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FOUNDATION INVESTIGATION REPORT FOR FOUNDATION VOID INVESTIGATION AT HIGHWAY 400/HIGHWAY 9 UNDERPASS EASTBOUND LANES REGION OF YORK, ONTARIO CONTRACT NO. 99-26 CHANGE ORDER NO. CO-99-26-18

Submitted to:

Fermar Paving Limited
1921 Albion Road
Rexdale, Ontario, M9W 5S8
Canada

Submitted by:

AMEC Earth & Environmental Limited
104 Crockford Blvd.
Scarborough, Ontario, M1R 3C6
Canada

27 April 2001

TT20882

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PAVEMENT AND FOUNDATIONS SECTION

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27 April 2001
Ref. No. TT20882

Fermar Paving Limited
1921 Albion Road
Rexdale, Ontario
M9W 5S8 Canada

Attention: Mr. Walter Di Francescantonio

Dear Sir:

**RE: FINAL FOUNDATION INVESTIGATION REPORT
FOUNDATION VOID INVESTIGATION AT
HIGHWAY 400/HIGHWAY 9 UNDERPASS
EASTBOUND LANES
REGION OF YORK, ONTARIO
CONTRACT NO. 99-26
CHANGE ORDER NO. CO-99-26-18**

We take pleasure in enclosing five copies of our Final Foundation Investigation Report carried out for the above mentioned project and we will be glad to discuss any questions arising from this work.

Soil samples will be retained for a period of one year, and will thereafter be disposed of unless we are otherwise instructed.

We thank you for giving us this opportunity to be of service to you.

Sincerely,

for H-Shad

George SW Chow, P.Eng.,
Senior Vice-President.
MTO Designated Contact

GSWC/

Encl.: Report No. TT20882 (final)

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1.0 INTRODUCTION

AMEC Earth & Environmental Limited (AMEC), Consulting Geotechnical, Materials Quality Control and Environmental engineers, was retained by Fermar Paving Limited to carry out a foundation investigation for the approaches (east and west approaches) of the old Highway 400/Highway 9 Underpass (Eastbound Lanes) of the Region of York, Ontario.

Based on the information available to AMEC, it is understood that voids were noted adjacent to the catchbasins at the east and west approaches of the existing eastbound lanes of Highway 9 bridge over Highway 400. The purpose of the investigation was to obtain information about the sub-surface conditions at the site by means of exploratory boreholes, and based on the geotechnical investigation results, to investigate the causes of the occurrence of the voids and associated settlement, and to provide recommendations for the remedial measures. Any other design/construction work and environmental aspects directly or indirectly related to this project are outside the scope for this report and have not been investigated or addressed.

Authorization to proceed with the work was given in a fax transmittal on 24 November 2000, from Mr. Walter Di Francescantonio of Fermar Paving Limited and the enclosed MTO Change Order No. CO-99-26-18 dated 31 August 2000.

The results of the investigation, together with our comments and recommendations, are presented in this report. The anticipated construction conditions are also discussed, but only to the extent that they may influence design decisions. The construction methods discussed, however, express our opinion only and are not intended to direct the Contractors how to carry out the construction. Contractors should also be aware that the data and their interpretation presented in this report may not be sufficient to assess all the factors that may have an effect upon the construction.

The report was prepared with focus on the investigation of the cause of the voids/settlement problem of the fill materials and recommendations on remedial measures. It should be noted that the recommendations and opinions in this report are applicable only to the proposed project as described above.

We recommend on-going liaison with AMEC Earth & Environmental Limited during both the design and construction phases of the project to ensure that the recommendations in this report are correctly interpreted and implemented. Also, any queries concerning the geotechnical aspects of the proposed project should be directed to AMEC Earth & Environmental Limited for further elaboration and/or clarification.

It should be noted that this report supersedes all previous versions of reports dated earlier and AMEC will not be liable to any usage of previous reports.

.../...

2.0 SITE DESCRIPTION

The site is located at the intersection of Highway 400 and Highway 9, as shown on the key map of Drawing No. 1. The new eastbound lanes (two lanes) of Highway 9 bridge over the existing Highway 400 consists of a structure built over decades ago. The new westbound lanes (two lanes) structures were recently completed. Voids were noticed by the site staff at the locations near the existing catch basins of the old structure (eastbound lanes) during the structural rehabilitation works (Contract No. 99-26, WP No. 3-95-01).

At the time of the investigation, the eastbound lanes of Highway 9 was closed and under rehabilitation works. The east and west approach embankments are about 8m high with an average side slope of about 2H:1V. The elevations for Highway 9 and Highway 400 at the intersection are about 248 m and 240 m, respectively.

3.0 INVESTIGATION PROCEDURE

The fieldwork for this project was performed during the period of December 1 and 2, 2000 and consisted of drilling and sampling eight (8) boreholes (Borehole Nos. 1 to 8, inclusive). The plan locations of the boreholes, along with stratigraphic sections are shown on Drawing No.1. The plan location of the existing features on Drawing No. 1 are approximate only, and are based on our observations in conjunction with MTO plans.

At the time of investigation, the eastbound lanes of Highway 9 was closed for rehabilitation works by Fermar Paving Limited.

All the eight boreholes were advanced using solid stem continuous flight augers with a truck-mounted (CME 75) power auger drilling rig owned and operated by Atcost Soil Drilling Inc. The drilling was conducted under the full-time supervision of experienced geotechnical personnel from AMEC.

Sampling in the boreholes was effected at frequent intervals of depth (0.76 m to 1.5 m intervals) by the Standard Penetration Test Method (SPT), as specified in ASTM Method D 1586. This consists of freely dropping a 63.5 kg hammer a vertical distance of 0.76 m to drive a 51 mm diameter o.d. split barrel (split-spoon) sampler into the ground. The number of blows of the hammer to drive the sampler into the relatively undisturbed ground by a vertical distance of 0.30 m is recorded as the Standard Penetration Resistance or the 'N'-value of the soil and this gives an indication of the consistency or the relative density of the soil deposit.

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The boreholes were advanced to depths as follows:

LOCATION	BOREHOLE NO.	DEPTH OF BOREHOLE (m)	APPROX. ELEVATION (m)	
			Top	Bottom
East Approach	1	9.8	248.2	238.4
	2	9.6	248.1	238.5
	3	9.6	248.2	238.6
	4	9.6	248.2	238.6
West Approach	5	9.6	248.0	238.4
	6	8.1	247.9	239.8
	7	9.6	248.0	238.4
	8	6.6	248.0	241.4

The borehole locations were established in the field by our engineering staff, in relation to the existing centerline of the new 4-lanes of Highway 9 bridge. The borehole geodetic elevations were determined by the surveying staff of Fermar Paving Ltd. The locations of the profiles are presented in Drawing No. 1.

The soil samples were shipped in sealed containers to our geotechnical laboratory in Toronto (Scarborough) for further examination and classification. A laboratory testing programme, consisting of natural moisture content determinations and grain-size analyses, was performed on selected representative soil samples. The results of the laboratory tests are presented on the appropriate Record of Borehole sheets and also in Figure Nos. 1 to 5.

The boreholes were left open until the end of each work day to enable us to take additional water level readings inside the open boreholes. The boreholes were backfilled and compacted with auger cuttings.

4.0 SUB-SURFACE CONDITIONS

The subsurface conditions were explored at eight (8) borehole locations and are shown on Drawing No. 1, as well as indicated on the individual Record of Borehole Sheets. Cross sections of inferred subsurface stratigraphy are given on Drawing No. 1.

.../...

The existing ground surface at the time of investigation is generally level with ground elevations of about 247.9 m to 248.2 m.

In general, the boreholes indicate asphalt and pavement fill over sand fill to approximately Elevations 245.2 m to 240.7 ± m. The fill is assumed to be imported for the construction of the east and west approaches of Highway 9. In Boreholes 1 to 7, the fill is underlain by clayey silt till at depths of 5.0 m to 7.5 m below existing ground levels (Elevations 242.0 m to 240.7 m). In Borehole 8, the fill is underlain by a layer of sandy silt till (about 1.2 m thick) at a depth of 2.8 m (Elevation 245.2 m) below existing ground level followed by clayey silt till at 4.0 m depth (Elevation 244.0 m). All of the eight (8) boreholes were terminated in the clayey silt till deposit.

In May 1997, foundation investigation was carried out by Thurber Engineering Ltd (TEL) for the widening of Highway 9 and re-alignment of Highway 9 to Highway 400 S Ramp (WP 3-95-01, Site No. 37-33). This foundation investigation report may be referred for the conditions of the native sub-soils (but not for the fill materials) and groundwater levels. The approximate locations of the previous boreholes (Borehole 97-1 to 97-6, inclusive) are shown on Drawing No. 1 for reference purpose.

4.1 Asphalt

Asphalt pavement was encountered in all boreholes with the thickness varying from 400 mm to 500 mm for Boreholes 1 to 7, and 100 mm for Borehole 8.

4.2 Fill

Underlying the asphalt pavement, a fill composed of sand with gravel and some silt was encountered to the depths of 2.8 m to 7.5 m (Elevations 245.2 m to 240.7 m). Measured 'N'-values range from 1 to 52 blows/0.3m, indicating a very loose to very dense relative density. Measured natural moisture contents of the soil samples tested range from 2% to 13%.

The estimated fill thickness as inferred from borehole drilling are summarized below:

Location	Borehole No.	Fill Thickness (m)	Depths (m)	Elevations (m)
East Approach	1	7	0.5-7.5	247.7-240.7
	2	5.2	0.4-5.6	247.7-242.5
	3	5.1	0.4-5.5	247.8-242.7
	4	6.2	0.5-6.7	247.7-241.5
West Approach	5	6.5	0.5-7.0	247.5-241.0
	6	4.6	0.4-5.0	247.5-242.9
	7	6.3	0.4-6.7	247.6-241.3
	8	2.7	0.1-2.8	247.9-245.2

It should be noted that in our experience the thickness of fill could vary considerably in between and beyond borehole locations. Possible variations should therefore be taken into account when estimating quantities.

It should be noted that the higher blow counts values obtained at the top of the fill materials may be due to the more compacted base course materials or the frozen state of the materials. Occasional boulders encountered in the fill may also result in higher blow counts values. Except for Borehole 8, majority of the measured 'N'-values in the fill materials are within the range of 1 to 10 blows/0.3m, indicating very loose to loose relative density. In Borehole 1, the sampling spoon sank into the fill at about 6m depth (Elevation 242 m) under the weight of the hammer, and in Borehole 4, no recovery was obtained at about 6m depth (Elevation 242 m).

Laboratory test results from soil samples in this deposit are as follows:

East Approach (Boreholes 1 to 4):

Natural moisture content (%) : 2% to 13% (average 7%)
Grain Size (4 samples)

- Gravel : 11%-34%
- Sand : 58%-76%
- Silt : 9%-14%

The grain size curves for this material are provided on Figure 1.

West Approach (Boreholes 5 to 8):

Natural moisture content (%) : 2% to 7% (average 5%)
Grain Size (4 samples)

- Gravel : 8%-33%
- Sand : 58%-77%
- Silt : 9%-26%

The grain size curves for this material are provided on Figure 2.

Testing for moisture-density relationship of soil was carried out on two samples. Due to the sample size requirement for the test, the two testing samples were obtained by combining fill materials collected from Boreholes 1 to 4 (Sample A), and from Boreholes 5 to 8 (Sample B). The measured maximum dry density and optimum moisture content are about 2050kg/m^3 and 7% for Sample A, and about 2020kg/m^3 and 8% for Sample B. The test results are enclosed in Figures 4 and 5.

4.3 Sandy Silt (Glacial Till)

In Borehole 8, brown sandy silt till with trace clay and gravel of about 1.2m thick was encountered at a depth of 2.8m (Elevation 245.2 m) underlying the above fill materials. Measured 'N'-value was 50 blows/0.15m, indicating a very dense relative density. Measured natural moisture content of a soil sample was 7 %.

4.4 Clayey Silt (Glacial Till)

Underlying the fill in Boreholes 1 to 7 and below the sandy silt till in Borehole 8, a grey clayey silt till with sand and trace gravel was encountered. This till deposit extended to the remaining depth of all the eight boreholes drilled. Measured 'N'-values range from 12 to over 90 blows/0.3m, indicating a stiff to hard consistency, but generally hard.

One (1) grain size distribution analysis was conducted on a soil sample from the till deposit and are presented in Figure No. 3. The results indicate :

Grain Size :

- Gravel : 2%
- Sand : 20%
- Silt : 54%
- Clay : 24%

.../...

The natural moisture content of the samples tested varied between 9% and 20% (average 13%).

Boulders and/or cobbles are frequently embedded within glacial till deposits. The very high blow counts and augering resistances/refusal within the clayey silt till may infer the presence of cobbles and boulders.

4.5 Groundwater Conditions

Groundwater conditions in the open boreholes were observed during the drilling and on completion. Boreholes 2, 3, 5, 6, 7 and 8 were dry at the time of investigation. Groundwater level at about 9.5m depth (Elevation 238.7 m) was noted in open bore of Borehole 4. Soil cave-in at about 4.5m depth (Elevation 243.7 m) soon after completion of drilling was noted in Borehole 1 and the groundwater level could not be measured. However, it was noted that, during drilling and soil sampling operations, the moisture condition of the soil samples collected below approximately 6 m depth were wet to damp, indicating the possible groundwater level at about 6 m depth (Elevation 242 m) in Borehole 1.

Based on the report by TEL in May 1997, the groundwater levels (measured during the period between January 31, 1997 and February 26, 1997) for Borehole 97-1 (east approach) varied from elevations 238.4 m to 242.7 m, and that for Borehole 97-6 (west approach) maintained at about elevation 241.9 m. The groundwater level was in general slightly above the existing elevation of Highway 400 (about elevation 240 m).

It should be noted that the groundwater conditions discussed in this report refer only to those observed at the place and time of investigation. The groundwater table could fluctuate seasonally and in response to severe weather events or as a consequence of construction activities on the site or adjacent sites.

It should also be noted that a perched water level within the fill might be encountered due to more pervious fill overlying the relatively impervious cohesive till.

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5.0 DISCUSSION AND RECOMMENDATIONS

5.1 General

This section of the report provides our interpretation of the factual geotechnical data obtained during the investigation. Recommendations on geotechnical aspects of maintenance and alternative remedial works are made based on these interpretations. These recommendations are intended for use by the design engineer. Where comments are made on construction, they are provided only to highlight aspects of the construction that could affect design of the project. Those requiring information for construction should make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction method and scheduling.

All of the boreholes were backfilled to ground surface after completion of the drilling. Contractors undertaking remedial works should locate the boreholes in the field in relation to the approaches and satisfy themselves that the locations of the boreholes will not affect their proposed method of construction.

Existing services and structures will be encountered near the Highway 9 approach embankments and they may be sensitive to settlement. These services and structures should be carefully identified and accurately located prior to construction. Care should be taken to avoid damage to these services and structures, and to minimize settlement. Precaution, as necessary, should be taken with the use of construction equipment to avoid any damage or overloading of the existing embankment.

The professional services of AMEC retained for this project include only the geotechnical aspects of the subsurface conditions and design for remedial works. Other design, construction and environmental assessment work are outside of present scope of services.

5.2 Results of Foundation Void Investigation

From the results of this investigation, it is noted that, except for the top of the fill materials, the measured 'N'-values of the fill for the east and west approaches indicated very loose to loose relative density (relative density of less than 40%). The estimated bulk density and dry density of the fill materials may be in the order of 1700 kg/m^3 to 1900 kg/m^3 and 1300 kg/m^3 to 1500 kg/m^3, respectively. However, based on our experience and laboratory database for the compaction testing of granular B materials, the maximum dry densities vary between 1850 kg/m^3 to 2200 kg/m^3. Further, laboratory testing of two samples of existing fill materials indicated the measured maximum dry densities ranging between 2020 kg/m^3 and 2050 kg/m^3. These indicate that the current compaction state of the fill materials for the two approach embankments does not meet the current standard requirements of 95% compaction, and hence causing settlement of the approach embankments. The observed voids near the catch basins may be due to the fill settlement and the bridging effects of the stronger asphalt concrete and the underlying base course materials. It should be noted that the fill settlement might be enhanced by the vibration effects of the traffic loading of Highway 9.

It was noted that, in Borehole 1, the sampling spoon sank into the fill at about 6m depth (Elevation 242 m) under the weight of the hammer, and in Borehole 4, no recovery was obtained at about 6m depth (Elevation 242 m). As shown in the borehole location plan (Drawing No. 1), Boreholes 1 and 4 are located adjacent to the catch basins of the east approach embankment. These results indicated, at about 6m depth below the existing ground surface, the possible existence of voids inside the fill, or poor compaction state of the fill materials.

Preliminary slope stability analyses were performed on the existing conditions at the highest embankment slope (8m). The existing embankment slopes are assumed at an inclination of about 2H:1V. The stability of the embankment was analyzed by the limit equilibrium method using a computer programme Slope/W. For the purpose of analysis, the unit weight and friction angle for the fill materials are assumed to be 18 kN/m^3 and 30 degrees, respectively. The granular fill-till interface was assumed to constitute a rigid boundary, defining the maximum depth of any potential failure surface. Therefore, strength properties were not assigned to the till deposit.

The results of stability analysis indicate that the minimum factor of safety for the existing approach embankment is about 1.2, which is slightly less than the current safety standard requirements of 1.3. It should be noted that the estimated safety factor might vary due to the variation of soil properties (eg unit weight, degree of compaction, friction angle, etc.) of the fill materials

Based on the results of our investigation, a number of remedial options are proposed with details as discussed in the following Sections.

5.3 Proposed Remedial Works Options

A number of design options for remedial works were considered for remedial stabilization works at this site. The following three options, which are considered to be feasible for this site, have been considered:

- Option 1 - Grouting
- Option 2 - Berm construction
- Option 3 – Routine Maintenance and Settlement Monitoring

The advantage, limitation and estimated cost for each option are summarized in Table 1.

The following design options other than the above-proposed option are also studied:

- Excavation of fill followed by re-compaction. This involves construction of heavy temporary retaining structure (eg sheetpile or caisson wall up to 8 m high) to retain the existing westbound lanes of Highway 9 during the excavation works. This option will be very expensive and may cause instability of the westbound lanes of Highway 9. Further, the two eastbound lanes of Highway 9 will need to be closed for construction.

- Structural approach slab. The structural approach slab will be supported by piles (H-pile or caisson) founded in the hard clayey silt till deposit. The construction will be very expensive and lane closure of the two eastbound lanes will be required. Concrete slab with no support (slab resting on the embankment fill) is not considered to be feasible as the slab will settle with the fill and will be damaged by induced settlement cracks.

These design options are not considered to be feasible due to high construction cost and requirements of road closure of the two eastbound lanes of Highway 9, and will not be further discussed in this report.

5.3.1 Option 1 - Grouting

Permeation grouting (penetration grouting) technique can be used to fill the pore spaces in soil with grout without disturbing the soil formation. Permeation grouting refers to the replacement of air and water in voids between soil particles with a grout fluid at low injection pressure so as to prevent fracturing of the soil mass. Grouting will therefore increase the shear strength of the fill materials and hence reduce settlement and improve embankment slope stability.

Cementitious grout or cement-based grout is most commonly used, cost-effective materials for ground strengthening. The water to solids ratio is the prime determinant of their properties and characteristics including stability, fluidity, strength, and durability. Bentonite, chemical agent, fillers, etc may be added to enhance certain properties of the grout in order to achieve the specific purposes of grouting. In general terms, the grouting materials should achieve the following properties:

- Stability. A grout is considered stable if its particles remain in suspension of solution until it has reached the destination in the ground.
- Pre-defined setting time. Setting time is the time required for the grout to harden, normally within 4 to 24 hours. The grout should be designed to set within the pre-defined setting time to suit project requirements.
- Viscosity. The grout should have low viscosity so that it can penetrate into the pore spaces.

- Strength. The grout should achieve a required strength for the strengthening of the embankment.

In general, a grouting material should have low viscosity, a controllable setting time, and high strength once it is in the ground. Further, the grout should be non-toxic, permanent, and inexpensive.

The work can be carried out by standard drilling and grouting plant and equipment. The drilling and grouting operations should be organized as separate phases. Grouting should be commenced once the borehole is completed. In order to grout a particular depth of the ground, the corresponding length of borehole is isolated by expanding rubber packers built into the drilling rods. Grout is then only allowed to flow into the soil from between two packers, or if a single packer is used, between the packer and the bottom of the hole.

Grouting in stages may proceed in a descending or ascending direction. In the descending method, impregnation of the ground occurs in advance of the boreholes, which could be advantageous in loose soil. In the ascending technique grouting follows drilling as a separate phase; a benefit would be that water pressure testing is possible immediately prior to grouting, allowing for a choice of the most suitable grout type, pressure, and quantity of grout for that particular location.

The grout mix and grouting operations should be designed to avoid ground heaving, damages to the approach embankments, damages to existing utilities and structures. Any blocked sub-soil drainage system should be replaced immediately after the remedial works.

The grout mix design, grouting operations and selected grouting methods/procedures should be designed and performed by experienced specialist grouting contractor. The grout mix design grouting procedures, plant and equipment to be used should also be reviewed prior to construction works.

The construction work could be carried out by partial lane closure. One of the two eastbound lanes will be temporary closed and then re-open for traffic after the grouting work is completed. The same procedures will apply for the other lane for remedial works.

This option is considered to be advantageous in that the fill materials for the embankment are strengthened to minimize settlement and improve stability. However, this option is limited by the difficulty of the control of the penetration (in terms of quantity and direction) of the grouting materials in the fill and the verification and quality control of the work. Further, some underground utilities and sub-soil drainage may be damaged or blocked by the grouting operations. The estimated cost for this option will be lower than that for Option 2 but higher than that for Option 3. Road traffic will be affected due to lane closure.

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5.3.2 Option 2 – Berm Construction

Earth embankment berm may be constructed on the existing slopes of the approach embankments for the purposes of embankment slope stability. Preliminary stability analyses indicated that a berm of about 4m wide and half the embankment height is required. This option assumes the availability of space for the construction of the berm. Further site investigation is required to determine the variation of soil properties along the embankment slope and the change of elevations of the clayey silt till deposit in order to design the detail geometry of the proposed berm.

The materials used for the construction of the embankment fills should consist of approved, clean, non-frost susceptible earth fill (e.g. Select Subgrade Materials – OPSS 1010). The fill should be placed in lifts not exceeding 300 mm before compaction and each lift should be uniformly compacted to at least 95% of the Material's Standard Proctor Maximum Dry Density. The selection, placement and compaction of the fill should be carried out under a geotechnical engineer. Proper erosion measures of the earth fill should be implemented both during the construction and permanently. The finished berm should be covered by vegetation such as seeding or sodding. The finish side slopes should be 2H:1V or flatter.

The major advantage of this option is that the construction is simple and no road closure is required but the estimated construction cost for this option will be prohibitively high. This option is further limited by the space availability of the site. Other disadvantage of this option is that the actual compaction state of the existing loose fill will not be improved.

5.3.3 Option 3 – Routine Maintenance and Settlement Monitoring

This option consists of routine maintenance work of the existing Highway 9 and no major construction work will be carried out. If any settlement or void are noticed or reported, the embankment will be re-graded in accordance with the current procedures/practice of the MTO. A number of settlement points will be installed on the east and west approach embankments and monitored regularly by land surveying technique for a period of one to two years. Settlement records should be maintained and reviewed regularly by an experience MTO staff to assess the need of maintenance work and/or emergency remedial measures.

This option is considered to be the most cost-effective because of the following:

- Based on the information available to us, no major signs of instability or movement were noted in the past 30 years.
- The estimated minimum factor of safety of the existing embankment is about 1.2. No immediate risk of embankment failure is anticipated.

.../...

- The existing Highway 400 will be widened in the future. Any major remedial works for the existing Highway 9 should be reviewed in association with the new Highway 400 design in order to optimize the construction costs.

Based on the above, this Option is highly recommended.

5.3.4 Recommended Option

Based on the above discussions for the three proposed remedial works Options, and the balance between construction costs and possible road closure of Highway 9 (eastbound lanes), we recommend the following option:

- Option 3 – Routine Maintenance and Settlement Monitoring

5.4 Construction Inspection

It is recommended that a geotechnical programme of inspection and testing be carried out during the construction phase of the project (if any) to confirm that the conditions encountered are consistent with design assumptions; and to confirm that the various project specifications and material requirements and handling are being satisfied.

6.0 CLOSURE

The Statement of Limitations, included in the Appendix, is an integral part of this report.

Yours truly,
AMEC Earth & Environmental Ltd.

LICENSED PROFESSIONAL ENGINEER K. S. HO PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER RAMON MIRANDA PROVINCE OF ONTARIO

Kai-Sing Ho, Ph.D., P.Eng.
Senior Geotechnical Consultant
MTO Designated Contact

Ramon Miranda, P.Eng.
Head, Transport Department

TABLE 1
SUMMARY OF PROPOSED OPTIONS

PROPOSED OPTIONS	ADVANTAGE	LIMITATION	ESTIMATED COST LEVEL	ESTIMATED RELIABILITY
Option 1 - Grouting	• Fill up voids • Strengthen the fill • Minimize settlement • Improve embankment stability	• Require specialist contractor • Partial to complete road closure • Difficult to control grout penetration in terms of quantity and direction • Difficult to verify the effectiveness of the remedial work • Underground utilities and sub-soil drainage may be blocked • Underground services may be damaged • Possibility of ground heaving	Medium	About 80%
Option 2 - Berm Construction	• Simple construction method • No specialist contractor required • No road closure • Improve embankment stability	• Required large space to build the berm • Actual compaction state of the existing fill will not be improved • High cost	Prohibitively High	About 95%
Option 3 - Routine Maintenance and Settlement Monitoring	• No road closure • Low cost • The work can be carried out as part of routine maintenance • Accumulate settlement pattern and record to plan for cost effective design	• Require regular monitoring to ensure safety	Low	About 90%

DRAWINGS

Drawing No. 1

MOISTURE-DENSITY RELATIONSHIP OF SOILS
(Using 2.5 kg rammer and 305 mm drop)

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Client :- Fermar Paving Limited

Job No.:- TT20882

Date:- January 2, 2001

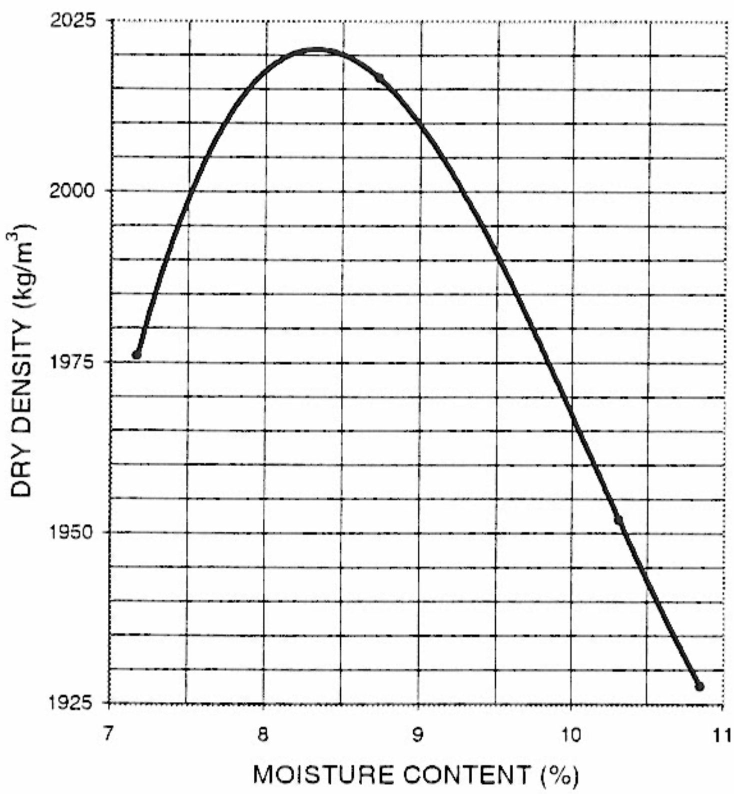
Project:- Hwy 400 / Hwy 9 Underpass

Test Method:- MTO LS 706 - Procedure - 3

Wet Density (kg/m^3)	2070.86	2117.66	2192.66	2153.20	2136.82
Moisture Content (%)	5.3	7.2	8.7	10.3	10.9
Dry Density (kg/m^3)	1967	1976	2017	1952	1928

MAXIMUM DRY DENSITY (kg/m^3) = **2021**

OPTIMUM MOISTURE CONTENT (%) = **8.3**



Sample# :- B
Sampled by :- PPMA
Date Sampled :- 02-Dec-00
Tested by :- HA
Date Tested:- 22-Dec-00

Rammer Type:- Manual
Preparation :- Dry
Oversize Materials :- -

Source :- Combined Samples from BH 5 to BH8

Soil Identification:- Sand with gravel some silt

Comments :-

PER : [signature]
S.Baskaran

Reporting of these test results constitutes a testing service only.

Engineering interpretation or evaluation of the test results is provided only on written request.

AMEC EARTH & ENVIRONMENTAL LIMITED
104Crockford blvd., Scarborough, Ontario, M1R 3C6, CANADA
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www.amec.com

Figure 5

MOISTURE-DENSITY RELATIONSHIP OF SOILS
(Using 2.5 kg rammer and 305 mm drop)

amec

Client :- Fermar Paving Limited

Job No.:- TT20882

Date:- January 3, 2001

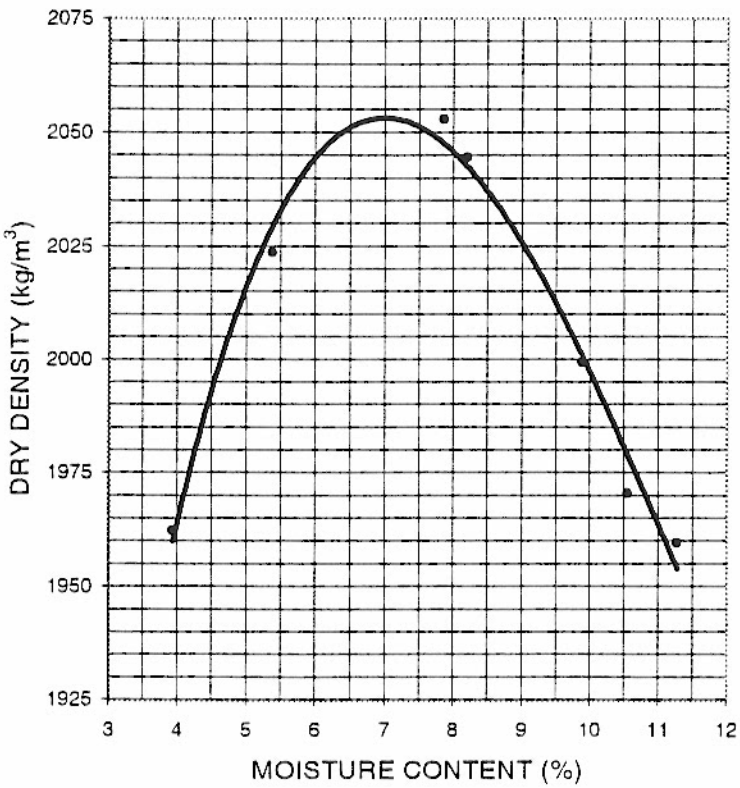
Project:- Hwy 400 / Hwy 9 Underpass

Test Method:- MTO LS 706 - Procedure - 3

Wet Density (kg/m^3)	2039.45	2132.39	2214.31	2178.53	2180.51	2212.34	2196.80
Moisture Content (%)	3.9	5.4	7.9	10.6	11.3	8.2	9.9
Dry Density (kg/m^3)	1962	2024	2053	1970	1960	2044	1999

MAXIMUM DRY DENSITY (kg/m^3) = **2053**

OPTIMUM MOISTURE CONTENT (%) = **7.0**



Sample# :- A

Sampled by :- PPMA

Date Sampled :- 01-Dec-00

Tested by :- HA

Date Tested:- 22-Dec-00

Rammer Type:- Manual

Preparation :- Dry

Oversize Materials :- -

Source :- Combined Samples from BH 1 to BH4

Soil Identification:- Sand with gravel some silt

Comments :-

PER : [signature]

S.Baskaran

Reporting of these test results constitutes a testing service only.

Engineering interpretation or evaluation of the test results is provided only on written request.

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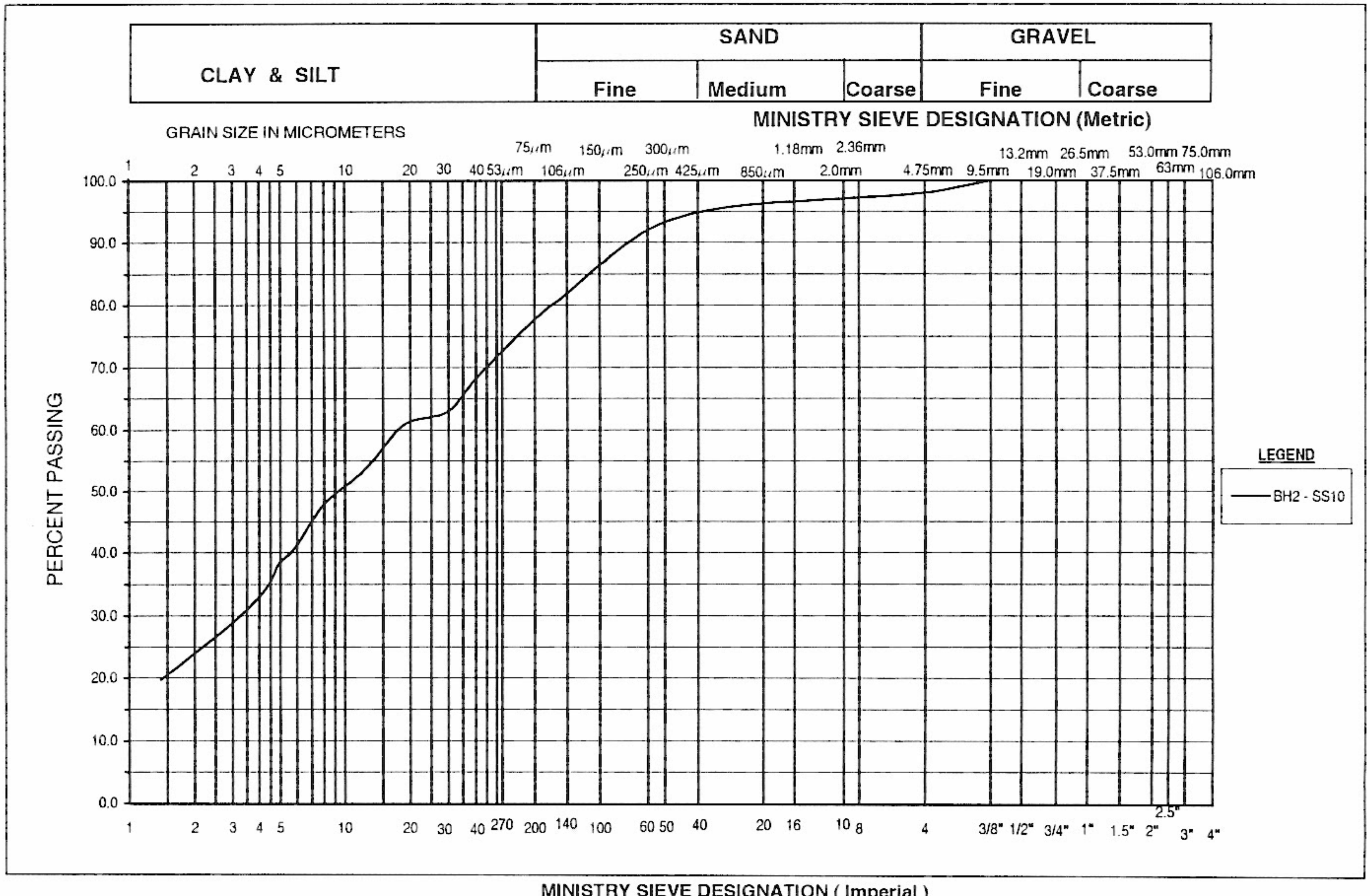
Figure 4

UNIFIED SOIL CLASSIFICATION SYSTEM



amec

GRAIN SIZE DISTRIBUTION

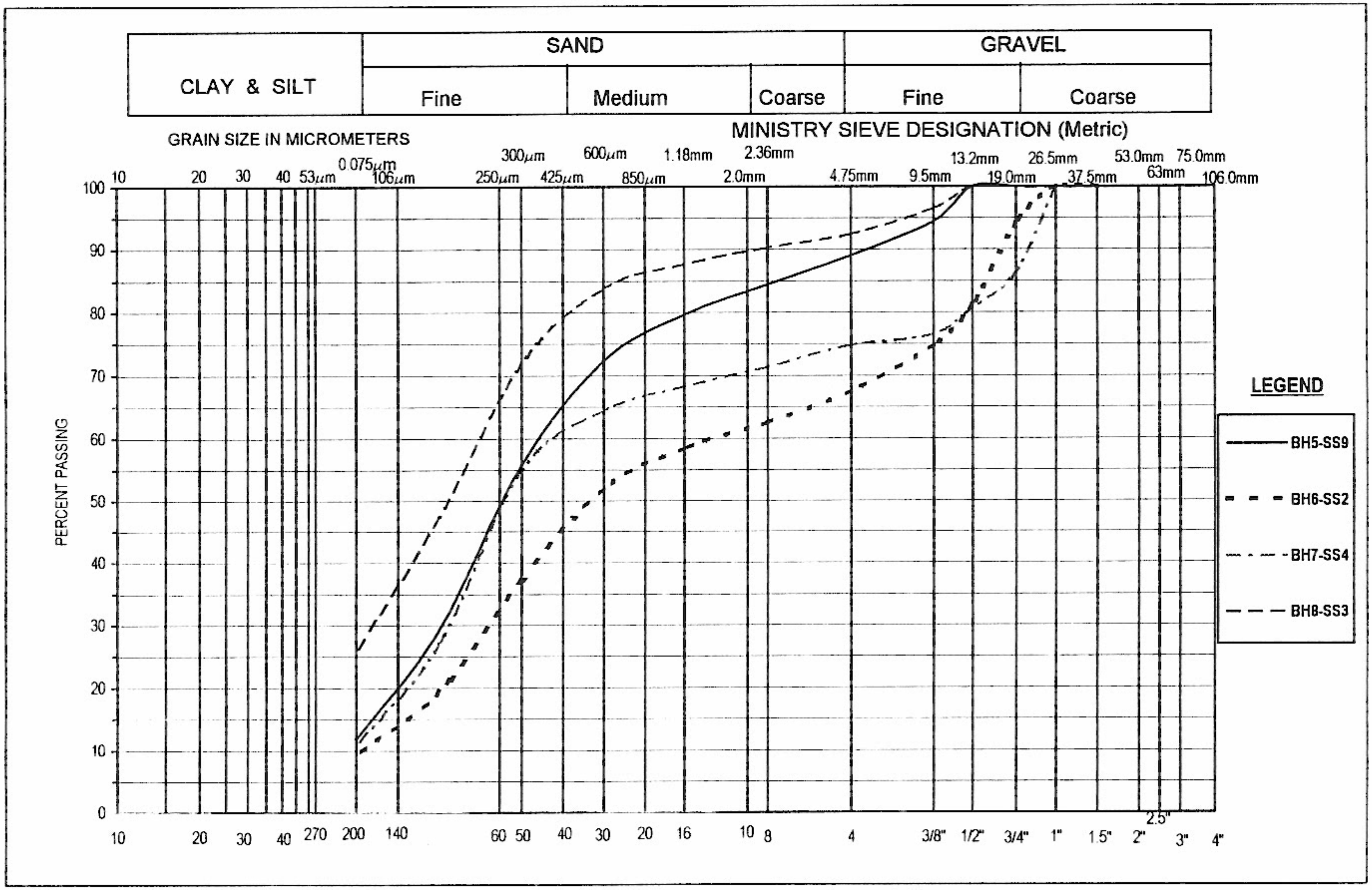
Clayey Silt with Sand, trace Gravel (GLACIAL TILL)

Figure No. 3

Contract No. 99 - 26

Job:- TT20882

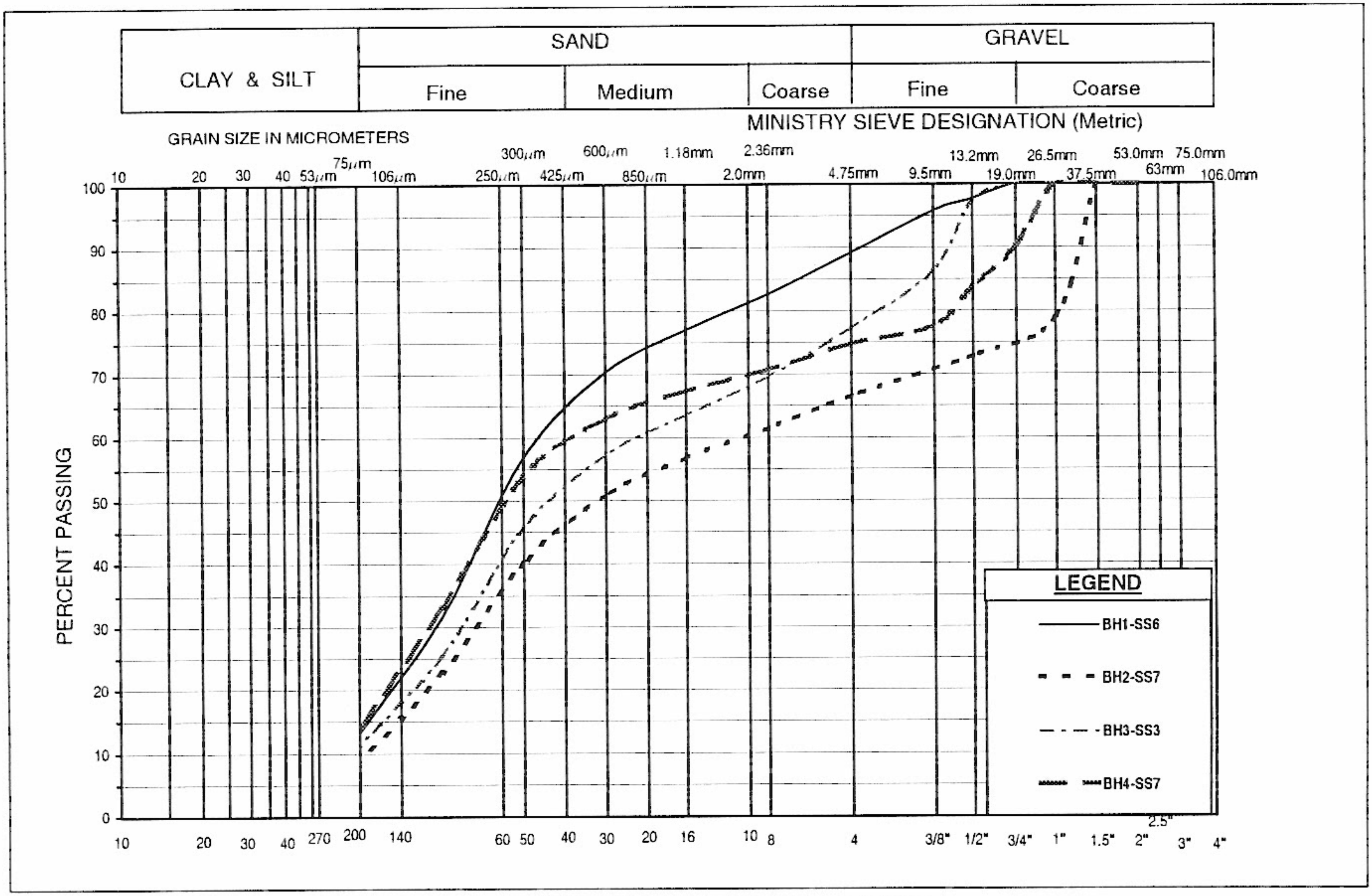
UNIFIED SOIL CLASSIFICATION SYSTEM



MINISTRY SIEVE DESIGNATION (Imperial)

amec	GRAIN SIZE DISTRIBUTION Sand with Gravel, some Silt (FILL)	Figure No. 2 Contract No. 99 - 26 Job:- TT20882

UNIFIED SOIL CLASSIFICATION SYSTEM



amec

GRAIN SIZE DISTRIBUTION
Sand with Gravel and some silt (FILL)

Figure No. I	
Contract No. 99 - 26	
Job:- TT20882	

FIGURES

Figure 1 to 5

RECORD OF BOREHOLE SHEETS

Borehole Nos. 1 to 8

NOTES TO BOREHOLE LOGS

DRILLING DATA

Method:

SolSt Augering	-	Solid Stem Augering
HolSt Augering	-	Hollow Stem Augering
WB	-	Washed Boring

SAMPLES

TYPE:

SS	-	Split Spoon
AS	-	Auger Sample
TW	-	Thinwall Open
TP	-	Thinwall Piston
WS	-	Washed Sample
BS	-	Block Sample
RC	-	Rock Core
PH	-	Sample Advanced Hydraulically
PM	-	Sample Advanced Manually

LABORATORY DATA

WP	-	Plastic Limit (%)
W	-	Water Content (%)
WL	-	Liquid Limit (%)
γ	-	Natural Unit Weight (kN/m³)
UNDR STRNG or C_u	-	Undrained Shear Strength (kPa) Field Vane: St-sensitivity
pp	-	Pocket Penetrometer
UC	-	Unconfined Compression
UU	-	Unconsolidated Undrained at Overburden Pressure
CU	-	Consolidated Undrained
CD	-	Consolidated Drained
TOV	-	Total Organic Vapours

Standard Penetration Test, 'N'-values The Standard Penetration Test (SPT) 'N'-values are the number of blows required to cause a standard 51 millimetre o.d. split barrel sample to penetrate 0.3 metres into undisturbed ground in a borehole when driven by a hammer with a mass of 63.5 kilograms falling freely a distance of a 0.76 metres. For penetrations of less than 0.3 metres, N-values are indicated as the number of blows for the penetration achieved (e.g. 50/25: 50 blows for 25 centimetre penetration).

Dynamic Cone Penetration Test: Continuous penetration of a conical steel point (51 millimetre o.d. 60° cone angle) driven by 475 J impact energy on a size drill rods. The resistance to cone penetration is measured as the number of blows for each 0.3 metres advance of the conical point into the undisturbed ground.

Soils are described by their composition and consistency or compactness.

CONSISTENCY: Cohesive soils are described on the basis of their undrained shear strength (C_u) or 'N'-values as follows:

C_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	>200
	VERY SOFT	*SOFT*	*FIRM*	*STIFF*	*VERY STIFF*	*HARD*
N (blows/0.3 metres)	0 - 2	2 - 4	4 - 8	8 - 15	15 - 30	>30

COMPACTNESS: Cohesionless soils are described on the basis of compactness as indicated by 'N'-values as follows:

N (blows/0.3 metres)	0 - 4	4 - 10	10 - 30	30 - 50	>50
	VERY LOOSE	*LOOSE*	*COMPACT*	*DENSE*	*VERY DENSE*

Rocks are described by their composition and structural features and/or strength.

RECOVERY: Sum of all recovered rock core pieces from a coring run expressed as a percent of the total length of the coring run.

ROCK QUALITY DESIGNATION (RQD): Sum of those intact core pieces, 100 millimetres in length expressed as a percent of the length of the coring run. Classification of a rock based on the RQD value as follows:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	*POOR*	*FAIR*	*GOOD*	*EXCELLENT*

JOINTING AND BEDDING:

SPACING	50 millimetres	50 - 300 millimetres	0.3 - 1.0 millimetres	1.0 - 3.0 millimetres	>3.0 millimetres
JOINTING	*VERY CLOSE*	*CLOSE*	*MOD. CLOSE*	*WIDE*	*VERY WIDE*
BEDDING	*VERY THIN*	*THIN*	*MEDIUM*	*THICK*	*VERY THICK*

MTO CONTRACT NO. 99-26

CHANGE ORDER NO. CO-99-26-18

DIST ____ HWY 9

DATUM Geodetic

RECORD OF BOREHOLE No 1

METRIC

LOCATION Station 25+210, o/s 1m Rt

BOREHOLE TYPE Solid Stem Augering

DATE 1 December 2000 - 1 December 2000

ORIGINATED BY PPM

COMPILED BY PPM

CHECKED BY KSH

ELEV / DEPTH	DESCRIPTION (SOIL PROFILE)	STRAT PLOT	SAMPLE NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
248.2 / 0.0	ASPHALT		1	AS	-		248	Cave on completion: 4.5m
247.7 / 0.5	SAND FILL with Gravel, some Silt, brown; very loose to loose; damp		2	SS	9			
	trace asphalt		3	SS	6		247	
			4	SS	4		246	
			5	SS	5			
			6	SS	4		245	11 76 (13)
			7	SS	8		244	
			8	SS	6		243	
			9	SS	4			
	some Silty Clay, brown; wet		10	SS	1		242	SS sank under the weight of hammer.
			11	SS	3		241	
240.7 / 7.5	CLAYEY SILT (GLACIAL TILL), trace Sand, Gravel, grey; stiff to hard; damp		12	SS	12		240	
			13	SS	15		239	
			14	SS	35			
238.4 / 9.8	End of Borehole							

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE; 20 40 60 80 100

PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L; WATER CONTENT (%) 10 20 30

UNIT WEIGHT γ kN/m³

+ 3, × 3: Numbers refer to Sensitivity

O 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 2

METRIC

MTO CONTRACT NO. 99-26
CHANGE ORDER NO. CO-99-26-18
LOCATION Station 25+213, o/s 3m Rt
ORIGINATED BY PPM
DIST ____ HWY 9
BOREHOLE TYPE Solid Stem Augering
COMPILED BY PPM
DATUM Geodetic
DATE 1 December 2000 - 1 December 2000
CHECKED BY KSH

ELEV / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
248.1					
0.0	ASPHALT	1	AS	-	GROUNDWATER IN OPEN BORE on completion: none
247.7 / 0.4	SAND (FILL) with Gravel, some to trace Silt, brown, very dense, damp	2	SS	52	
	dense	3	SS	31	frozen
	loose	4	SS	6	
		5	SS	5	
		6	SS	5	
		7	SS	5	33 58 (9)
		8	SS	6	
	compact	9	SS	11	
242.5 / 5.6	CLAYEY SILT (GLACIAL TILL) with Sand, trace Gravel, grey, damp, very stiff to hard	10	SS	36	2 20 54 24
		11	SS	30	
		12	SS	26	
		13	SS	29	
		14	SS	25	
238.5 / 9.6	End of Borehole				

Chart columns: DYNAMIC CONE PENETRATION RESISTANCE PLOT (20, 40, 60, 80, 100); SHEAR STRENGTH kPa (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE; 20, 40, 60, 80, 100); PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L; WATER CONTENT (%) (10, 20, 30); UNIT WEIGHT γ kN/m³; ELEVATION SCALE 248 to 239; GROUND WATER CONDITIONS.

$+^3, \times^3$: Numbers refer to Sensitivity   ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No 3

1 OF 1 **METRIC**

MTO CONTRACT NO. 99-26
CHANGE ORDER NO. CO-99-26-18
LOCATION Station 25+213, o/s 6m Rt
ORIGINATED BY PPM
DIST ____ HWY 9
BOREHOLE TYPE Solid Stem Augering
COMPILED BY PPM
DATUM Geodetic
DATE 1 December 2000 - 1 December 2000
CHECKED BY KSH

ELEV / DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLE NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
248.2								
0.0	ASPHALT		1	AS	-		248	GROUNDWATER IN OPEN BORE on completion: none
247.8 / 0.4	SAND (FILL) with Gravel, some Silt, brown; compact; damp		2	SS	14			
	-----		3	SS	8		247	23 66 (11)
	very loose to loose		4	SS	5			
			5	SS	6		246	
			6	SS	8		245	
			7	SS	4		244	
			8	SS	6		243	
242.7 / 5.5	CLAYEY SILT (GLACIAL TILL) trace Sand, Gravel, grey; damp; very stiff to hard		9	SS	14			
			10	SS	32		242	
			11	SS	20		241	
			12	SS	23		240	
			13	SS	27		239	
238.6 / 9.6	End of Borehole							

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE — 20 40 60 80 100

PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L; WATER CONTENT (%) 10 20 30

UNIT WEIGHT γ kN/m³

$+^3, \times^3$: Numbers refer to Sensitivity $O^{3\%}$ STRAIN AT FAILURE

RECORD OF BOREHOLE No 4

1 OF 1 **METRIC**

MTO CONTRACT NO. 99-26
CHANGE ORDER NO. CO-99-26-18
LOCATION Station 25+209, o/s 8m Rt
ORIGINATED BY PPM
DIST ___ HWY 9
BOREHOLE TYPE Solid Stem Augering
COMPILED BY PPM
DATUM Geodetic
DATE 1 December 2000 - 1 December 2000
CHECKED BY KSH

ELEV DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	WATER CONTENT (%)	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
248.2							
0.0	ASPHALT	1	AS	-	248		GROUNDWATER IN OPEN BORE on completion: 9.5m
247.7 / 0.5	SAND (FILL) with Gravel, some Silt, brown; compact; damp	2	SS	22		○	frozen
		3	SS	14	247		
	very loose to loose	4	SS	5		○	
					246		
		5	SS	4	245	○	
					244		
		6	SS	6	243		
		7	SS	7		○	25 61 (14)
	wet	8	SS	2	242		SS8: no recovery
241.5 / 6.7	CLAYEY SILT (GLACIAL TILL), trace Sand, Gravel, grey; very stiff to hard; damp	9	SS	21	241	○	
		10	SS	20	240		
		11	SS	33	239	○	
238.6 / 9.6	End of Borehole						

Column headings also include: SOIL PROFILE; SAMPLES; STRAT PLOT; GROUND WATER CONDITIONS; DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE; 20 40 60 80 100); PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L (10 20 30); UNIT WEIGHT γ kN/m³.

$+^3, \times^3$: Numbers refer to Sensitivity $O^{3\%}$ STRAIN AT FAILURE

RECORD OF BOREHOLE No 5

1 OF 1 **METRIC**

MTO CONTRACT NO. 99-26

CHANGE ORDER NO. CO-99-26-18 | LOCATION Station 25+168, o/s 2m Rt | ORIGINATED BY PPM

DIST ______ HWY 9 | BOREHOLE TYPE Solid Stem Augering | COMPILED BY PPM

DATUM Geodetic | DATE 2 December 2000 - 2 December 2000 | CHECKED BY KSH

ELEV / DEPTH	DESCRIPTION	SAMPLE NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
248.0						
0.0	ASPHALT	1	AS	-		GROUNDWATER IN OPEN BORE on completion: none
247.5 / 0.5	SAND (FILL) with Gravel, some Silt, brown; dense, damp	2	SS	38		frozen
	-----				247	
	very loose to loose	3	SS	9		
		4	SS	6	246	
		5	SS	5	245	
		6	SS	5	244	
	----- trace cobbles	7	SS	5	243	
		8	SS	5	242	
		9	SS	7		11 77 (12)
241.0 / 7.0	CLAYEY SILT (GLACIAL TILL) trace Sand lenses, Gravel, grey; very stiff to hard, damp	10	SS	18	241	
		11	SS	44	240	
		12	SS	44	239	
238.4 / 9.6	End of Borehole					

Column headings also printed: STRAT PLOT; GROUND WATER CONDITIONS; DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100); SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, X LAB VANE; 20 40 60 80 100); PLASTIC LIMIT W_P, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L – WATER CONTENT (%) 10 20 30; UNIT WEIGHT γ kN/m³.

+ ³, X ³ Numbers refer to Sensitivity   O ³% STRAIN AT FAILURE

RECORD OF BOREHOLE No 6

1 OF 1 **METRIC**

MTO CONTRACT NO. 99-26
CHANGE ORDER NO. CO-99-26-18
DIST ______ HWY 9
DATUM Geodetic

LOCATION Station 25+164, o/s 3m Rt
BOREHOLE TYPE Solid Stem Augering
DATE 2 December 2000 - 2 December 2000

ORIGINATED BY PPM
COMPILED BY PPM
CHECKED BY KSH

ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	WATER CONTENT (%)	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
247.9									
0.0	ASPHALT		1	AS	-				GROUNDWATER IN OPEN BORE on completion: none; frozen
247.5 0.4	SAND (FILL) with Gravel, some Silt, brown; dense; damp		2	SS	34			o	32 58 (10)
							247		
	loose		3	SS	9				
			4	SS	7			o	
							246		
							245		
			5	SS	7				
							244		
	compact		6	SS	15			o	
242.9 5.0	CLAYEY SILT (GLACIAL TILL) trace Sand, Gravel, grey; damp; hard						243		
			7	SS	91/25			o	
							242		
	trace Sand lenses; moist to wet		8	SS	80				
							241		
239.8	wet		9	SS	65		240	o	
8.1	End of Borehole								

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH kPa: O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE: 20 40 60 80 100
PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT W_L; WATER CONTENT (%) 10 20 30
UNIT WEIGHT γ kN/m³

+³, ×³: Numbers refer to Sensitivity O³% STRAIN AT FAILURE

RECORD OF BOREHOLE No 7

1 OF 1 **METRIC**

MTO CONTRACT NO. 99-26
CHANGE ORDER NO. CO-99-26-18
DIST ____ HWY 9
DATUM Geodetic

LOCATION Station 25+168, o/s 8m Rt
BOREHOLE TYPE Solid Stem Augering
DATE 2 December 2000 - 2 December 2000

ORIGINATED BY PPM
COMPILED BY PPM
CHECKED BY KSH

Column headings: SOIL PROFILE (ELEV/DEPTH, DESCRIPTION, STRAT PLOT); SAMPLES (NUMBER, TYPE, "N" VALUES); GROUND WATER CONDITIONS; ELEVATION SCALE; DYNAMIC CONE PENETRATION RESISTANCE PLOT (20, 40, 60, 80, 100); SHEAR STRENGTH kPa (O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE; 20, 40, 60, 80, 100); PLASTIC LIMIT W_p, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) (10, 20, 30); UNIT WEIGHT γ kN/m³; REMARKS & GRAIN SIZE DISTRIBUTION (%) (GR SA SI CL)

Ground surface elevation: 248.0

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	REMARKS & GRAIN SIZE DISTRIBUTION (%)
248.0 / 0.0	ASPHALT	1	AS	-	GROUNDWATER IN OPEN BORE on completion: none; frozen
247.6 / 0.4	SAND (FILL) with Gravel, some Silt, brown; compact; damp	2	SS	26	
		3	SS	10	
	----- very loose to loose	4	SS	7	25 64 (11)
		5	SS	5	
		6	SS	7	
		7	SS	5	
	----- trace Gravel	8	SS	7	
241.3 / 6.7	CLAYEY SILT (GLACIAL TILL) trace Sand, Gravel, grey; hard; damp	9	SS	52	
		10	SS	42	
		11	SS	41	
238.4 / 9.6	End of Borehole				

Elevation scale: 247, 246, 245, 244, 243, 242, 241, 240, 239

$+^3, \times^3$: Numbers refer to Sensitivity $O^{3\%}$ STRAIN AT FAILURE

RECORD OF BOREHOLE No 8

METRIC

MTO CONTRACT NO. 99-26

CHANGE ORDER NO. CO-99-26-18

LOCATION Station 25+159, o/s 7m Rt

ORIGINATED BY PPM

DIST ____ HWY 9

BOREHOLE TYPE Solid Stem Augering

COMPILED BY PPM

DATUM Geodetic

DATE 2 December 2000 - 2 December 2000

CHECKED BY KSH

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	ELEVATION SCALE	WATER CONTENT (%)	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
248.0							
247.9 / 0.1	ASPHALT	1	AS	-			GROUNDWATER IN OPEN BORE on completion: none frozen
	SAND (FILL) with Silt, Gravel brown; dense; damp	2	SS	42	247		
	----- trace Gravel; loose to compact	3	SS	9		~7	7 67 (26)
		4	SS	14	246	~7	
245.2 / 2.8	SANDY SILT (GLACIAL TILL) trace Clay, Gravel, brown; very dense; damp	5	SS	50/15	245	~7	
244.0 / 4.0	CLAYEY SILT (GLACIAL TILL) trace Sand, Gravel, trace Silt seams grey; hard; damp	6	SS	70	244, 243		
		7	SS	98	242	~17	
241.4 / 6.6	End of Borehole						

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE; 20 40 60 80 100

PLASTIC LIMIT W_p, NATURAL MOISTURE CONTENT W, LIQUID LIMIT W_L; WATER CONTENT (%) 10 20 30

UNIT WEIGHT γ kN/m³

$+^3, \times^3$: Numbers refer to Sensitivity   O$^{3\%}$ STRAIN AT FAILURE

APPENDIX

Limitations of Report

LIMITATIONS OF REPORT

The conclusions and recommendations given in this report are based on information determined at the testhole locations. The information contained herein in no way reflects on the environmental aspects of the project, unless otherwise stated. Subsurface and groundwater conditions between and beyond the testholes may differ from those encountered at the testhole locations, and conditions may become apparent during construction, which could not be detected or anticipated at the time of the site investigation. It is recommended practice that the Geotechnical Engineer be retained during construction to confirm that the subsurface conditions throughout the site do not deviate materially from those encountered in testholes. The benchmark and elevations used in this report are primarily to establish relative elevation differences between the testhole locations and should not be used for other purposes, such as grading, excavating, planning, development, etc.

The design recommendations given in this report are applicable only to the project described in the text and then only if constructed substantially in accordance with the details stated in this report. Since all details of the design may not be known, we recommend that we be retained during the final design stage to verify that the design is consistent with our recommendations, and that assumptions made in our analysis are valid.

The comments made in this report on potential construction problems and possible methods are intended only for the guidance of the Designer. The number of testholes may not be sufficient to determine all the factors that may affect construction methods and costs. For example, the thickness of surficial topsoil or fill layers may vary markedly and unpredictably. The Contractors bidding on this project or undertaking the construction should, therefore, make their own interpretation of the factual information presented and draw their own conclusions as to how the subsurface conditions may affect their work. This work has been undertaken in accordance with normally accepted geotechnical engineering practices. No other warranty is expressed or implied.

Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. AMEC Earth & Environmental Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

LICENSED PROFESSIONAL ENGINEER — K. S. HO — Apr. 27/01 — PROVINCE OF ONTARIO

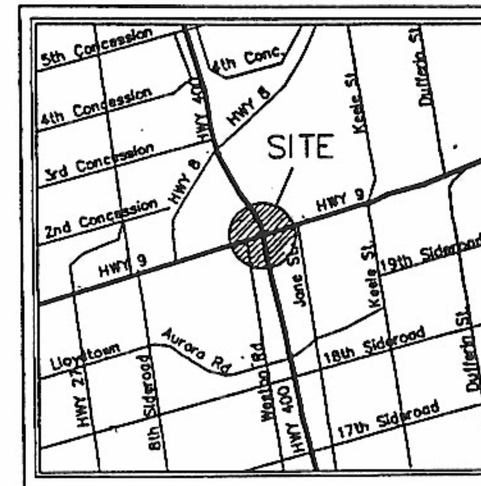
LICENSED PROFESSIONAL ENGINEER — RAMON MIRANDA — 4/27/01 — PROVINCE OF ONTARIO

PROJECT NO.
CONT. No. 99-26
Change Order No. CO 99-26-18

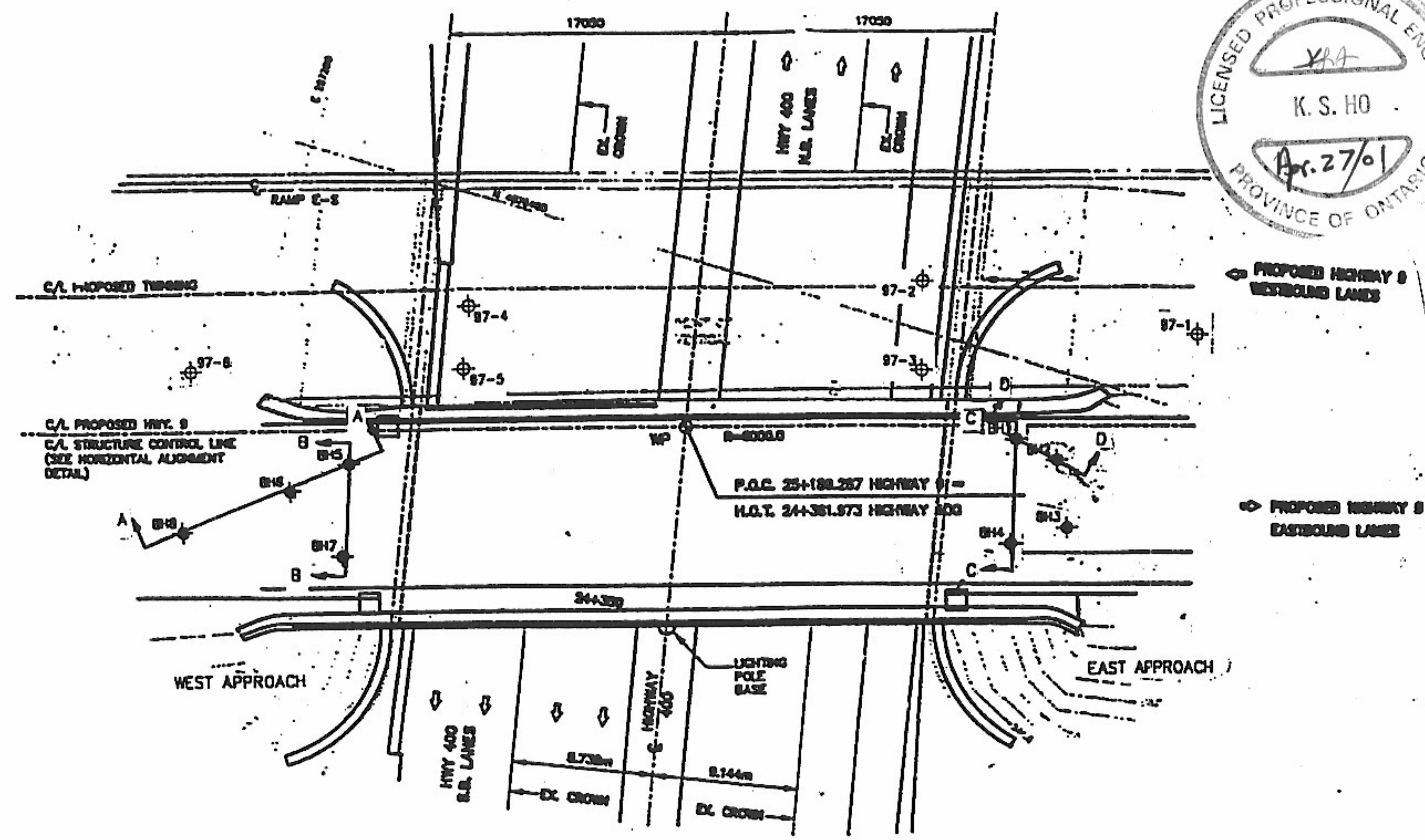
SHEET

HWY.400 – HWY.9 UNDERPASS
BORE HOLE LOCATIONS & SOIL STRATA

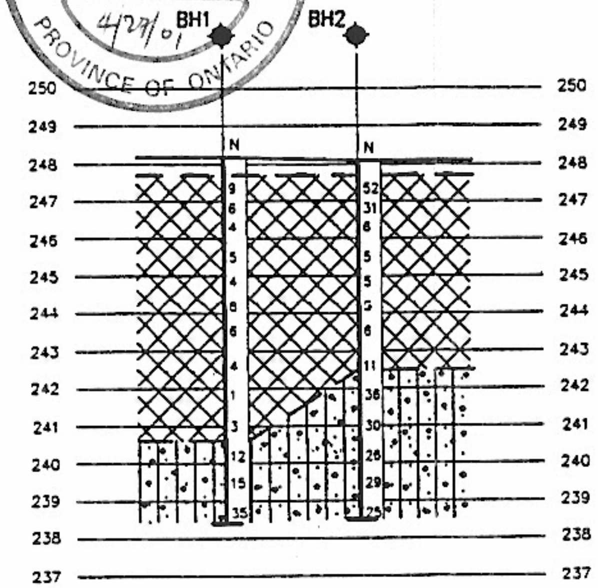
AMEC Earth & Environmental Ltd.



KEY PLAN
N.T.S.



PLAN
2m 0 2m



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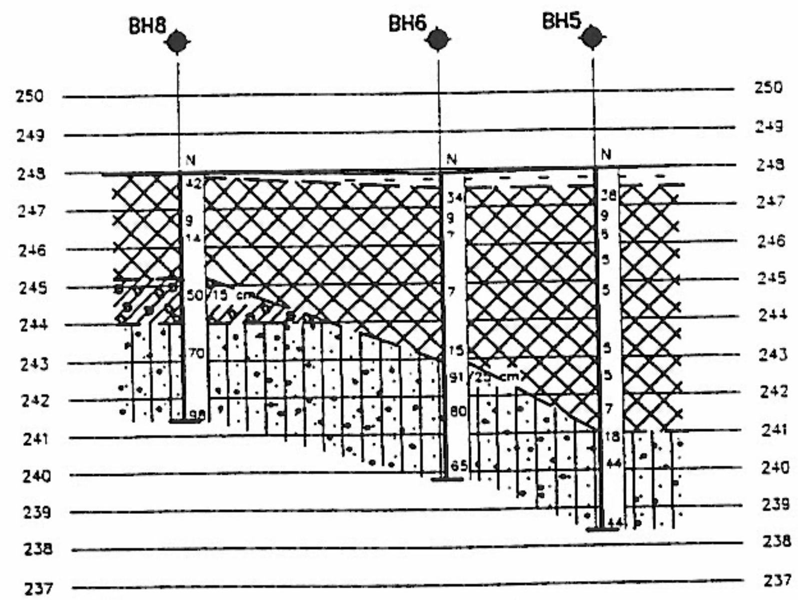

SECTION A–A
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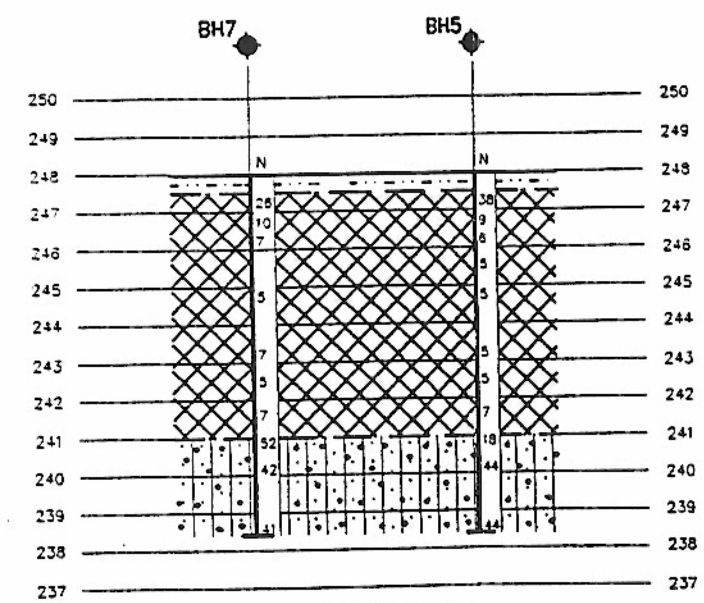
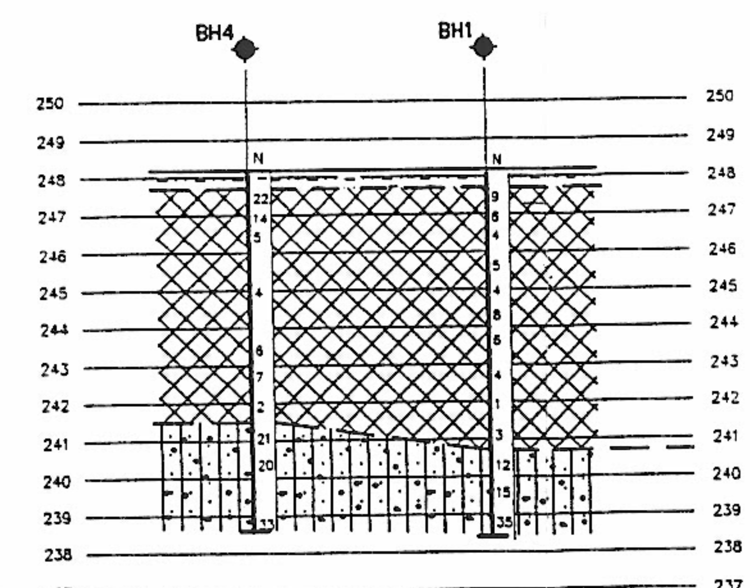


SECTION B–B
1m 0 1m



SECTION C–C
1m 0 1m

LEGEND

- Bore Hole
- Previous Borehole by others (WP3-95-01, May 1997)
- 'N' Blows/0.3m (Std Pen Test, 475 J/blow)
- WL at time of investigation– Dec.2000

No	ELEVATION (m)	APPROX. CO-ORDINATES STATION	OFFSET
BH1	248.2	25+210	1 Rt
BH2	248.1	25+213	3 Rt
BH3	248.2	25+213	6 Rt
BH4	248.2	25+209	8 Rt
BH5	248.0	25+168	2 Rt
BH6	247.9	25+164	3 Rt
BH7	248.0	25+168	8 Rt
BH8	248.0	25+159	7 Rt

–NOTE–
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section GC 2.01 of OPS Gen.Cond.

SOIL STRATIGRAPHY LEGEND

- ASPHALTIC CONCRETE
- SAND FILL WITH GRAVEL, SOME SILT brown, Very Loose to Compact
- SANDY SILT (GLACIAL TILL) trace CLAY, GRAVEL, brown Very Dense
- CLAYEY SILT (GLACIAL TILL) trace SAND, GRAVEL, grey Stiff to Hard

REV.	DATE	BY	JOB No. TT20882

HWY No 400 – HWY No 9			DIST
SUBM'D AD	CHECKED KSH	DATE December,2000	SITE
DRAWN KW	CHECKED	APPROVED	DWG 1