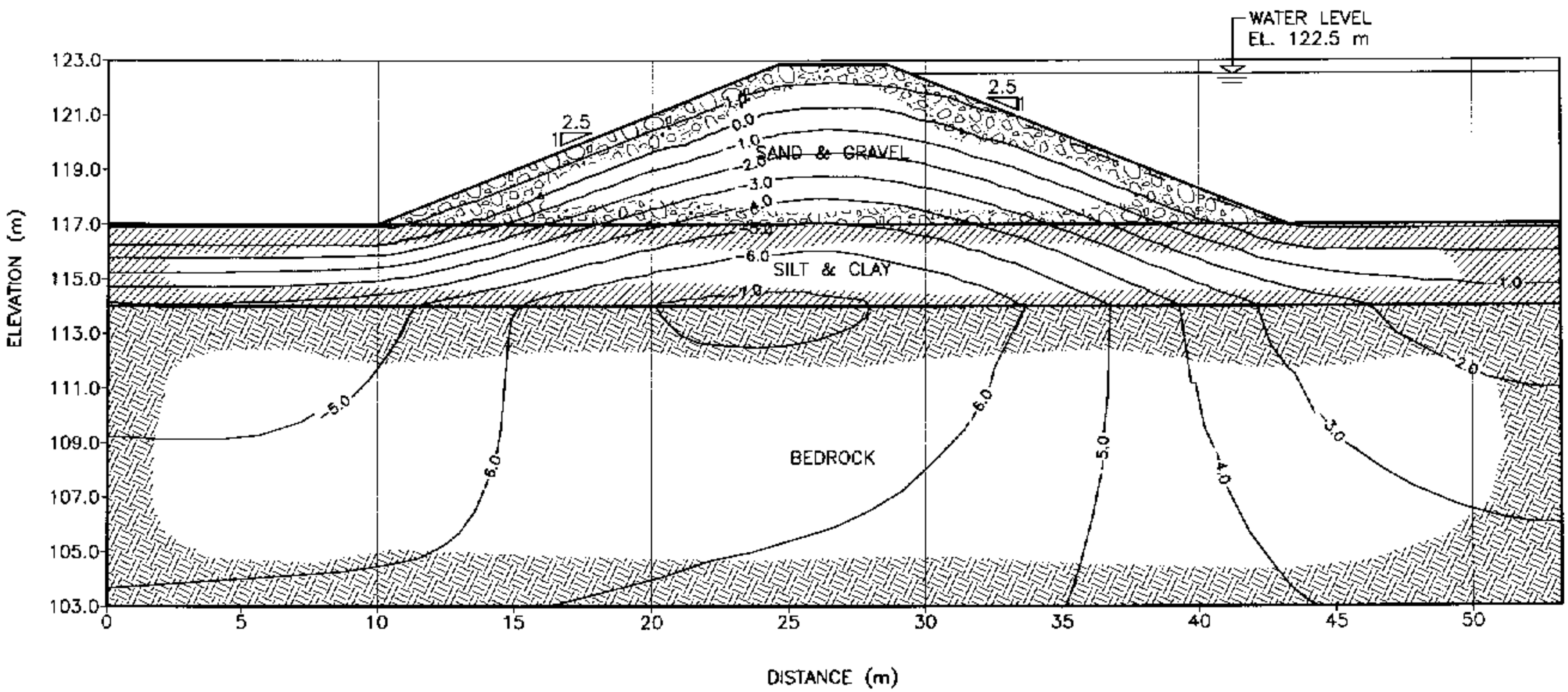
amec Earth & Environmental	PROJECT:	GEOTECHNICAL ANALYSIS FOR P-LAKE SEWAGE LAGOON, CAPE DORSET
	TITLE:	BERM TEMPERATURES AFTER 10 YEARS OF OPERATION
CLIENT: DILLON CONSULTING LIMITED	DATE: AUGUST 2007	JOB No.: YX00748 · CAD FILE: 00748N00.dwg · FIGURE No.: FIGURE 7 · REV. A



LEGEND:

- SAND AND GRAVEL
- SILT/CLAY
- BEDROCK

SCALE
1:250
0 1 2 3 4 5 m

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CLIENT: DILLON CONSULTING LIMITED

PROJECT: GEOTECHNICAL ANALYSIS FOR P-LAKE SEWAGE LAGOON, CAPE DORSET

TITLE: BERM TEMPERATURES AFTER 30 YEARS OF OPERATION

DATE:	JOB No.:	CAD FILE:	FIGURE No.:	REV.
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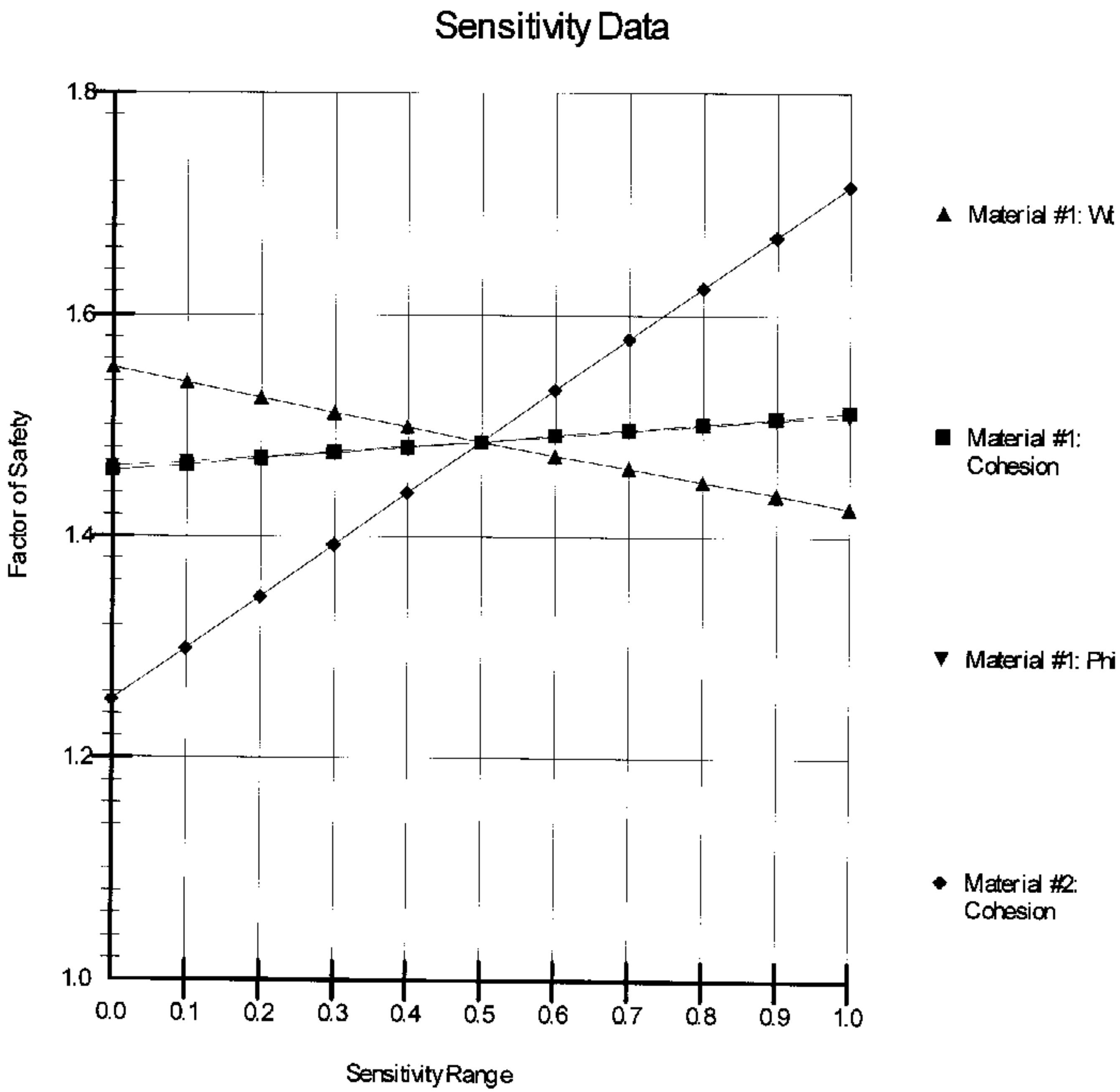
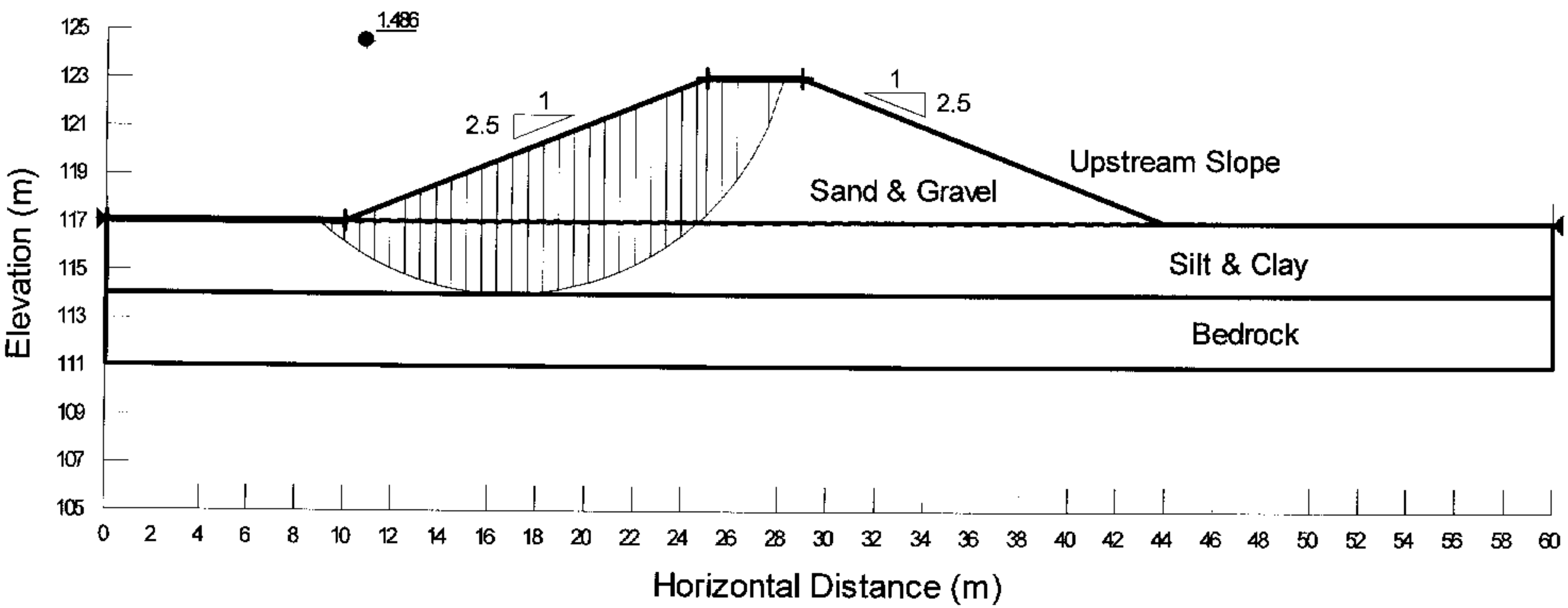
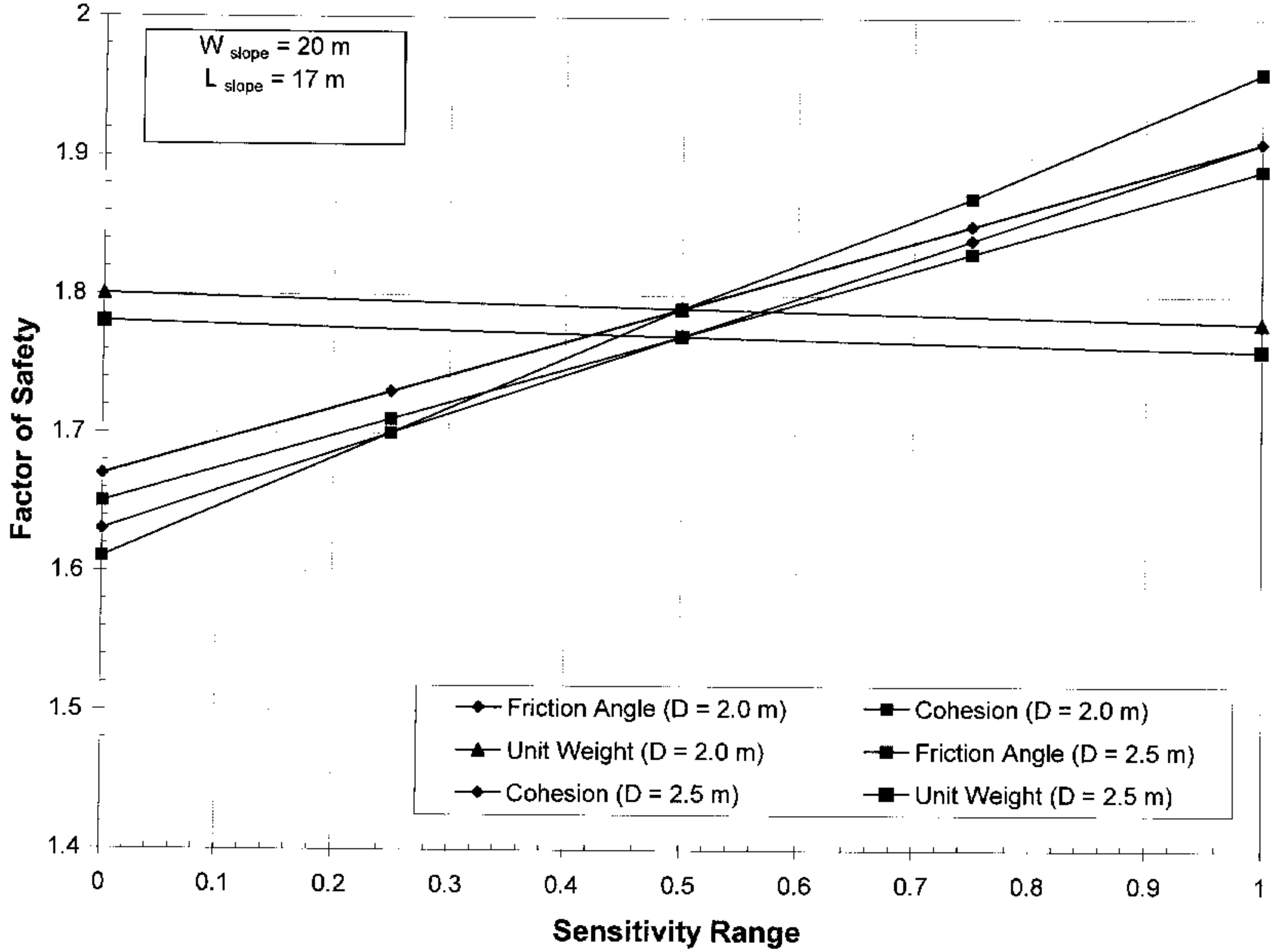


amec Earth & Environmental	PROJECT: GEOTECHNICAL ANALYSIS FOR P-LAKE SEWAGE LAGOON, CAPE DORSET
	TITLE: SENSITIVITY PLOTS FOR BERM SLOPE STABILITY
CLIENT: DILLON CONSULTING LIMITED	DATE: AUGUST 2007 / JOB No.: YX00748 / CAD FILE: 00748N01.dwg / FIGURE No.: FIGURE 9 / REV. A



amec Earth & Environmental	PROJECT: GEOTECHNICAL ANALYSIS FOR P-LAKE SEWAGE LAGOON, CAPE DORSET				
	TITLE: FACTOR OF SAFETY FOR LAGOON BERM (MEAN VALUE OF SOIL PARAMETERS)				
CLIENT: DILLON CONSULTING LIMITED	DATE: AUGUST 2007	JOB No.: YX00748	CAD FILE: 00748N01.dwg	FIGURE No.: FIGURE 10	REV. A



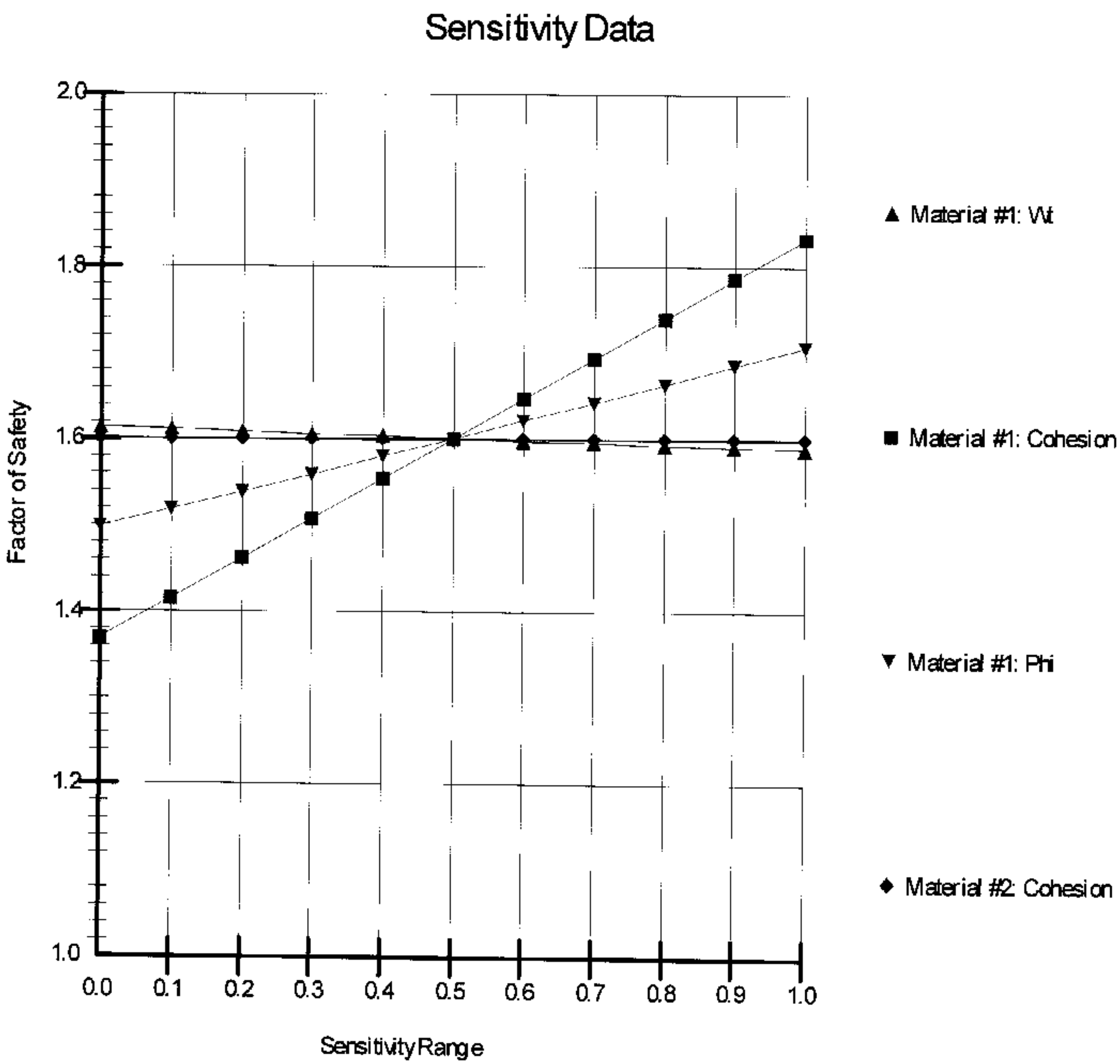
amec Earth & Environmental

CLIENT: DILLON CONSULTING LIMITED

PROJECT: GEOTECHNICAL ANALYSIS FOR P-LAKE SEWAGE LAGOON, CAPE DORSET

TITLE: SENSITIVITY PLOTS FOR STABILITY OF ACTIVE ZONE WITHIN LAGOON BERM

DATE:	JOB No.:	CAD FILE:	FIGURE No.:	REV.
AUGUST 2007	YX00748	00748N01.dwg	FIGURE 11	A



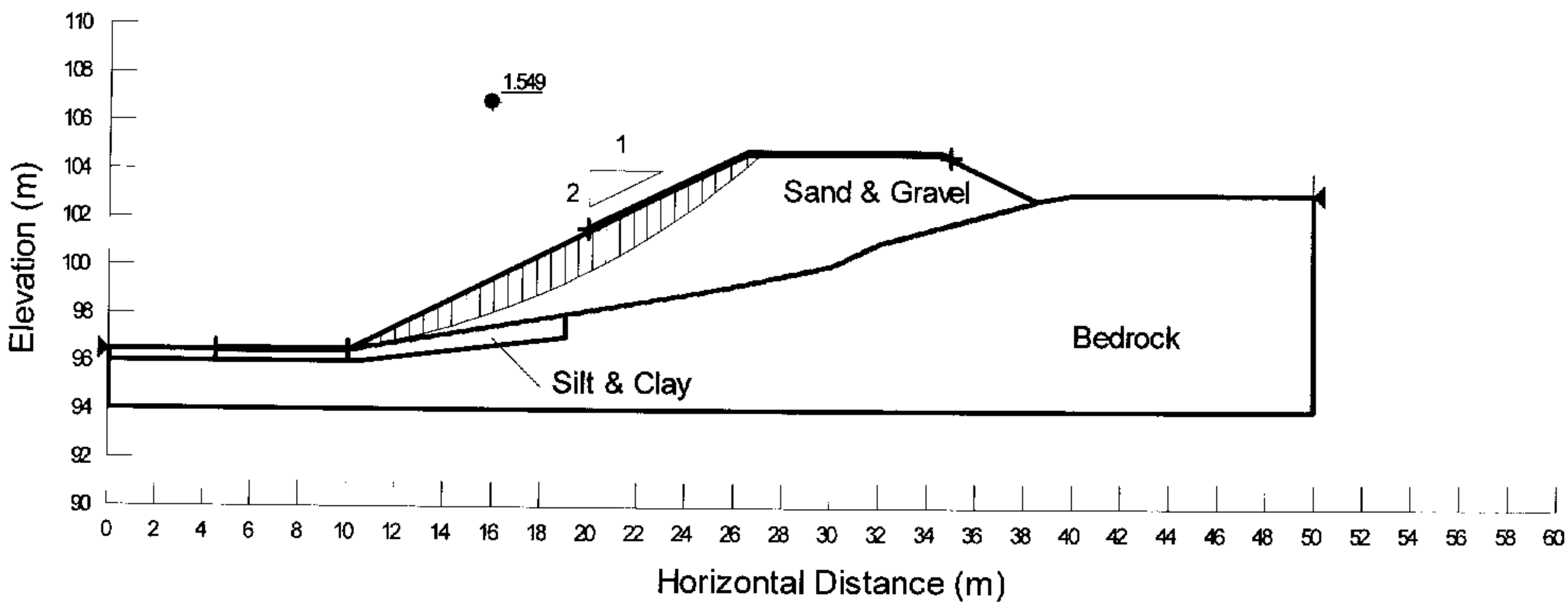
amec Earth & Environmental

CLIENT: **DILLON CONSULTING LIMITED**

PROJECT: **GEOTECHNICAL ANALYSIS FOR P-LAKE SEWAGE LAGOON, CAPE DORSET**

TITLE: **SENSITIVITY PLOTS FOR ROAD SLOPE STABILITY**

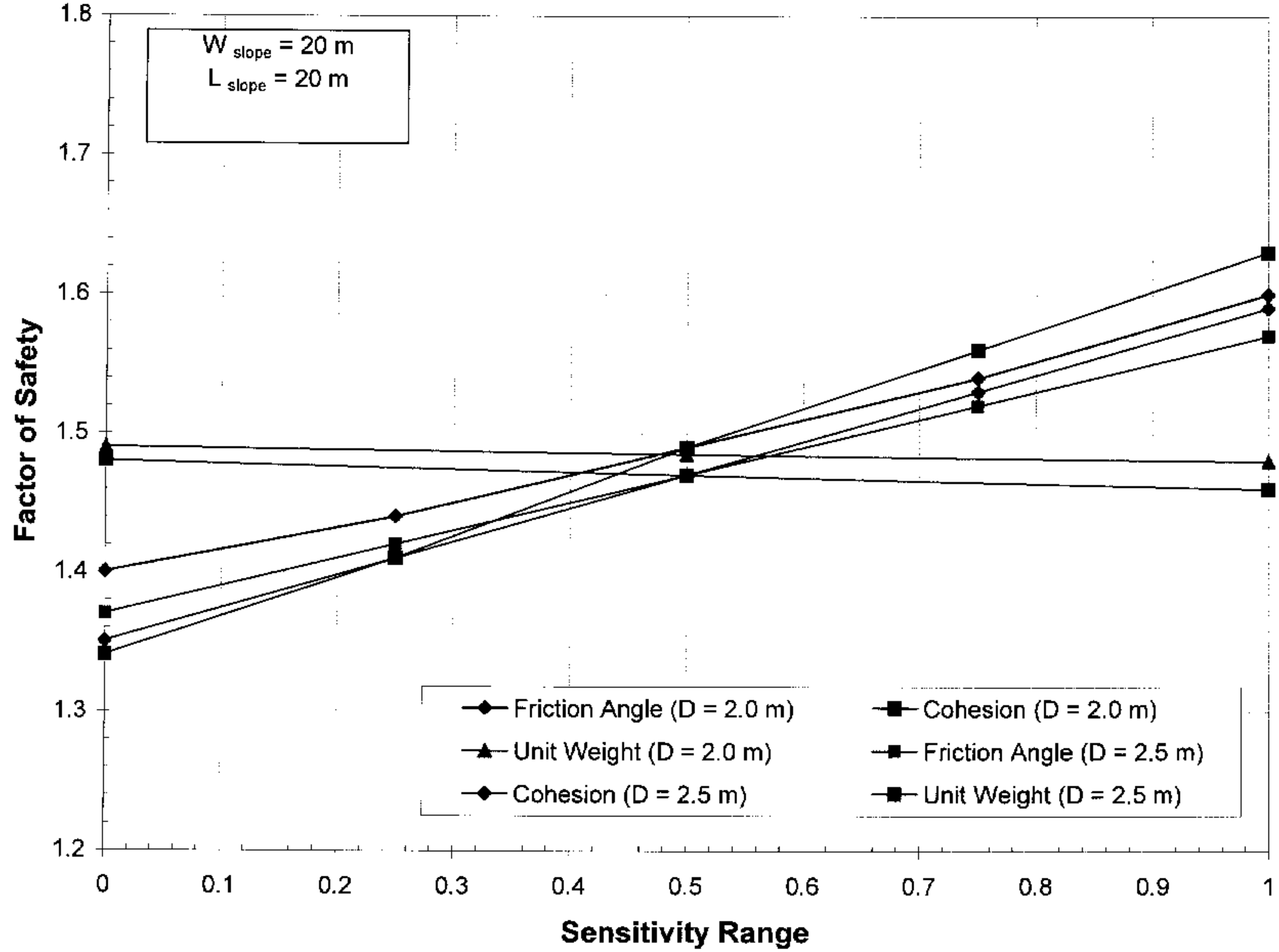
DATE:	JOB No.:	CAD FILE:	FIGURE No.:	REV.
AUGUST 2007	YX00748	00748N01.dwg	FIGURE 12	A



amec Earth & Environmental	PROJECT: GEOTECHNICAL ANALYSIS FOR P-LAKE SEWAGE LAGOON, CAPE DORSET			
CLIENT: DILLON CONSULTING LIMITED	TITLE: FACTOR OF SAFETY FOR ROAD SLOPE (MEAN VALUE OF SOIL PARAMETERS)			
	DATE: AUGUST 2007	JOB No.: YX00748	CAD FILE: 00748N01.dwg	FIGURE No.: FIGURE 13	REV. A

*PLOT 1:1=A (P)

J:\YX\00748\00748N01.dwg - FIGURE 13 - Aug. 20, 2007 3:50pm - nichelle.newbigging



amec Earth & Environmental	PROJECT: GEOTECHNICAL ANALYSIS FOR P-LAKE SEWAGE LAGOON, CAPE DORSET
	TITLE: SENSITIVITY PLOTS FOR STABILITY OF ACTIVE ZONE WITHIN ROAD SLOPE
CLIENT: DILLON CONSULTING LIMITED	DATE: AUGUST 2007 | JOB No.: YX00748 | CAD FILE: 00748N01.dwg | FIGURE No.: FIGURE 14 | REV: A

APPENDIX X – DESIGN CRITERIA

MEMO

DILLON
CONSULTING

TO: File
cc:
FROM: Gary Strong, P. Eng.
DATE: July 27, 2007
SUBJECT: Cape Dorset Lagoon - Design Criteria
OUR FILE: 054319-3000

In response to the questions raised at the technical hearing on July 11, 2007, this memo summaries the design criteria for the lagoon in Cape Dorset. The information is complied from the existing reports into one memo for ease of reference.

Design Criteria

Design Parameter	**Criteria**
Lagoon Volume (20 year community demand based on annual retention lagoon design)	96,100 m3
Free Board (per INAC design requirements)	1.0 m
Berm Slope Stability	Greater than 1.25
Operational Parameters	
Decant	Annual decant in fall (September) each year over a 2 week period
Filling rate	1/12 of the annual volume each month. First fill after 1 period of over wintering.
Water Balance	Off site drainage and run off to be directed away from lagoon. Precipitation is equal to evaporation.
Water retention System	Freeze back of a lined berm and an impermeable liner. Liner to be keyed into the foundation soils or bedrock.
Temperature Data	Environment Canada's Data
Acceptable berm Permeability	10^{-8} $m^3/m^2/sec$
Berm Height – maximum (based on site geometry and volume requirements)	6 m
Berm Crest minimum for constructability	4 m

ISSUE	INAC	GN	EC	AE	BGC	NWB	Proposed Action by GN	July 11, 2007 Meeting Resolutions
Application before the NWB	The proponent is encouraged to submit a license renewal application that addresses all municipal activities related to freshwater consumption and waste disposal practices as soon as possible.						No Action	Note that Dillon is not the Applicant
	The need for developing a municipal license application supplementary questionnaire should be considered.						No Action	
Construction of P-Lake Sewage Lagoon								
Design	INAC recommends that the NWB require the applicant to file final design plans that are stamped, signed, and dated by a qualified professional with in advance of project implementation.	NWB ensure that all final design and construction drawings are signed by a registered professional engineer registered in Nunavut, prior to issuing the water license.	Proponent is to ensure that all construction activities on the sewage lagoon do not result in sedimentation of any surrounding water bodies. Preventative measures, such as the use of silt curtains/fences should be used to help mitigate any potential impacts.	A concern that the Board is being asked to use an engineering document to support an amendment application that may not have been sealed by a Professional Engineer.	3.1(1) The review copy is not signed and professionally sealed. The Board should confirm to BGC that the original documents received from Dillon are signed and bear the professional seal of the responsible engineer, registered to practice in Nunavut.		Seal Documents have been received by NWB.	Confirmed
					3.1(2) In Section 1 there should be a paragraph noting that this document addresses the concerns and issues raised by the previous review particularly the items noted to Dillon during the September 19, 2006 Technical hearing.		This does not impact the licence process	NWB to provide internal document (containing issues from previous review) to Applicant. Issues and document should be addressed by Applicant. Some of issues may be addressed in this (July 11 2007) meeting and these should be noted. Estimated date to submit information to NWB is beginning of August if practical.
					3.1(4) In section 2 the water license requirements should include the technical requirements derived from the technical hearing held in Cape Dorset September 19, 2006		NWB to provide specifics for these items.	see comment for 3.1 (2) above.
					3.1(5) There is no section that discusses the design criteria or design constraints		Will address	Applicant to address BGC June 2006 correspondence on the issue. Correspondence should be available from NWB ftp site.
					3.1(6) There are numerous typo's, formatting problems and missing details [ ] to suggest that this is draft version, not a final document. The Board should insist that Dillon submit a completed version, especially considering that the report may not be signed and sealed.	Confirm hardcopy on the public registry signed and sealed by Dillon	This does not impact the licence process.	Confirmed that electronic version is the same as the hardcopy final document received at NWB head office
					3.1(7) In Section 4.1 there are minor discrepancies with respect to the design volume of sewage to be treated. At the top of page 8, a value of 96,100 m3 is given, Table 4.1 shows 36 047 m3 and at the bottom of the page it is set at 36 000m3.		This does not impact the licence process.	96,100 m3 is the final design volume. Discrepancies are due to rounding of significant figures.
Qualitative and Quantitative Effects of the Deposit of Waste				p.9, Section 5 Qualitative and Quantitative Effects of the Deposit of Waste, 1st para. states that "aquatic life in P Lake will be adversely affected but the report does not say how or why	3.1(8) In Section 5.4 Dillon noted that chart 5.1 indicates a significant recharge component to P Lake on that in that respect, P Lake is not practical as a sewage lagoon unless recharge water is directed away from the proposed lagoon. Therefore the use of ditching to divert recharge water is carried forward in the conceptual design development. There is however, no further discussion of this issue in the rest of the design document, nor are diversion ditches shown in the drawing or mentioned in the specifications. It is noted that the north and south berms are intended to act as diversion berms. However they are constructed out of granular materials of their effectiveness needs to be demonstrated. BGC also notes that use of ditches in permafrost affected terrain is not recommended		Will address	AE: Dillon confirms that there are no fish in P lake, DFO verbally expressed satisfaction as long as applicant meets 1992 guideline of ocean. NWB to request DFO to confirm in writing (email sufficient) that P Lake is not a fishery. Also refer to June 7 2007 letter from EC. BGC: Applicant to provide drawings that indicates ditch drainage detail. Since ditches are contained in rock with GCL ditch size BGC is satisfied.
				clearly the applicant's responsibility to demonstrate, from an engineering and geotechnical perspective that this proposed lagoon system would retain effluent for the prescribed retention period in order to achieve the required treatment prior to being able to safely release treated effluent back to the environment. Given the geotechnical concerns noted in all of BGC Engineering's comments on Dillon's and AMEC's work to date, there are reasons to be concerned that this system may not be sufficiently "watertight" and therefore with less retention time available, may not treat the sewage as predicted in this report.	3.1(9) The statements made in Section 5.5 regarding groundwater movement from the lagoon are not supported. As discussed later in a subsequent section of this memorandum, the site investigation and analyses completed to date do not support the fact that the lagoon, as currently designed will hold water.		AMEC has presented their data and information. There needs to be more specifics from the reviews on why they do not agree with the AMEC geothermal model.	See resolution to BGC issue 3.1(3). AMEC to confirm date of latest drilling program, particularly whether data was before or after September 2006 technical meeting. Applicant will define water tightness, define design criteria and develop mitigative steps on a conceptual level for various contingency scenarios.

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ISSUE	INAC	GN	EC	AE	BGC	NWB	Proposed Action by GN	July 11 2007 Meeting Resolutions
				On page 12 references for the assumed temperatures and treatment times are not indicated in the report text. These elements are fundamental and critical in the use of this formula, however treatment times of 70 to 90 days appear to be reasonable in this case. Are there any typical temperatures available from other NWT or Nunavut systems at this latitude to verify the 7 dC temperature limit ?			No there is insufficient data to provide the information requested.	Lagoon water temperature of 7 degrees is referenced from Northern Territories response to Canada Wide Strategy (see EC letter June 7 2007). Note that strategy may not be a public document. Applicant to clarify reference in final response to NWB. AE is satisfied.
Fisheries				p 16, Section 6 P Lake Fisheries; re: the reference to forage fish – what is the source of this information and how were the specific species derived ? Are the Sticklebacks considered by DFO to be an important species that may be affected by the release of this effluent ? Under 6.1 why was there no electro-fishing done to determine the fish resource in P Lake ? What fisheries resource is present at the determined compliance point at Tellik Inlet and what is the impact of this effluent on the ocean environment and fish habitat ? It appears that while a very short term fishery survey was carried out on P Lake, no such investigation was done for the fish habitat at the suggested compliance point.			No action	See resolution to AE issue pg9 Section 5 (line 1). Applicant to forward previously prepared information on fisheries issue to the Board and discuss 1992 criteria for marine discharge. Date of applicant submission based on hearing schedule. Note that NWB has obligation to ensure that terms are as strict or stricter than any other regulations.
				p 21, Section 6.3 Conclusion of Fisheries Investigation. Section 6 of the report concentrates on the possible fisheries resource and habitat implications at P Lake, rather than the location of the suggested compliance point at Telik Inlet where virtually no time or effort was spent trying to characterize that environment in terms of fisheries resources, background environmental information and water quality or the possible impact of this effluent release to the ocean.			No action	Applicant to provide more information on Telik Inlet fisheries
					3.1(10) The design report lack details concerning the design and construction of the lagoon dikes. This is a major deficiency, considering the previous comments made by BGC, the discussions of the technical hearing and the fact that additional site investigations were carried out, leading to a revised design. No discussion is provided regarding the basis for the design changes from the previous submission.		There submission contained a re-designed berm, and the follow-up geotechnical investigation.	Applicant to provide stability, seepage, and geothermal designs for dikes. Information may have been submitted perviously. Does BGC have Annex to GN submission? Dillon to review what reports should have been submitted to NWB from GN (provide list). NWB to confirm what information was distributed for review in May. Confirm that all appropriate information has been reviewed by BGC.
					3.1 (11) In section 11 Dillon noted that "The design elements have used standard engineering practices as reviewed by the geotechnical engineer". This statement is not supportable based on the geotechnical deficiencies noted in this memorandum. In addition, this section omits addressing the specific issues previously raised by the Board.		No action. Dillon's statements are valid.	Applicant to provide stability, seepage, geothermal designs. Information may have been submitted previously. BGC has seen 2005 and 2006 investigation. Does BGC have Annex to GN submission? Dillon to review what reports should have been submitted to NWB from GN (provide list). Confirm what information was distributed for review in May. Confirm that all information has been reviewed by NWB consultants?
				qualitative and quantitative effects of the use of waters or the deposit of waste (i.e. treated sewage effluent) on the drainage basin where the use is to be undertaken . . . and the anticipated impact of the use or deposit on other users			no action	see resolution to AE issue p. 21, Section 6.3 (line 15)
				report should go further in providing the Board with more information regarding the system's treatment capability in the removal or reduction in nutrients, additional treatment capability of P Lake, the downstream wetlands and drainage course to Telic Inlet as well as the possible impact on fish and the environment in Telik Inlet to satisfy the applicant's responsibilities to meet this requirement of the Nunavut Waters and Nunavut Surface Rights Tribunal Act.			There are no available models that have been calibrated to the environment in this community. We have provided the best available assessment based on know information.	see resolution to AE issue p. 21, Section 6.3 (line 15)
				There is no mention in the report of the effects of winter temperatures on the operation of the lagoon system – is the 0.5 m allowance for sludge enough depth to prevent the lagoon from freezing to the bottom once it is discharged to that elevation in the fall ? If not it will freeze to the bottom and result in sheet flow freezing solid as sewage is discharged from the truck down the discharge flume. In the spring then the entire lagoon could be frozen and the possible impact on the systems treatment processes and capability should be further examined.			There are no available models that have been calibrated to the environment in this community. We have provided the best available assessment based on know information.	see resolution to AE issue on pg 12 (line 13). Dillon confirms that lagoon effluent calculation recognizes that lagoon will freeze to bottom over winter.

ISSUE	INAC	GN	EC	AE	BGC	NWB	Proposed Action by GN	July 11 2007 Meeting Resolutions
				p.25, Section 11 Assessment of the Requirements of the Nunavut Water Board, we do not believe the applicant through this report has fully investigated the qualitative and quantitative effects of the deposit of this waste on the P Lake basin, or more importantly the Talik Inlet environment. Further not all of the possible adverse impacts of this potential effluent release have been fully identified or investigated.			There are no available models that have been calibrated to the environment in this community. We have provided the best available assessment based on know information	see resolution to AE issue p. 2' Section 6.3 (line 15)
Talik under P-Lake			The proponent should provide confirmation the presence of a through talik under P-lake that could result in contamination of groundwater and facilitate the transport of contaminants. If a through talik is present, EC recommends that the bottom of the lagoon be lined with an impermeable liner to prevent contamination of the groundwater. Movement of sewage through ground water is not to be used as a dilution factor for treatment.				See geotechnical report	no issues brought to table by AE or BGC, will be addressing in response to P-1.
Technical Specifications					3.3 (1) The specification do not seem to be properly updated. [] The Board must be satisfied that the supporting document to the water license application reflects the current plans		No action	Dillon confirmed that specs have not changed and cannot change because the specs are now part of a signed contract. Documents are current.
					3.3(2) What is the revised construction schedule?		Not related to the licensing process.	Dillon confirmed completion by August 1 2007
	The proponent should state whether berm liners will extend into non-fractured bedrock so as to reduce the likelihood of subsurface water flow beyond the sewage lagoon footprint			Has the requirement for a full liner across the entire bottom and sides of the pond to fully contain the treated effluent and achieve the desired level of treatment been examined and investigated ?	3.3(4) In section 02072 "Geotextiles":		See geotechnical report. The use of a full liner has been investigated but the use of a lined berm was selected.	Dillon confirmed that full liner is cost prohibitive.
					Part 1.3.1 define "GCL"			Dillon confirmed GCL is Geosynthetic Clay liner
					Part 2.1.1, 2.1.2 and 2.1.6, and Tables 1523-3-1 and 1523-3-2 were not found.			Dillon to provide shop drawings. Table numbers may have changed
					Part 3.1.10 seems to be written generically. The Drawings do not show a clay liner, a granular sub-liner sampler blanket or a geomembrane. The term "geosynthetic clay liner" is introduced. If this means "GCL" then it is in conflict with the drawings , which show "Granular Clay Liner"		The term GCL has been discusussed in many comments. The liner to be used is Bentomat ST Geosynthetic Caly Liner as supplied by CETCO lining Technologies.	See proposed action by GN. Resolved.
					3.3(5) Section 02315, "Excavating, Trenching and Backfilling", Part 1.3.4, unsuitable materials should include massive ice lenses.		Agreed	resolved above.
					3.3(6) Section 02318, "rock Removal":		No action	
	The proponent should state which aggregate borrow sources it intends to exploit for the sewage lagoon's		Any stockpiled material should be stored above the high water mark of any water body and in		Part 1.2.1 , not sure what circumstances would warrant a minimum rock excavation of "50mm"		No action	resolved above. Clarification provided.
					Part 3.2, the drawings do not distinguish between soil and rock, but show excavated slopes (i.e. liner trench) vertical, assuming rock conditions. There is no guidance with respect to excavated slopes in soil.		A geotechnical engineer will be on site to direct the contractor during excavation.	Dillon confirmed that there is no guidance with respect to slopes and soil. See proposed action by GN
					3.3(7) Section 02661, "Sewage Storage Lagoons":			BGC confirm, no issue remains.
					Part 2, in several locations there is reference to a rip rap specification. There is no Section 02371 [] or Section 02454 - Rip Rap.		Material selected on site by engineer.	Dillon confirmed that Riprap being used on site is being inspected on site as agreed to by contractor and engineer. Using quarry blast rock from island. Dillon agrees to provide as built details (likely not available before final hearing)
	The proponent should provide justification that the frozen core dyke concept is realistic. Furthermore, the proponent should explain whether a low-permeability soil core will designed for unfrozen performance will be established within the dyke and if or if not, why?				Part 3.3.2 indicates that dike is to be constructed in the summer in unfrozen conditions. There is no statement regarding the foundation condition although summer construction would indicate that it too would not necessarily be frozen. Based on these specifications the berms are not being constructed as a frozen dam. As such the GCL is the primary liner. This is not the normal application of a GCL. The role of a GCL is to act as a secondary liner as would have been the case if the berm was designed and constructed as a frozen dam. A HDPE liner is considered to be a primary liner and should be backed up with a GCL for secondary containment.		The use of a GCL as a primary liner is common practice in both northern and southern Canada for lagoons.	refer to resolution to BGC issue 3.1 (5) (line 8) Dillon to rerun geothermal analysis to reflect what is being built and materials being used. Demonstrate containment through freezing.

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ISSUE	INAC	GN	EC	AM	BGC	NWB	Proposed Action by GN	July 11 2007 Meeting Resolutions
					Part 3.3.3 ASTM D 698 [application in question for the type of material] For this material compaction specifications should be based on relative density as per ASTM D4253 [] and D 4254 []. The dike fill is considered to be structural fill and should be placed as dense as possible, based on field trials. Compaction of granular fill should include moisture conditioning to improve density. The field trials should establish the maximum relative density achievable using the available equipment.		Proctor values are being used along with on site nuclear densometer testing to control berm construction.	Dillon confirmed that fill has sufficient fines to meet spec. Dillon will provide construction records for fill material. Resolved.
					Part 3.5 Flexible Lining - assume this is the same as GCL. Terminology for the liner should be consistent.		See above	no action needed. Dillon confirmed that flexible lining is GCL.
					Part 3.5.1 requires that a layer of granular material in unfrozen condition be placed on the bottom and sides of the lagoon as indicated. Where is this detailed indicated? Normally there should be a layer of bedding sand on either side of the GCL. This is not shown. Note that the liner is shown being placed on a 1:1 slope on Drawing 111. This slope appears too steep to safely work on and to carry out the installation procedures as specified and would also be too steep for placing any of the bedding material that has been omitted from the drawings, but alluded to in the specification (part 3.1.15). Compaction of the cover layer on a 1:1 slope would be difficult. Dillon should confirm if placing the liner on a 1:1 slope is in compliance with the manufacturer's specifications. [] Dillon should present a stability analysis to confirm that the proposed liner configuration is stable.		AMEC provided the review of the liner installation.	Dillon confirmed that sand bedding is being provided from the gravel source at 300mm thickness, AMEC to perform stability analysis on dyke at 1:1 GCL slope under thawed conditions. Ensure design meets GCL manufacturer specifications. Ensure design meets safety standard for slopes.
					Part 3.5.9 indicates that the liner sheets are to be cut to fit accurately around inlets, outlets, sleeves, concrete structures and other projections through the lining. There are no further details provided in either the specification or the drawings with respect to this critical component of the lagoon retention system.		Will provide response.	Dillon will provide record drawings and contractor procedures
					Part 3.7 Leakage Testing. This section is completely inadequate for the purpose intended and poorly conceived. The purpose of the lagoon is to retain water in order for the sewage to be treated. There is no way that the method given in the specification will yield any defensible data to determine that a leak exists or to conclusively direct the contractor to undertake repairs at no cost to the owner.		agreed - no leakage testing will be completed.	resolved by stated action. Test in that is in spec is not what will be done. No in-situ hydraulic testing will be completed.
					Some of the major concerns with respect to the methodology provided are as follows: [refer to page 7 of the submission from BGC]			resolved as above (line 40) Part 3.7.
Drawings	INAC also recommends that the NWB require the applicant to file final as-built designs that are stamped, signed and dated by a qualified professional prior to the lagoon's start-up operation date.				BGC was provided copies of drawings 101, 109, 111, and 112 to review. These copies were unstamped-presumably originals on file with the Board are stamped copies. If not they should be.	"NWB has stamped/sealed drawings "issued for tender March 2006"	No action	resolved
				the access road, should be regulated as it is a key component to the success of the proposed sewage collection and treatment system and should be properly engineered and constructed under license terms and conditions.	It is assumed that other drawing pertain to the access road and were not included in the present submission. The Board should however be satisfied with the details and the as-built information with respect to the road for completeness. In order to issue a water license for the entire facility.		No action	Access Road is only an NWB issue if stream crossings are involved or road causes impacts to waterbodies. INAC has indicated that the road is outside the NWB jurisdiction in email dated sometime in 2005(?) NWB to locate the email and contact Dillon if unable to locate. Review road with respect to operations and maintenance. Issue with AE resolved.
					Drawing 101: There is no information to show that the lateral extent of the GCL is sufficient to prevent end-run seepage around the ends of the liner at the abutments for both the east and west berms.		Liner extended past the limit of the berm by a minimum of 2.0 meters.	Dillon confirmed that GCL will extend beyond the 2m indicated if shattered rock is found. Resolved.
					Drawing 109: The north berm is constructed using Type II granular material. It is also designed to act as a surface water runoff diversion berm. There is a minor fines component in this material however it will not act as a seepage barrier, particularly since the steepest hydraulic gradient is straight through the berm. Therefore, some seepage into the lagoon can be expected. The same problem applies to the road on the south side of the lagoon.		See note above on skirting.	See resolution to BGC Issue 3.1.6, line 11

Issue	INAC	[illegible]	EC	AE	BGC	[illegible]	Proposed Action by GN	July 11 2007 Meeting Resolutions
					Drawing 111 [Refer to submission from BGC page 8-9]			Resolved: Dillon will submit record drawings and AMEC will rerun geothermal model on as constructed. Possible to submit before hearing but not 30 days in advance. Confirmed that excavating 3m below stripped surface of foundation. Confirmed backfilling GCL trench with sandy silt
								Re Detail 4: Confirmed that detail is longitudinal section of abutment tie into main berm. As built details will be provided
								Re Detail 6: Dillon confirmed they will provide bedding and as-builts, see note under detail 8 regarding bentonite; may need to inspect HDPE outfall pipe downstream of liner, not a structural key, just to access bedding under manhole.
								Re Detail 8: Dillon to clean up detail 8, particularly downstream toe
								Detail 10: Dillon will issue field instruction to contractor to place geoweb on top of GCL and show on as-builts.
Geotechnical Investigations				there is no mention in the report of any predictable thawing/settlement of the underlying permafrost which could de-stabilize the lagoon berms/dykes, or necessary mitigation thereof. Is the underlying soil at this site thaw-stable ?	Refer to submission from BGC Section 4/6 page 8-11		See AMEC geothermal assessment.	Dillon confirm that site is thaw stable. BGC issues resolved by Dillon commitment to geothermal remodeling of as built conditions. Ensure what is built, is modeled.
Water Use								
Waste Disposal								
Sewage Effluent	The proponent proposes that the new sewage lagoon's effluent have a discharge criteria of 80 mg/L biological oxygen demand, 100 mg/L total suspended solids, and 10E fecal Coliforms.	For a marine discharge of 150-600 liters per capita per day with a mixing conditions similar to a bay or fjord these standards are; BOD 120 mg/l and TSS 180 mg/L Additionally as the proposed discharge point is close to local harvesting and recreational areas criteria for fecal Coliform should also be applied	Hamlet must ensure that any effluent discharges must be in compliance with Section 36(3) of the Fisheries Act.	This report is silent on whether or not the predicted quality of this effluent will not be toxic to fish in terms of nutrient reduction or removal.			No action	Dillon confirms effluent from designed lagoon will be toxic to fish, Dillon confirms that they will not be in compliance with Section 36(3) of Fisheries Act. Question is for EC.
				Section 6 does not explain why the regulation point or more correctly, the compliance point, is at the edge of Tellik Inlet as suggested here, especially when the estimated effluent quality is for the outlet of the lagoon. If the two federal departments have agreed that effluent meeting the criteria set out in the Guidelines for the Discharge of Treated Municipal Wastewater in the Northwest Territories, 1992, is applicable to the Tellik Inlet location, this should be fully referenced (who, how and when). I would suggest that effluent being discharged at this compliance point should be non-toxic to fish per the Fisheries Act (as measured by an LC50 bioassay test) and this report is silent in this regard.			This is a suggestion to the Board - no action by GN.	Resolved. Agreed that issue is up to Board. Dillon confirms that they would like compliance point to be edge of inlet.
				p.13 Section 5.7 Fecal Coliform Reduction, the reference to the influent fecal Coliform figure is text book and it would be beneficial to confirm this with some typical similar data from other North of 60 communities. The approach here may be considered to be too generic an application – can this be verified with data from other northern community lagoon systems ? Previously Dillon had stated that a "design standard" of 10^4 for Fecal Coliform coming out of the constructed retention lagoon and then P Lake was to be met. Is that standard still to be followed and if so what is that standard based on ?			We have provided other community data previously.	See resolution to AE issue pg 12 (line 13). Dillon confirms they are above standard for fecal coliforms ($1.5x10^4$). Dillon to include wetland in effluent calculations. Resolved.
				p. 15, Section 5.8 TSS Reduction, 1st para.: Is the reference to 85% to 95% reduction in TSS in lagoons with detention times over 180 days for single celled lagoons or multi-celled lagoons as a comparison to this proposed single celled lagoon ?			This information is based on the est Practices issued by INAC.	Dillon will verify the reference and answer question prior to the 30 day review period, before comment deadline for final hearing.
Solid Waste								
Hazardous Waste								
Waste Oil								

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ISSUE	INAC	GN	EC	AE	NRC	[illegible]	Proposed Action by DH	July 11 2007 Meeting Resolutions
Spill Contingency Planning		DOE would like to ensure that as condition of the licence an updated plan is submitted to NWB prior to commissioning of the new facility	The proponent should produce a Spill Contingency Plan which includes the new operations and infrastructure. The plan should facilitate response to spills which might occur during construction and operation of the project. The plan should include a list of available spill response equipment and the names of trained personnel who will be on-site and available in the case of a spill.				Agreed as part of the terms of the licence.	If provided as part of terms of Licence, then the condition may state "have in place prior to operation of the facility", would be good timing to have a SCP submitted prior to the hearing. (added by DH)
Operation and Maintenance		DOE requests that submission and approval of sewage disposal plan be a condition of the license.	An updated Operations and Maintenance Manual should be submitted for approval. The O & M Plan should include removal and disposal of sewage sludge. Estimates should be made of the quantities of sludge likely to be produced, the required frequency of extraction from the lagoons; and operational procedures developed for environmentally sound removal and disposal.				Agreed as part of the terms of the licence.	See above Plan.
Abandonment and Restoration								
Monitoring	The proponent should commit to monitoring the effectiveness of its sewage lagoon's treatment process. Developing a municipal wastewater effluent quality trend analyses for these three parameters and others of interest, such as pH, ammonia nitrogen, and total phosphorus, effluent temperature, and air temperature would be a useful. By doing this, the proponent can analyze collected data and determine whether the timing of effluent discharge is adequate.	DOE would like to see the license specify a monitoring station at the last point of effluent control. With a likely fall discharge period of approximately 60 days, samples taken for the purposes of monitoring effluent quality should be collected on the first and last day of discharge, and 30 days after the first day of discharge.	the proponent monitoring the quality of the effluent being discharged at the outlet of the wetland treatment area. sampling be completed at the outfall of the lagoon, in order to understand treatment efficiency.	p. 15. Section 5.8 TSS Reduction, last para., no details are provided for the suggested operational sequence of a fall discharge from the lagoon, such as start and end dates, rate of discharge, monitoring of effluent water quality and discharge flow rates, maximum flow rate to prevent rapid draw-down failure of the lagoon berms, etc.			Agreed as part of the terms of the licence.	Dillon to provide concepts of O&M issues before 30 day review period
	The proponent should establish subsurface water quality monitoring wells down gradient of the proposed sewage lagoon to determine whether municipal wastewater effluent is seeping through the lagoon's base into the active layer, and if so, whether the quality of the subsurface water meets requirements set by the NWB.						Agreed as part of the terms of the license.	
	The proponent should develop a detailed monitoring program for the NWB's consideration as it drafts municipal license terms and conditions. This is due to the proponent's familiarity with the project area. A monitoring program should specify sampling site locations by global positioning system coordinates, parameters to be analyzed at each sampling site, when samples are to be taken, who will collect the samples, where the samples will be sent, and a quality assurance/quality control plan for sample collection procedures.			other than the reference to a general sampling program in a proposed sampling/monitoring program found in Table 9.1, there are no specifics in the report regarding the expected degree of nutrient removal and toxicity to fish with respect to the proposed treatment and disposal system.			The proposed monitoring program was included in the submission.	resolved by proposed action. Note: all monitoring that is required by the Applicant should be included in the proposed program along with justifications for parameters and frequency. This will provide the Board some direction in the event that none of the intervening statements discuss the monitoring issue. (inserted by DH)

ISSUE	INAC	QIA	EC	AE	[illegible]	[illegible]	Proposed Action by GN	July 11 2007 Meeting Resolutions
				p. 12, Section 7 The Impact of the Deposit of Waste; While the text states that the deposit of waste will adversely impact the water quality of ? Lake the report does not indicate how or by how much or for what parameters. And nothing is indicated for the possible impacts on the water quality of Telik Inlet. p.23 Section 9.1: Sampling Protocol, we agree that the proposed sampling locations are appropriate, however no sampling location was identified for the compliance point located just before the effluent would enter Telik Inlet (unless the applicant is saying that water samples at the end of the wetlands is considered to be the same water quality as that which would enter Telik Inlet). Individual effluent parameters to be monitored should include BOD TSS, pH, Oil & Grease, dissolved oxygen, Fecal Coliforms, Total Coliforms, toxicity to fish - Bioassay Concentration (LC50), Toxic Organic Substances, Phosphorus and Ammonia (Nitrogen).			There are no available models that have been calibrated to the environment in this community. We have provided the best available assessment based on crew information.	Dillon confirms that one of sampling points will be at top of water fall. Also discussed the practicality of obtaining samples and having them delivered to an lab, on time, to satisfy methodology. Very difficult.(2nd part insert by D.H.)

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