



**APRIL 2012**

## **FOUNDATION INVESTIGATION AND DESIGN REPORT**

**WICK DRAIN FOUNDATION TREATMENT AREAS - PHASE 3  
HIGHWAY 69 FOUR-LANING  
FROM 3.5 KM NORTH OF HIGHWAY 522  
NORTHERLY TO 4.5 KM NORTH OF HIGHWAY 64  
MINISTRY OF TRANSPORTATION, ONTARIO  
G.W.P. 5203-06-00  
VOLUME 1 of 2**

**Submitted to:**

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**REPORT**

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# **PART A**

**FOUNDATION INVESTIGATION REPORT**

**WICK DRAIN FOUNDATION TREATMENT SWAMP AREAS – PHASE 3**

**HIGHWAY 69 FOUR-LANING**

**FROM 3.5 KM NORTH OF HIGHWAY 522**

**NORTHERLY TO 4.5 KM NORTH OF HIGHWAY 64**

**MINISTRY OF TRANSPORTATION, ONTARIO**

**G.W.P. 5203-06-00**



## 1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by McCormick Rankin, a member of MMM Group Limited (MRC) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation investigation services for five (5) swamp crossings, which are considered to be candidate sites for wick drain foundation, along the proposed new Highway 69. This work is being carried out in support of the detail foundation investigation and design by Peto MacCallum Limited (Peto) in the Phase 3 section of Highway 69 Four-Laning from 3.5 km north of Highway 522, northerly to 4.5 km north of Highway 64, under G.W.P. 5378-02-00. The general location of this section of the proposed Highway 69 Four-Laning alignment is shown on Drawing 1.

The terms of reference and the scope of work for the foundation investigation services are outlined in MTO's Request for Proposal, dated January 2006. Golder's proposal for foundation engineering services associated with the wick drain areas is contained in Section 6.8 of MRC's Technical Proposal for this assignment and in Golder's letter titled "Proposal for Additional Foundation Engineering Services, Detail Wick Drain Design (Rev. 1)", dated February 2, 2009. The work has been carried out in accordance with Golder's Supplemental Specialty Quality Control Plan for foundation engineering services for this project, dated June 2, 2006. The General Arrangement (GA) Drawing for the proposed new alignment of Highway 69 was provided to Golder by MRC on February 11, 2009.

## 1.1 Background

Swamp crossings considered potentially suitable for wick drain foundation treatment as a means of increasing the rate of construction, reducing the magnitude of long-term settlement and enhancing the stability of the proposed roadway embankments were identified by Peto, as discussed at a meeting between MTO, MRC, Peto and Golder on March 12, 2007. At that time, Peto was still in the process of gathering subsurface information at most of the swamps, however the swamp crossing on the west side of the Highway 69 / Highway 64 Interchange was considered by Peto a potential candidate site for wick drain foundation treatment. Following Golder's review and assessment of the available subsurface information provided by Peto and forwarded to us by MRC by email on February 8, 26 and 28, 2007, it was concluded that this site was not suitable for such foundation treatment, as discussed in Golder's Technical Memorandum dated June 19, 2007.

Subsequently, Golder carried out a preliminary assessment of available information provided by Peto, which was forwarded to us by MRC on March 25, April 3, 12 and 28, 2008 for an additional seven (7) swamp crossings identified by Peto as potential candidate sites for wick drain foundation treatment. Based on our review of the subsurface information provided, we considered that these swamps would be potentially suitable for such foundation treatment, as discussed in our Technical Memorandum dated July 4, 2008. At a follow-up meeting on December 9, 2008 between MTO, MRC, Peto and Golder, and further to the review of the July 4, 2008 Memorandum, available additional subsurface information and re-evaluation of alternative foundation treatment methods, it was concurred that Golder would proceed with the investigation and gathering of pertinent subsurface information for the design of wick drain foundation treatments at five (5) of the seven (7) swamp crossings originally identified, namely:

| Swamp Crossing                                 | Designation       |
|--|-------------------|
| Highway 69 SBL and NBL<br>STA 17+700 to 18+150 | Swamp 302 SBL/NBL |
| Highway 69 SBL<br>STA 16+050 to 16+350         | Swamp 305 SBL     |



## FOUNDATION REPORT – WICK DRAIN TREATMENT AREAS – PHASE 3 – HIGHWAY 69 G.W.P. 5203-06-00

| Swamp Crossing                         | Designation   |
|--|---------------|
| Highway 69 SBL<br>STA 15+350 to 15+800 | Swamp 306 SBL |
| Highway 69 SBL<br>STA 14+425 to 14+500 | Swamp 307 SBL |
| Highway 69 SBL<br>STA 13+160 to 13+450 | Swamp 310 SBL |

However, following completion of additional investigation by Peto and foundation investigation by Golder, only four (4) swamps crossings have been identified as candidate sites for wick drain foundation treatment.

This report addresses the foundation investigation work carried out for the above all five (5) swamp crossings where wick drain foundation treatment was considered suitable to mitigate settlement and stability issues associated with the roadway embankment through these areas.

A detailed list of the wick drain swamp crossings investigated, including proposed embankment heights and number of boreholes, dynamic cone penetration tests and cone penetration tests advanced at the five (5) sites is presented in Table 1. A separate report will be submitted detailing the foundation investigation for the culverts located within the wick drain foundation treatment areas.

The purpose of this investigation is to supplement the subsurface information obtained by Peto in the swamps along the roadway alignment within the wick drain areas by borehole drilling, cone penetration testing, in situ testing and laboratory testing of selected samples. Golder's investigation is specific to obtaining subsurface information pertinent for the assessment of wick drain foundation treatment at the critical embankment section(s) within the swamp crossings. In describing the subsurface conditions at the wick drain foundation treatment swamp areas, Golder has relied on the data as provided by Peto in their Technical Memorandum titled "06TF033C 889Tech memo Wick Drain Swamps" dated December 14, 2007.

The swamp limits for this investigation were located in the field by Callon Dietz Inc. (Callon Dietz), a professional surveying company retained by MRC.

## 2.0 SITE DESCRIPTION

The section of the new Highway 69 alignment in which the five swamps considered candidate sites for wick drain foundation treatment addressed in this report extends from approximately 2.7 km north of the intersection with Highway 522 and approximately follows the alignment of the existing Highway 69 for about 3.7 km northerly to approximately 1 km north of Pickerel River Road. The future Highway 69 will run generally in a southwest-northeast direction with the project limits located within the Township of Mowat.

In general, the topography in the area of the overall project limits consists of rolling terrain, including densely treed areas and numerous bedrock outcrops separated by low-lying swamps containing areas of standing water, various vegetation types and surficial organic soils. The ground surface along the new highway alignment within the limits of the study area varies between about Elevation 206 m and Elevation 186 m, referenced to Geodetic datum, and is gently sloping downward from northeast to southwest towards Georgian Bay. A detailed description of each investigated swamp crossing is presented in Section 4.0. The approximate locations of the five swamp areas investigated are shown on Drawing 2.



## **3.0 INVESTIGATION PROCEDURES**

### **3.1 Investigation by Golder**

The field work for the additional foundation investigation pertinent for wick drain foundation design was carried out in March 2009 during which time a total of twelve (12) boreholes and twenty-six (26) cone penetration tests (CPTs) were advanced along the proposed alignment of the new Highway 69 within the swamps identified as noted above. The locations of the boreholes and CPTs are shown in plan on Drawings A1 to E1, included in the respective appendices.

The field investigation was carried out using D-50 and D-25 track-mounted drill rigs supplied and operated by Walker Drilling Ltd. of Utopia, Ontario. The boreholes were advanced through the overburden using 108 mm inside diameter (I.D.) hollow-stem augers, 108 mm outside diameter (O.D.) solid-stem augers and NW casing. Soil samples were taken at varying depths and depth intervals, depending on the depth to and thickness of the cohesive deposits, using a 50 mm outer diameter (O.D.) split-spoon sampler operated by an automatic hammer, performed in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586-08a Standard Test Method for Standard Penetration Test). At select locations, a 76 mm O.D. thin-walled 'Shelby' tube sampler (ASTM D1587-08 Standard Practice for Thin-Walled Tube Sampling) was utilized to obtain relatively undisturbed samples of cohesive soils. Field vane shear tests were conducted in cohesive soils for measurement of undrained shear strengths (ASTM D2573-08 Standard Test Method for Field Vane Shear Test). All boreholes were backfilled with bentonite upon completion in accordance with Ontario Regulation 903 (as amended by).

The boreholes were advanced to depths up to about 20.7 m below existing ground surface, generally penetrating at least 1.5 m below the cohesive deposit, or terminated on refusal to further sampler and/or auger advancement. In three boreholes, dynamic cone penetration tests (DCPTs) were advanced through the bottom of the boreholes to refusal to further penetration at depths up to about 30.5 m below ice/snow surface. The depths to refusal do not confirm bedrock, but may be inferred to indicate potential proximity to the bedrock surface.

The CPTs, an in situ testing technique used for the nearly continuous characterisation of subsurface soils, were advanced to refusal, encountered at depths ranging from about 9.1 m to 22.7 m below ice/snow or ground surface. The CPT consists of a special probe equipped with electronic sensing elements to continuously measure tip resistance, local side friction on a sleeve and porewater pressure. It is pushed into the ground at a constant rate (ASTM D5778-07 Standard Test Method for Piezocone Penetration) and a nearly continuous stratigraphic profile together with inferred engineering properties such as shear strength and stress history, can be interpreted from the results.

At this site, the CPT equipment was advanced using the hydraulic system on the drill rig. Cone Penetration Test sheets are included with the Record of Borehole sheets in Appendices A to E. Profiles of tip resistance, friction and porewater pressure are presented together with interpreted profiles of undrained shear strength and classification index that is used to infer the soil type (i.e. soil stratigraphy).

The groundwater conditions and water levels in the open boreholes were observed during the drilling operations and are described on the Record of Borehole sheets in Appendices A to E. It should be noted that groundwater elevations as encountered in the boreholes may not be representative of static groundwater levels since the groundwater levels in the boreholes may not have stabilized on completion of drilling. Furthermore, groundwater elevations will vary and fluctuate depending on seasonal precipitation and local soil permeability.

The field work was carried out under the overall supervision of members of our engineering and technical staff, who located the boreholes and CPTs, supervised the drilling, sampling and in situ testing operations, logged the boreholes, and examined and cared for the soil samples. The samples were identified in the field, placed in appropriate containers, labelled and transported to our Mississauga geotechnical laboratory where the samples underwent further visual examination and laboratory testing. All of the laboratory tests were carried out to relevant MTO and/or ASTM Standards. Index testing such as water content, grain size distribution, specific gravity, unit weight, and Atterberg limits were carried out. In addition, one dimensional consolidation





(oedometer) tests (both horizontally and vertically trimmed) as well as consolidated isotropic undrained (CIU) triaxial tests with pore pressure measurements were carried out on select samples of the cohesive deposits.

The results of the laboratory testing on samples obtained from the swamp crossings are included in Appendices A to E. A summary of the consolidation test and the triaxial test results is presented in Table 2.

The proposed centreline of the highway was staked in the field by Callon Dietz prior to drilling. The as-drilled borehole locations, in stations and offsets, were measured in reference to the centreline alignment and were subsequently converted into MTM NAD 83 coordinates in AutoCAD. Borehole elevations were surveyed by a member of our technical staff in reference to the ground surface elevations at the centreline median stakes which were referenced to the contour plan provided to Golder by Callon Dietz (received on April 23, 2009). The borehole locations presented in the Record of Borehole sheets and shown on Drawings A1 to E1 are positioned relative to MTM NAD 83 northing and easting coordinates and the ground surface elevations are referenced to Geodetic datum.

### 3.2 Investigation by Others

The original foundation investigation of the swamps for which wick drain foundation treatment was proposed was carried out by Peto MacCallum Limited (Peto) and provided to us as follows:

- Borehole Records, Dynamic Cone Penetration Test (DCPT) Records and laboratory index testing data as reported in Peto's Technical Memorandum titled, "06TF033C 889 Tech memo Wick Drain Swamps December 14, 2007.pdf";
- The results of ten (10) laboratory consolidation tests as reported in emails dated April 3 and April 11, 2008 and February 2, 2009;
- Eight (8) Record of Borehole sheets for additional boreholes advanced in Swamp 305 as reported in an email dated July 30, 2008.

The locations of the Peto boreholes and DCPTs advanced within the extent of the wick drain area for each swamp have been converted from station and offset to MTM NAD 83 coordinates, as presented on Drawings A1 to E1.

The Record of Borehole and Record of Penetration Test sheets for the applicable Peto boreholes and DCPTs, together with the results of the laboratory tests carried out on selected soil samples as summarized on the Record of Borehole sheets, are presented in Appendix F.

The results of the laboratory consolidation tests performed by Peto on selected samples of the cohesive deposits for each swamp crossing, together with the results of the consolidation and triaxial tests performed by Golder, are summarized in Table 2.

The data from the Peto investigations, together with the supplemental investigation carried out by Golder, have been utilized to develop the subsurface model of critical areas (combination of greatest thickness of cohesive deposit, highest embankment, lowest shear strength of the cohesive deposit) within the five swamp crossings and to identify the required extent of the wick drain area for each swamp crossing.



## **4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS**

### **4.1 Regional Geology**

As delineated in *The Physiography of Southern Ontario*<sup>1</sup>, this section of Highway 69 lies within the physiographic region known as the Georgian Bay Fringe, which extends along the east side of Georgian Bay through the Parry Sound and Muskoka areas, then eastward from Muskoka in patches into the area north of the Kawartha Lakes.

This part of the Georgian Bay Fringe physiographic region was never submerged during periods of glacial recession. As a result, the surficial soils in this area consist of very shallow deposits of sand, silt and clay overlying metamorphic bedrock; numerous bare knobs and ridges of bedrock are present throughout the area. Localised low-lying swampy areas, containing peat and/or organic soils overlying soft/loose native soils, are present in valleys between the bedrock outcrops and ridges.

The bedrock in the area consists typically of gneisses of the Britt Domain of the Central Gneiss Belt, a subdivision of the Grenville Structural Province, as described in *Geology of Ontario, OGS Special Volume 4*<sup>2</sup>. Deposition of Paleozoic strata initially covered and later erosion during glaciation subsequently exposed these Precambrian rocks.

### **4.2 General Overview of Local Subsurface Conditions**

The detailed subsurface soil and groundwater conditions as encountered in the boreholes and CPTs advanced by Golder during this investigation, together with the results of the laboratory tests carried out on selected soil samples, are given on the Record of Borehole and Cone Penetration Test sheets in Appendices A to E. More detailed results from the laboratory testing are provided in Appendices A to E. The stratigraphic boundaries shown on the Record of Borehole sheets and on the stratigraphic profiles shown on Drawings A1, A2, B2, C1, D1 and E1 are inferred from non-continuous sampling, observations of drilling progress and the results of Standard Penetration Tests (SPTs) and in situ testing. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. Further, subsurface conditions will vary between and beyond the borehole, DCPT and CPT locations.

It should be noted that the orientation (i.e. north, south, east, west) stated in the text of the report is typically referenced to project north (along the proposed Highway 69 alignment) and therefore may differ from that shown on the drawings.

In general, the stratigraphy encountered at the various areas investigated by Golder and Peto is similar. The overburden (soil materials) thickness is variable, ranging from no cover (i.e. bedrock outcrops present at ground surface) to about 30.5 m. The simplified stratigraphy generally consists of:

- surficial layers of topsoil, peat and organic material up to about 4.9 m thick, but typically less than about 2.0 m thick;
- upper deposits of sand to silt in some areas up to about 5.5 m thick;
- deposits of clayey silt to clay ranging in thickness from about 2.7 m to 25 m, interbedded with silt and sand layers in some areas; and
- lower deposits of silt and sand underlying the cohesive deposits in some areas, with thickness up to about 6 m where fully penetrated.

<sup>1</sup> Chapman, L.J. and Putnam, D.F., 1984. *The Physiography of Southern Ontario*, Ontario Geological Survey, Special Volume 2, Third Edition. Accompanied by Map P.2715, Scale 1:600,000.

<sup>2</sup> *Geology of Ontario*, 1991. Ontario Geological Society, Special Volume 4, Part 2. Ministry of Northern Development and Mines, Ontario.



Descriptions of the subsurface conditions at each investigated swamp crossing are provided in the following sections of this report. Where relatively significant thicknesses of overburden were encountered, the various soil types are described in detail for each main deposit.

### 4.3 Highway 69 SBL and NBL – STA 17+700 to 18+150 (Swamp 302 SBL/NBL)

The plan and profile along the centreline of the embankment of the new Highway 69 SBL and NBL alignments showing the borehole, Dynamic Cone Penetration Test (DCPT) and Cone Penetration Test (CPT) locations, and interpreted stratigraphy within the extent of the swamp area considered for the wick drain foundation treatment in the Township of Mowat are shown on Drawings A1 and A2 in Appendix A. These alignments extend across a swamp area and the proposed roadway embankments will be up to about 6.5 m high above the existing grade. A total of four (4) boreholes (Boreholes 302-1 to 302-4) and eight (8) cone penetration tests (CPTs 302-1 to 302-8) were advanced by Golder, and a total of thirty four (34) boreholes (Boreholes 302-19 to 302-21, 302-23 to 302-25, 302-27, 302-29 to 302-35, 302-37, 302-39 to 302-41, 302-43 to 302-45, 302-47, 302-49 to 302-51, 302-53 to 302-55, 302-57, 302-59, 302-60 and 302-63 to 302-65) and twelve (12) dynamic cone penetration tests (DCPTs 302-22, 302-26, 302-28, 302-36, 302-38, 302-42, 302-46, 302-48, 302-52, 302-56, 302-58 and 302-62) were advanced by Peto to investigate the subsurface conditions within this swamp area. The topography along these alignments is generally flat to low-lying with ground cover consisting of a wet grassy area in the northern portion of the swamp and a moderately treed area in the southern portion of the swamp with occasional shallow open water.

In general, the subsurface soils along the NBL and SBL alignments in this area consist of a surficial layer of peat and/or organic clayey silt to silty clay underlain by a deposit of clayey silt to clay. The clayey silt to clay deposit is in turn underlain by a deposit of silt to sand and silt. Towards the southern portion of the proposed wick drain area (south of STA 17+850), a deposit of sand to silt was encountered at ground surface or beneath the ice/snow cover and peat. Resistance to dynamic cone penetration, cone penetration and borehole advancement, indicative of the potential bedrock surface, was encountered at greater depths near the north limit of the swamp at about STA 18+050 and near the south limit of the swamp at about STA 17+800. Bedrock outcrops are present to the north and south of the swamp and at some locations to the south of the swamp.

#### Ice / Snow / Water

Ice and packed snow or water to depths of about 0.1 m to 0.8 m was encountered in Boreholes 302-1 to 302-4, 302-19, 302-20, 302-24 and 302-63 to 302-65.

#### Peat / Topsoil

A deposit of dark brown fibrous peat containing wood fragments was encountered at the ground surface or below the ice and snow cover in all boreholes except in Boreholes 302-1, 302-3, 302-4, 302-19 and 302-24. The top of the peat deposit ranges from about Elevation 189.5 to 185.3 m and its thickness ranges from about 0.1 m to 2.1 m. In Borehole 302-41, an approximately 0.3 m thick layer of topsoil was encountered at the ground surface at about Elevation 186.7 m.

The Standard Penetration Test (SPT) 'N'-values recorded within the peat deposit range from 0 blows (weight of hammer) to 10 blows per 0.3 m of penetration, indicating a very soft to stiff consistency.

The natural water content measured on samples of the peat is between about 24 percent and 1609 percent, and the organic content measured on selected samples of the peat is between about 10 percent and 95 percent.



### Organic Clayey Silt to Silty Clay / Organic Silt

A deposit of grey organic clayey silt to silty clay or organic silt containing trace peat and trace sand was encountered below the ice and snow cover in Borehole 302-1, and below the peat deposit in Boreholes 302-33, 302-35, 302-43, 302-44, 302-45, 302-47, 302-49, 302-54, 302-55, 302-57, 302-60 and 302-63 to 302-65. The top of this deposit ranges from about Elevation 186.3 m to 185.8 m and its thickness varies between about 0.3 m and 2.6 m.

The SPT 'N'-values measured within the organic clayey silt to silty clay were between 0 blows (weight of hammer) and 21 blows per 0.3 m of penetration, indicating generally a very soft consistency to very stiff consistency where roots are present. The SPT 'N'-values recorded within the organic silt range between 0 blows (weight of hammer and rods) and 2 blows per 0.3 m of penetration, indicative of a very loose relative density.

The natural water content measured on samples of the organic deposits ranges from about 44 percent to 128 percent and the measured organic content on samples of these deposits ranges from about 3 percent to 6 percent.

Grain size distribution tests were performed by Peto on three (3) samples of these organic deposits and the results are summarized on the Record of Borehole sheets in Appendix F.

An Atterberg limits test carried out by Peto on a sample of the organic deposit measured a liquid limit of about 45 percent, a plastic limit of about 22 percent and a corresponding plasticity index of about 23 percent. The results of the Atterberg limits test are summarized on the Record of Borehole sheet in Appendix F and indicate the soil to be silty clay of intermediate plasticity.

### Sand to Silt

A mottled brown to grey cohesionless deposit comprised of sand, silty sand, sand and silt, sandy silt and silt was encountered below the ice and snow cover in Boreholes 302-3, 302-4 and 302-24, and below the peat/topsoil in Boreholes 302-21, 302-23 to 302-25, 302-27, 302-29, 302-30, 302-31, 302-32, 302-34, 302-37 and 302-41. The deposit generally contains trace to some clay, trace gravel, organics and rootlets. In Borehole S302-20 a pocket of clayey silt was encountered overlying the silty sand deposit, and in Boreholes 302-27, 302-39 and 302-51, the sand and silt to silty sand deposit was encountered as an interlayer within the silty clay to clayey silt deposit. In general, this deposit was encountered primarily to the south of STA 17+900. The top of this deposit varies between about Elevation 189.4 m and 185.4 m, and its thickness varies between about 0.6 m and 5.7 m.

The SPT 'N'-values measured within the sand to silt deposit range from 1 blow to 77 blows per 0.3 m of penetration, indicating a very loose to very dense relative density.

The natural water content measured on samples of this deposit ranges from about 15 percent to 44 percent.

Grain size distribution tests were performed by Peto on seven (7) samples of this deposit and the results are summarized on the Record of Borehole sheets in Appendix F.

An Atterberg limits test carried out by Peto on a sample of the silt deposit measured a liquid limit of about 20 percent, a plastic limit of about 17 percent and a corresponding plasticity index of about 3 percent. The results of the Atterberg limits test are summarized on the Record of Borehole sheet in Appendix F and indicate the material to be silt of low plasticity.

As noted above, an approximately 1.6 m thick pocket of grey and brown clayey silt containing organics was encountered overlying the silty sand deposit in Borehole 302-20. A single SPT 'N'-value of 4 blows per 0.3 m of penetration was recorded within this cohesive material indicating a soft consistency.



## Clayey Silt to Clay

A deposit of brown to grey clayey silt to clay, trace sand and containing occasional layers of silt was encountered either below the sand to silt or below the organic deposits in all the boreholes considered in this swamp area except Borehole 302-19 to 302-21. As noted above, in Boreholes 302-27, 302-39 and 302-51, an approximately 1.4 m to 1.6 m thick interlayer of sand and silt to silty sand was encountered within the silty clay to clayey silt deposit. The top of this cohesive deposit ranges from about Elevation 187.5 m to 183.3 m and its thickness ranges from about 3.0 m to 10.5 m. Where encountered, the clayey silt to clay deposit was fully penetrated in the boreholes advanced between about STA 17+750 and 18+150.

The SPT 'N'-values recorded within the cohesive deposit range between 0 blows (weight of hammer) and 10 blows per 0.3 m of penetration. In situ field vane tests carried out within this deposit measured undrained shear strengths ranging from about 11 kPa to 84 kPa, but typically less than about 35 kPa. The sensitivity is calculated to range between about 2 and 10, and typically about 3. The field vane test results together with the SPT 'N'-values indicate that the clayey silt to clay deposit has a generally very soft to firm consistency.

The natural water content measured on samples of this deposit ranges from about 21 percent to 79 percent.

Grain size distribution tests were carried out by Peto on eighteen (18) samples of this cohesive deposit and the results are summarized on the Record of Borehole sheets in Appendix F.

Atterberg limits tests were carried out by Golder on six (6) specimens of this cohesive deposit and by Peto on eighteen (18) specimens of this deposit. The liquid limits range from about 20 percent to 55 percent, the plastic limits range from about 18 percent to 24 percent, and the plasticity indices range from about 6 percent to 33 percent. The results of the Atterberg limits tests carried out by Golder are shown on the plasticity chart on Figure A.S302-1 in Appendix A and the results of the Atterberg limits tests carried out by Peto are summarized on the Record of Borehole sheets in Appendix F. The results indicate that the soil ranges from a clayey silt of low plasticity to clay of high plasticity.

A total of eight (8) cone penetration tests (CPTs 302-1 to 302-8) were performed in this swamp crossing of which four (4) tests were used for determination of the pore pressure designation at specific horizon within the clay deposit. The range of the coefficient of consolidation in the horizontal direction ( $c_h$ ) obtained from a total of nineteen (19) CPT pore pressure dissipation tests is summarized below.

| <b><math>C_h</math> CPT-Field<br/>(<math>\text{cm}^2/\text{s}</math>)</b> |                      |                      |
|---|----------------------|----------------------|
| <b>Upperbound</b>   | <b>Lowerbound</b>    | <b>Average</b>       |
| $1.2 \times 10^{-1}$  | $1.1 \times 10^{-2}$ | $3.0 \times 10^{-2}$ |

Laboratory consolidation tests were carried out by Golder on six (6) specimens of the cohesive deposit obtained from Shelby tube samples in Boreholes 302-1 and 302-2. Preconsolidation stresses ranging between about 100 kPa and 140 kPa were estimated from the void ratio versus logarithmic pressure plots and from the total work versus pressure plots. Bulk unit weights ranging between about  $15.6 \text{ kN/m}^3$  and  $20.4 \text{ kN/m}^3$ , and specific gravities ranging between about 2.72 and 2.77 were measured on the consolidation test specimens. Details of the Golder test results are shown on Figures A.S302-2 to A.S302-7 in Appendix A and are summarized below, together with the results of two (2) consolidation tests performed on this deposit by Peto.



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| Borehole Sample No.                     | Sample Depth / Elevation | $\sigma_{vo}'$ (kPa) | $\sigma_p'$ (kPa) | $\sigma_p' - \sigma_{vo}'$ (kPa) | OCR | $C_c$ | $C_r$ | $e_o$ | $c_v^*$ (cm <sup>2</sup> /s) |
|---|--------------------------|----------------------|-------------------|----------------------------------|-----|-------|-------|-------|------------------------------|
| Borehole 302-1 Sample 6                 | 4.1 m / 182.2 m          | 20                   | 140               | 120                              | 7.0 | 0.62  | 0.04  | 1.50  | $1.0 \times 10^{-1}$         |
| Borehole 302-1 Sample 7                 | 6.4 m / 179.9 m          | 35                   | 135               | 100                              | 3.9 | 0.17  | 0.02  | 0.87  | $1.0 \times 10^{-1}$         |
| Borehole 302-2 Sample 3                 | 4.1 m / 182.0 m          | 20                   | 140               | 120                              | 7.0 | 0.78  | 0.08  | 1.87  | $7.0 \times 10^{-2}$         |
| Borehole 302-2 Sample 4                 | 6.4 m / 179.7 m          | 35                   | 110               | 75                               | 3.1 | 0.12  | 0.03  | 0.69  | $6.7 \times 10^{-2}$         |
| Borehole 302-2 Sample 5                 | 9.4 m / 176.7 m          | 55                   | 110               | 55                               | 2   | 0.22  | 0.03  | 1.23  | $8.1 \times 10^{-2}$         |
| Borehole 302-2 Sample 5 <sup>(2)</sup>  | 9.4 m / 176.7 m          | 55                   | 100               | 45                               | 1.8 | 0.23  | 0.02  | 1.07  | $7.5 \times 10^{-2}$         |
| Borehole 302-29 Sample 7 <sup>(1)</sup> | 7.9 m / 181.1 m          | 100                  | 250               | 150                              | 2.5 | 0.85  | 0.06  | 1.62  | $1.3 \times 10^{-2}$         |
| Borehole 302-44 Sample 5 <sup>(1)</sup> | 4.9 m / 181.6 m          | 30                   | 205               | 175                              | 6.8 | 0.18  | 0.02  | 0.9   | $2.1 \times 10^{-2}$         |

Note: \* For stress range of  $19 \text{ kPa} \leq \sigma_v' \leq 314 \text{ kPa}$  (for Golder test results)  
 For stress range of  $17 \text{ kPa} \leq \sigma_v' \leq 532 \text{ kPa}$  (for Peto test results)  
 1 Laboratory consolidation test results obtained from Peto  
 2 Vertically Trimmed Oedometer (VTO) sample orientation, measured  $C_h$  (cm<sup>2</sup>/s)

where:  $\sigma_{vo}'$  is the effective overburden stress in kPa  
 $\sigma_p'$  is the preconsolidation stress in kPa  
 OCR is overconsolidation ratio  
 $e_o$  is initial void ratio  
 $C_c$  is the compression index  
 $C_r$  is the recompression index  
 $c_v$  is the coefficient of consolidation in cm<sup>2</sup>/s

Laboratory consolidated isotropic undrained triaxial compression tests (CIU) with pore pressure measurement were carried out on four (4) samples of the cohesive deposit obtained from Shelby tube samples in Boreholes 302-1 and 302-2. In total, four (4) sets of three (3) specimens were tested. The details of the test results are shown on Figure A.S302-8 to A.S302-11 in Appendix A and the results are summarized below.





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| Borehole Sample No.     | Sample Depth / Elevation | Effective Cohesion, $c'$ (kPa) | Effective Angle of Internal Friction, $\phi'$ (degrees) |
|-------------------------|--------------------------|--------------------------------|---|
| Borehole 302-1 Sample 6 | 4.1 m / 182.2 m          | 6                              | 34  |
| Borehole 302-1 Sample 7 | 6.4 m / 179.9 m          | 0                              | 35  |
| Borehole 302-2 Sample 3 | 4.1 m / 182.0 m          | 10                             | 34  |
| Borehole 302-2 Sample 5 | 9.4 m / 176.7 m          | 4                              | 33  |

Note: Assessed shear strength parameters are only valid over range of stress conditions used in the laboratory test.

The triaxial test samples were consolidated to pressures representative of the estimated in situ effective stresses and maximum effective stresses under the proposed embankment loads, at the respective sample depths. The interpreted effective strength parameters provided above are applicable only to design situations for which the stress conditions during testing are representative. Reference should be made to individual test results for details of the testing conditions.

### Silt to Sand and Silt

A deposit of grey silt to sand and silt, trace to some clay, was encountered below the clayey silt to clay deposit in all the boreholes except in Boreholes 302-19 to 302-21 which encountered refusal at shallow depth. The top of this deposit varies between about Elevation 182.6 m and 174.5 m and its thickness ranges from about 0.6 m to 5.7 m as delineated in the boreholes, and extends to a thickness of about 12.2 m as inferred from the resistance to dynamic cone penetration. Most boreholes and DCPTs advanced in this swamp were terminated within the silt to sand and silt deposit to depths of up to about 19.8 m below ground/ice surface, corresponding to about Elevation 166.7 m.

The SPT 'N'-values measured within the silt to sand and silt deposit range from 0 blows (weight of rod) to 22 blows per 0.3 m of penetration, indicating a very loose to compact relative density.

The natural water content measured on samples of this deposit ranges between about 20 percent and 30 percent.

Grain size distribution tests were performed by Peto on twenty six (26) samples of this deposit and the results are summarized on the Record of Borehole sheets in Appendix F.

Atterberg limits tests were carried out by Golder and by Peto on three (3) separate samples of this deposit. One Atterberg limits test performed by Golder measured a liquid limit of about 26 percent, a plastic limit of about 23 percent and a corresponding plasticity index of about 3 percent. The results of this Atterberg limits test are shown on the plasticity chart on Figure A.S302-12 in Appendix A, indicating the material to be silt of low plasticity. The other two Atterberg limits tests performed by Golder and those carried out by Peto indicate the material to be non-plastic.

### Refusal

In Boreholes 302-19 to 302-21, 302-23 to 302-25, 302-27, 302-35, 302-40, 302-41, 302-43 to 302-45, 302-49, 302-50 and 302-63, and DCPTs 302-22, 302-26, 302-42, 302-46, 302-48, 302-56 and 302-62, refusal to further



auger / sampler advancement and/or cone penetration, indicating the potential bedrock surface, was encountered at depths ranging between about 0.8 m and 18.8 m below ground/ice surface, corresponding to about Elevation 188.2 m and 167.7 m.

### Groundwater Conditions

In general, the samples taken in the boreholes were moist to wet. Water levels observed in the boreholes upon completion of drilling range from about Elevation 188.8 m to 182.3 m, measured at ice/ground surface or up to a depth of about 6.1 m below ground surface. Boreholes 302-20, 302-29 and 302-31 were observed to be dry upon completion of drilling.

### 4.4 Highway 69 SBL – STA 16+050 to 16+350 (Swamp 305 SBL)

The plan and profile along the centreline of the embankment of the new Highway 69 SBL alignment showing the borehole, Dynamic Cone Penetration Test (DCPT) and Cone Penetration Test (CPT) locations, and interpreted stratigraphy within the extent of the swamp area considered for the wick drain foundation treatment in the Township of Mowat are shown on Drawings B1 and B2 in Appendix B. The alignment extends across a swamp area and the proposed embankment will be up to about 2.5 m high above existing grade. A total of three (3) boreholes (Boreholes 305-1 to 305-3) and six (6) cone penetration tests (CPTs 305-1 to 305-6) were advanced by Golder, and a total of fourteen (14) boreholes (Boreholes 305-7, 305-9, 305-13, 305-16, 305-19, 305-21, 305-25, 305-28, 305-31, 305-33, 305-37, 305-39, 305-40 and 305-43) and five (5) dynamic cone penetration tests (DCPTs 305-10, 305-15, 305-22, 305-27, and 305-34) were advanced by Peto to investigate the subsurface conditions within this swamp area. The topography in the swamp is generally flat, encompassing an open, wet, grassy area and shallow open water.

In general, the subsurface soils along the SBL alignment in this swamp consist of surficial deposits of peat/topsoil and/or organic clay to organic silt, underlain by an upper deposit of silty clay to clayey silt at some locations. The organic deposits and/or the upper silty clay to clayey silt deposit are underlain by a deposit of sand to silt, which in turn is underlain by a lower deposit of clay to clayey silt. At some locations, a deposit of silt to sand was encountered underlying the clay to clayey silt deposit prior to refusal on probable bedrock or to cone penetration. Resistance to dynamic cone penetration, cone penetration and borehole advancement, indicative of the potential bedrock surface, was encountered at greater depths between about STA 16+175 and 16+225. Bedrock outcrops are present to the north and south limits of the swamp.

### Ice / Snow / Water

Ice or snow and water to depths between about 0.3 m and 1.7 m was encountered in all boreholes advanced within the main lower portion of the swamp area, in Boreholes 305-10 to 305-33.

### Peat / Topsoil

A deposit of dark brown to grey fibrous to amorphous peat containing roots and topsoil was encountered at the ground surface and/or underlying the ice/water/snow cover in all boreholes except in Boreholes 305-13 and 305-40. The top of this organic deposit ranges from about Elevation 188.1 m to 185 m to the south of STA 16+300, and at about Elevation 192.1 m to the north of STA 16+300 as a thin veneer over bedrock outcrop or shallow soil over bedrock. The thickness of this deposit ranges from about 0.1 m to 3.2 m. It is noted that some discrepancy exists between the elevation of the ground surface or top of peat as encountered in the Peto boreholes and as defined by the ground surface survey in this area.



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The Standard Penetration Test (SPT) 'N'-values recorded within the peat deposit are 0 blows (weight of hammer and/or rod) per 0.3 m of penetration, indicating a very soft consistency.

The natural water content measured on samples of this deposit ranges from about 45 percent to 620 percent, and the organic content measured on samples of this deposit are about 13 percent and 65 percent.

### Organic Clay to Clayey Silt / Organic Silt

A deposit of brown to grey organic clay to organic clayey silt and/or organic silt containing trace sand, sandy silt and sand seams was encountered underlying the peat deposit in Boreholes 305-1, 305-16, 305-19, 305-25, 305-31, 305-33 and 305-37, and below the ice/water cover in Borehole 305-13. The top of this organic deposit ranges from about Elevation 186.9 m to 183.7 m and its thickness ranges from about 0.3 m to 1.9 m.

The SPT 'N'-values measured within the organic deposit range from 0 blows (weight of hammer and/or rod) to 4 blows per 0.3 m of penetration, indicating a very soft to soft consistency / very loose relative density.

The natural water content measured on samples of this organic deposit ranges from about 40 percent to 141 percent, and the organic content measured on a sample of this deposit is about 7 percent.

### Silty Clay to Clayey Silt (Upper)

Discontinuous layers of silty clay to clayey silt containing silty sand seams was encountered below the topsoil in Borehole 305-7, and below the peat and organic clayey silt in Boreholes 305-21 and 305-33, respectively. The top of the layers range from about Elevation 187.7 m to 182.9 m, and the thickness ranges from about 0.5 m to 1.5 m.

The SPT 'N'-values measured within the layers are 0 blows (weight of hammer and rod) and 2 blows per 0.3 m of penetration, indicating a very soft consistency.

The natural water content measured on a sample of this deposit is about 36 percent.

### Sand to Silt

A deposit of comprised of grey sand trace to some silt, silty sand, sandy silt and silt trace to some sand was encountered below the organic deposit or below the upper silty clay to clayey silt layers in all boreholes advanced within the extent of the swamp area except in Boreholes 305-39 and 305-40. The deposit generally contains trace to some clay, trace gravel, occasional thin layers of clay and silty sand (within the silt deposit). Also, localized pockets of clay to clayey silt were encountered within the deposit in Boreholes 305-2, 305-3, 305-7, 305-9, 305-13, 305-16 and 305-37, as further described below. The top of the deposit typically ranges from about Elevation 187.8 m to 181.4 m, except in Borehole 305-43 where the silt deposit was encountered on the higher ground at about Elevation 191.8 m. The thickness of the deposit ranges from about 0.3 m to 6.4 m. Borehole 305-3 was terminated within the silt deposit at a depth of about 6.7 m, corresponding to about Elevation 180.5 m.

The SPT 'N'-values recorded within this deposit range from 0 blows (weight of hammer and/or rod) to 10 blows, per 0.3 m of penetration, indicating a very loose to loose relative density.

The natural water content measured on samples of this deposit ranges from about 21 percent to 53 percent. In Borehole 305-2, the upper portion of the silt deposit was observed to be slightly organic and an organic content test performed on a sample of this deposit is about 4.9 percent.



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A grain size distribution test carried out by Golder on one (1) sample of the silt deposit is shown on Figure B.S305-1 in Appendix B. Peto performed grain size distribution tests on eight (8) samples of the sand to silt deposit and the results are summarized on the Record of Borehole sheets in Appendix F.

An Atterberg limits test was carried out by Golder on one (1) specimen of the silt deposit and by Peto on two (2) specimens of the silt deposit. In general, the liquid limits range between about 18 percent and 19 percent, plastic limits range between about 14 percent and 17 percent, and the plasticity indices range between about 2 percent and 4 percent. The results of the Atterberg limits test carried out by Golder are shown on the plasticity chart on Figure B.S305-2 in Appendix B and the results of the Atterberg limits tests carried out by Peto are summarized on the Record of Borehole sheets in Appendix F. The results indicate the material is a silt of low plasticity.

A laboratory multistage consolidated isotropic undrained triaxial compression test (CIU) with pore pressure measurement was carried out on one (1) sample of the silt deposit at two (2) different confining pressures. The details of the test results are shown on Figure B.S305-3 in Appendix B, and the results are summarized below.

| Borehole /<br>Sample No.     | Sample<br>Depth /<br>Elevation | Effective<br>Cohesion, $c'$<br>(kPa) | Effective Angle of<br>Internal Friction, $\phi'$<br>(degrees) |
|------------------------------|--------------------------------|--------------------------------------|---|
| Borehole 305-3 /<br>Sample 2 | 7.9 m /<br>178.9 m             | 0                                    | 32  |

The triaxial test sample was consolidated to pressures representative of the estimated in situ effective stresses and maximum effective stresses under the proposed embankment loads at the sample depth. The interpreted effective strength parameters provided above are applicable only to design situations for which the stress conditions during testing are representative.

### Clay to Clayey Silt (Lower)

A deposit of mottled brown to grey clay to clayey silt, trace to some sand and trace gravel containing silt interlayers and sand and silt seams was encountered below the sand to silt deposit in all boreholes advanced within the extent of the swamp area except in Boreholes 305-7, 305-9, 305-13, 305-39, 305-40 and 305-43 drilled on the south and north perimeters of the swamp. The top of this deposit varies between about Elevation 182.2 m and 178.2 m, and its thickness varies between about 3.7 m and 17.7 m, but is typically greater than 7 m thick. As noted above, approximately 0.9 m to 2.8 m thick localized pockets of grey clayey silt to clay trace to some silt and trace sand were encountered within the sand to silt deposit, between about Elevation 187.4 m and 181.2 m in Boreholes 305-2, 305-3, 305-7, 305-9, 305-13, 305-16 and 305-37.

The SPT 'N'-values recorded within the cohesive deposit and the cohesive pockets typically range from 0 blows (weight of hammer and/or rod) to 4 blows per 0.3 m of penetration, with a SPT 'N'-value as high as 6 blows per 0.3 m of penetration recorded within the cohesive deposit containing silt and sand interlayers or seams. In Borehole 305-2, a SPT 'N'-value of 29 blows per 0.3 m of penetration was recorded at the bottom of the deposit straddling a layer of silt below the clayey silt and this higher 'N'-value is influenced by the presence of gravel and cobbles within the lower portion of the deposit. In situ field vane tests carried out within the cohesive deposits measured undrained shear strengths between about 18 kPa and 100 kPa, but typically less than about 50 kPa. The sensitivity is calculated to range between about 1 and 8, and is typically about 4. The field vane test results together with the SPT 'N'-values indicate that the clay to clayey silt deposit has a generally very soft to firm consistency.

The natural water content measured on samples of the cohesive deposit and pockets ranges from about 25 percent to 80 percent.



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Atterberg limits tests were carried out by Golder on five (5) specimens of the cohesive deposits and by Peto on twelve (12) specimens of this deposit. The liquid limits range from about 24 percent to 102 percent, the plastic limits range from about 14 percent to 31 percent, and the plasticity indices range from about 7 percent to 72 percent. The results of the Atterberg limits tests carried out by Golder are shown on the plasticity chart on Figure B.S305-4 in Appendix B and the results of the Atterberg limits tests carried out by Peto are summarized on the Record of Borehole sheets in Appendix F. The results indicate that the soil in this cohesive deposits range from a clay of high plasticity to clayey silt of low plasticity.

A total of six (6) cone penetration tests (CPTs 305-1 to 305-6) were performed in this swamp crossing of which three (3) tests were used for determination of the pore pressure dissipation at specific horizons within the clay deposit. The range of the coefficient of consolidation in the horizontal direction ( $c_h$ ) obtained from a total of twelve (12) CPT pore pressure dissipation tests carried out is summarized below.

| $C_h$ CPT-Field<br>( $\text{cm}^2/\text{s}$ ) |                      |                      |
|---|----------------------|----------------------|
| Upperbound                                    | Lowerbound           | Average              |
| $6.2 \times 10^{-2}$                          | $1.9 \times 10^{-3}$ | $4.6 \times 10^{-3}$ |

Laboratory consolidation tests were carried out by Golder on two (2) specimens of the cohesive deposit obtained from Shelby tube samples in Boreholes 305-1 and 305-3. Preconsolidation stresses of about 100 kPa and 40 kPa were estimated from the void ratio versus logarithmic pressure plots and from the total work versus pressure plots. Bulk unit weights of about  $16.8 \text{ kN/m}^3$  and  $15.0 \text{ kN/m}^3$ , and specific gravities of about 2.78 were measured on the consolidation test specimens. Details of the Golder test results are shown on Figures B.S305-5 and B.S305-6 in Appendix B and are summarized below, together with the results of four (4) consolidation tests performed on samples of this deposit by Peto.

| Borehole<br>Sample No.                      | Sample<br>Depth /<br>Elevation | $\sigma_{vo}'$<br>(kPa) | $\sigma_p'$<br>(kPa) | $\sigma_p' - \sigma_{vo}'$<br>(kPa) | OCR | $C_c$ | $C_r$ | $e_o$ | $c_v^*$<br>( $\text{cm}^2/\text{s}$ ) |
|---|--------------------------------|-------------------------|----------------------|-------------------------------------|-----|-------|-------|-------|---------------------------------------|
| Borehole 305-1<br>Sample 7                  | 13.8 m /<br>172.9 m            | 80                      | 100                  | 20                                  | 1.3 | 0.63  | 0.06  | 1.49  | $1.3 \times 10^{-2}$                  |
| Borehole 305-3<br>Sample 1                  | 3.4 m /<br>183.8 m             | 20                      | 40                   | 20                                  | 2   | 1.06  | 0.10  | 2.30  | $2.0 \times 10^{-3}$                  |
| Borehole 305-16<br>Sample 8 <sup>(1)</sup>  | 11.0 m /<br>176.5 m            | 50                      | 180                  | 130                                 | 3.6 | 0.95  | 0.09  | 1.79  | $2.7 \times 10^{-3}$                  |
| Borehole 305-20<br>Sample 10 <sup>(1)</sup> | 14.0 m /<br>174.3 m            | 115                     | 205                  | 90                                  | 1.8 | 0.70  | 0.07  | 1.44  | $3.7 \times 10^{-3}$                  |
| Borehole 305-20<br>Sample 17 <sup>(1)</sup> | 21.0 m /<br>167.3 m            | 150                     | 420                  | 270                                 | 2.8 | 1.26  | 0.08  | 1.71  | $9.4 \times 10^{-3}$                  |
| Borehole 305-23<br>Sample 10 <sup>(1)</sup> | 12.5 m /<br>179.6 m            | 65                      | 290                  | 225                                 | 4.5 | 1.16  | 0.08  | 1.89  | $6.2 \times 10^{-3}$                  |

Note: \* For stress range of  $19 \text{ kPa} \leq \sigma_v' \leq 156 \text{ kPa}$  (for Golder test results)

For stress range of  $34 \text{ kPa} \leq \sigma_v' \leq 532 \text{ kPa}$  (for Peto test results)

<sup>(1)</sup> Laboratory consolidation test results obtained from Peto



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where:  $\sigma_{vo}'$  is the effective overburden stress in kPa  
 $\sigma_p'$  is the preconsolidation stress in kPa  
OCR is overconsolidation ratio  
 $e_o$  is initial void ratio  
 $C_c$  is the compression index  
 $C_r$  is the recompression index  
 $c_v$  is the coefficient of consolidation in  $\text{cm}^2/\text{s}$

Laboratory consolidated isotropic undrained triaxial compression tests (CIU) with pore pressure measurement were carried out on three (3) samples of the cohesive deposits obtained from Shelby tube samples in Boreholes 305-1, 305-2 and 305-3. In total, two (2) sets of three (3) specimens were tested for the CIU, and one (1) specimen was tested using a multistage CIU at three (3) difference confining pressures. The details of the test results are shown on Figure B.S305-7 to B.S305-9 in Appendix B, and the results are summarized below.

| Borehole /<br>Sample No.     | Sample<br>Depth /<br>Elevation | Effective<br>Cohesion, $c'$<br>(kPa) | Effective Angle of<br>Internal Friction, $\phi'$<br>(degrees) |
|------------------------------|--------------------------------|--------------------------------------|---|
| Borehole 305-1 /<br>Sample 7 | 13.8 m /<br>172.9 m            | 7                                    | 30  |
| Borehole 305-2 /<br>Sample 2 | 4.8 m /<br>181.9 m             | 0                                    | 30  |
| Borehole 305-3 /<br>Sample 1 | 3.4 m /<br>183.8 m             | 3                                    | 45  |

Note: Assessed shear strength parameters are only valid over range of stress conditions used in the laboratory test.

The triaxial test samples were consolidated to pressures representative of the estimated in situ effective stresses and maximum effective stresses under the proposed embankment loads, at the respective sample depths. The interpreted effective strength parameters provided above are applicable only to design situations for which the stress conditions during testing are representative. Reference should be made to individual test reports for details of the testing conditions.

### Silt to Sand

A deposit of grey silt to sand, trace to some clay and trace gravel was encountered below the clay to clayey silt deposit in Boreholes 305-2, 305-19, 305-21 and 305-37 and inferred from the dynamic cone penetration test in Borehole 305-1, 305-22 and 305-27. The silt deposit encountered in Borehole 305-2 was noted to contain sand and gravel layers in the split-spoon sample. The top of this deposit ranges from about Elevation 175.0 m to 163.2 m, and its thickness ranges from about 0.2 m to 2.3 m, extending to an interpreted thickness of about 9.8 m as inferred from the resistance to dynamic cone penetration. The DCPT driven from the bottom of the Borehole 305-1 and DCPTs 305-22 and 305-27 were terminated within the silt deposit at depths of between about 25.9 m and 30.5 m, corresponding to Elevation 161.6 m and 156.2 m.

The SPT 'N'-values recorded within this deposit typically range from 0 blows (weight of hammer and rod) to 4 blows, per 0.3 m of penetration, indicating a very loose to loose relative density. In Borehole 305-2, a SPT 'N' value of 29 blows was recorded at the bottom of the borehole, indicative of a compact relative density, followed by auger refusal on sloping surface.

The natural water content measured on samples of this deposit is between about 23 percent and 30 percent.





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Grain size distribution tests were carried out by Peto on two (2) samples of this deposit and the results are summarized on the Record of Borehole sheets in Appendix F.

An Atterberg limits test carried out by Peto on one (1) sample of the silt deposit measured a liquid limit of about 21 percent, a plastic limit of about 19 percent and a corresponding plasticity index of about 2 percent. The results of the Atterberg limits test are summarized on the Record of Borehole sheet in Appendix F and indicate the material to be silt of low plasticity.

### Bedrock / Refusal

Bedrock was encountered at ground surface in Borehole 305-40 at about Elevation 191.2 m. In all boreholes and DCPTs, except in Borehole 305-1 and DCPTs 305-22 and 305-27, refusal to further sampler and/or auger advancement or cone penetration, indicative of the potential bedrock surface, was encountered at depths between about 0.6 m and 31.7 m below ice/snow or ground surface, corresponding to between about Elevation 190.6 m and 155.8 m.

### Groundwater Conditions

In general, the samples taken in the boreholes were wet. Water levels observed in the boreholes upon completion of drilling range from about Elevation 187.5 m to 186.5 m, measured at ice/snow and ground surface or up to a depth of about 1.0 m below ice surface, while Borehole 305-9, 305-39 and 306-43 were observed to be dry upon completion of drilling.

## 4.5 Highway 69 SBL – STA 15+350 to 15+800 (Swamp 306 SBL)

The plan and profile along the centreline of the embankment of the new Highway 69 SBL alignment showing the borehole, Dynamic Cone Penetration Test (DCPT) and Cone Penetration Test (CPT) locations, and interpreted stratigraphy within the extent of the swamp area considered for the wick drain foundation treatment in the Township of Mowat are shown on Drawing C1 in Appendix C. The alignment extends across a swamp area and the proposed roadway embankment will be up to about 3 m high above existing grade. Two (2) boreholes (Boreholes 306-1 and 306-2) and six (6) cone penetration tests (CPTs 306-1 to 306-6) were advanced by Golder, and a total of twenty (20) boreholes (Boreholes 306-13, 306-16, 306-19, 306-21, 306-25, 306-28, 306-31, 306-33, 306-37, 306-40, 306-43, 306-45, 306-49, 306-52, 306-55, 306-61, 306-63, 306-64, 306-65 and 306-68), and eight (8) dynamic cone penetration tests (DCPTs 306-15, 306-22, 306-27 and 306-34, 306-39, 306-46, 306-51 and 306-58) were advanced by Peto to investigate the subsurface conditions within this swamp area. The topography of this section of proposed highway is generally flat and low-lying, sloping downwards towards a creek that traverses the northern portion of this swamp. The ground cover consists of grasses and densely treed areas.

In general, the subsurface soils along the SBL alignment in this area consist of surficial deposits of peat/topsoil and/or organic clayey silt to clay, underlain by a layer of sandy silt to silt at some locations. The organic deposit and the sandy silt layer are in turn underlain by a deposit of clay to clayey silt, which is underlain by a deposit of silt to sand in places. Resistance to dynamic cone penetration, cone penetration and borehole advancement, indicative of the potential bedrock surface, was encountered at greater depths between about STA 15+450 and 15+550. Bedrock outcrops are present to the north and south of the swamp.



### Peat / Topsoil

A deposit of dark brown fibrous to amorphous peat or topsoil was encountered at the ground surface in all boreholes advanced in this swamp area, except in Borehole 306-1 and 306-2. The top of the peat/topsoil layer varies between about Elevation 192.2 m and 189.0 m, and its thickness varies between about 0.1 m and 0.9 m.

The Standard Penetration Test (SPT) 'N'-values recorded within the peat layer are 0 blows (weight of hammer and rod) and 1 blow per 0.3 m of penetration, indicative of a very soft consistency.

The natural water content measured on samples of the peat is between about 92 percent and 239 percent, and the organic content of two (2) samples of the peat is about 15 percent and 42 percent.

### Organic Clayey Silt to Clay

A deposit of grey to brown organic clayey silt to clay, trace sand, was encountered at the ground surface or below the peat deposit in Borehole 306-1, 306-2, 306-16, 306-19, 306-25, 306-28, 306-31, 306-33, 306-37 and 306-40, all located to the south of creek traversing the area. The organic deposit generally contains layers of silt, wood fragments, shell fragments and layers of fibrous/amorphous peat. The top of this deposit ranges from about Elevation 189.4 m to 188.1 m, and its thickness ranges from about 0.6 m to 2.3 m.

The SPT 'N'-values measured within the organic clayey silt to clay are 0 blows (weight of hammer and rod) and 1 blow per 0.3 m of penetration. In situ field vane tests carried out within this deposit measured undrained shear strengths ranging from about 18 kPa to 24 kPa, and the sensitivity is calculated to be about 4. The field vane test results together with the SPT 'N'-values indicate that the organic clayey silt to silty clay deposit has a very soft to soft consistency.

The natural water content measured on samples of this deposit is between about 87 percent and 119 percent, and the organic content measured on samples of this deposit is between about 4 percent and 6 percent.

Grain size distribution tests were carried out by Peto on two (2) samples of this deposit and the results are summarized on the Record of Borehole sheets in Appendix F.

An Atterberg limits test carried out by Peto on a sample of the organic clay deposit measured a liquid limit of about 54 percent, a plastic limit of about 36 percent and a corresponding plasticity index of about 18 percent. The results of the Atterberg limits test are summarized on the Record of Borehole sheet in Appendix F and indicate the material to be organic clay of high plasticity.

### Sandy Silt to Silt

A layer of brown to grey sandy silt to silt was encountered below the organic deposit in Boreholes 306-31, 306-33, 306-37, 306-43 and 306-61. The top of this layer ranges from about Elevation 190.6 m to 187.8 m, and its thickness ranges from about 0.4 m to 0.9 m.

The SPT 'N'-values measured within this layer range from 0 blows (weight of hammer and rod) to 4 blows per 0.3 m of penetration, indicating a very loose to loose relative density.

The natural water content measured on one (1) sample of this layer is about 85 percent.

### Clay to Clayey Silt

A deposit of brown to grey clay to clayey silt, trace sand and containing thin layers of silt throughout was encountered below the organic clayey silt to silty clay and sandy silt to silt deposits in all boreholes. The top of this deposit ranges from about Elevation 192.1 m to 186 m, and its thickness ranges from about 1.8 m to 13.2 m.



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The clay to clayey silt deposit was fully penetrated in the boreholes advanced between about STA15+400 and 15+750, or extended to refusal condition.

The SPT 'N'-values recorded within the cohesive deposit range from 0 blows (weight of hammer and rod) to 10 blow per 0.3 m of penetration, with SPT 'N'-values up to 10 blows per 0.3 m of penetration recorded near the surface of this deposit in some boreholes. In situ field vane tests carried out within this deposit measured undrained shear strengths ranging from about 9 kPa to 64 kPa, but typically less than about 20 kPa. The sensitivity is calculated to range from about 1 to 9 and is typically less than 4. The field vane test results, together with the SPT 'N'-values, indicate that the clay to clayey silt deposit has a generally very soft to firm consistency.

The natural water content measured on samples of this deposit ranges from about 14 percent to 97 percent.

A grain size distribution test carried out by Golder on one (1) sample of this deposit is shown on Figure C.S306-1 in Appendix C. Peto performed grain size distribution tests on eighteen (18) samples of this deposit and the results are summarized on the Record of Borehole sheets in Appendix F

Atterberg limits tests were carried out by Golder on three (3) specimens of the cohesive deposit and by Peto on seventeen (17) specimens of this deposit. The liquid limits range from about 21 percent to 81 percent, the plastic limits range from about 14 percent to 36 percent, and the plasticity indices range from about 6 percent to 57 percent. The results of the Atterberg limits tests carried out by Golder are shown on the plasticity chart on Figure C.S306-2 in Appendix C and the results of the Atterberg limits tests carried out by Peto are summarized on the Record of Borehole sheets in Appendix F. The results indicate that the soil ranges from a clay of high plasticity to clayey silt of low plasticity.

A total of six (6) cone penetration tests (CPTs 306-1 to 306-6) were performed in this swamp area of which three (3) tests were used for determination of the pore pressure dissipation at specific horizons within the clay deposit. The range of the coefficient of consolidation in the horizontal direction ( $c_h$ ) obtained from a total of eleven (11) CPT pore pressure dissipation tests carried out is summarized below.

| <b><math>C_h</math> CPT-Field<br/>(cm<sup>2</sup>/s)</b> |                      |                      |
|--|----------------------|----------------------|
| <b>Upperbound</b>  | <b>Lowerbound</b>    | <b>Average</b>       |
| $3.0 \times 10^{-2}$                                     | $3.1 \times 10^{-3}$ | $6.8 \times 10^{-3}$ |

Laboratory consolidation tests were carried out by Golder on two (2) specimens of the cohesive deposit obtained from Shelby tube samples in Boreholes 306-1 and 306-2. Preconsolidation stresses of about 35 kPa and 65 kPa were estimated from the void ratio versus logarithmic pressure plots and from the total work versus pressure plots. Bulk unit weights of about 14.5 kN/m<sup>3</sup> and 14.9 kN/m<sup>3</sup> and specific gravities of about 2.75 and 2.76 were measured on the corresponding consolidation test specimens. Details of the test results are shown on Figures C.S306-3 and C.S306-4 in Appendix C and are summarized below, together with the results of three (3) consolidation tests performed on this deposit by Peto.

| <b>Borehole<br/>Sample No.</b> | <b>Sample<br/>Depth /<br/>Elevation</b> | <b><math>\sigma_{vo}'</math><br/>(kPa)</b> | <b><math>\sigma_p'</math><br/>(kPa)</b> | <b><math>\sigma_p' - \sigma_{vo}'</math><br/>(kPa)</b> | <b>OCR</b> | <b><math>C_c</math></b> | <b><math>C_r</math></b> | <b><math>e_o</math></b> | <b><math>c_v^*</math><br/>(cm<sup>2</sup>/s)</b> |
|--------------------------------|---|--|---|--|------------|-------------------------|-------------------------|-------------------------|--|
| Borehole 306-1<br>Sample 5     | 7.9 m /<br>180.7 m                      | 45   | 65                                      | 20   | 1.4        | 1.21                    | 0.11                    | 2.33                    | $2.5 \times 10^{-2}$                             |
| Borehole 306-2<br>Sample 3     | 4.9 m /<br>184.5 m                      | 25   | 35                                      | 10   | 1.4        | 1.16                    | 0.09                    | 2.68                    | $2.5 \times 10^{-3}$                             |



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|  |                    |    |     |     |     |      |      |      |                      |
|--|--------------------|----|-----|-----|-----|------|------|------|----------------------|
| Borehole 306-16<br>Sample 7 <sup>(1)</sup> | 6.4 m /<br>182.6 m | 50 | 170 | 120 | 3.4 | 0.86 | 0.07 | 1.78 | $6.4 \times 10^{-3}$ |
| Borehole 306-55<br>Sample 5 <sup>(1)</sup> | 4.9 m /<br>185.0 m | 60 | 110 | 50  | 1.8 | 0.99 | 0.08 | 1.94 | $4.1 \times 10^{-3}$ |
| Borehole 306-28<br>Sample 7 <sup>(1)</sup> | 7.9 m /<br>181.3 m | 50 | 170 | 120 | 3.4 | 0.63 | 0.04 | 1.37 | $4.1 \times 10^{-3}$ |

Note: \* For stress range of  $19 \text{ kPa} \leq \sigma_v' \leq 155 \text{ kPa}$  (for Golder test results)  
For stress range of  $34 \text{ kPa} \leq \sigma_v' \leq 255 \text{ kPa}$  (for Peto test results)

1 Laboratory consolidation test results obtained from Peto

where:  $\sigma_{vo}'$  is the effective overburden stress in kPa  
 $\sigma_p'$  is the preconsolidation stress in kPa  
OCR is overconsolidation ratio  
 $e_o$  is initial void ratio  
 $C_c$  is the compression index  
 $C_r$  is the recompression index  
 $c_v$  is the coefficient of consolidation in  $\text{cm}^2/\text{s}$

Laboratory consolidated isotropic undrained triaxial compression tests (CIU) with pore pressure measurement were carried out on two (2) samples of the cohesive deposit obtained from Shelby tube samples in Boreholes 306-1 and 306-2. In total, two (2) sets of three (3) specimens were tested at different confining pressures. The details of the test results are shown on Figure C.S306-5 and C.S306-6 in Appendix C, and the results are summarized below.

| Borehole<br>Sample No.     | Sample<br>Depth /<br>Elevation | Effective<br>Cohesion, $c'$<br>(kPa) | Effective Angle of<br>Internal Friction, $\phi'$<br>(degrees) |
|----------------------------|--------------------------------|--------------------------------------|---|
| Borehole 306-1<br>Sample 5 | 7.9 m /<br>180.7 m             | 7                                    | 25  |
| Borehole 306-2<br>Sample 3 | 4.9 m /<br>184.5 m             | 5                                    | 25  |

Note: Assessed shear strength parameters are only valid over range of stress conditions used in the laboratory test.

The triaxial test samples were consolidated to pressures representative of the estimated in situ effective stresses and maximum effective stresses under the proposed embankment loads, at the respective sample depths. The interpreted effective strength parameters provided above are applicable only to design situations for which the stress conditions during testing are representative. Reference should be made to the individual test reports for details of the testing conditions.

### Silt to Sand

A deposit of grey silt, trace to some sand and trace to some clay, sandy silt with gravel, and sand some gravel and trace silt was encountered below the clay to clayey silt deposit and extends to refusal on probable bedrock in Boreholes 306-13, 306-16, 306-28, 306-31, 306-33, 306-37, 306-40, 306-43, 306-45, 306-52, 306-55, 306-61 and 306-65. The silt deposit generally contains thin layers of silty clay to clay and occasional sandy layers. The top of this deposit ranges from about Elevation 189.4 m to 174.2 m and its thickness ranges from about 0.3 m to 4.9 m.



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The SPT 'N'-values recorded within this deposit range from 0 blows (weight of hammer and rod) to 10 blows per 0.3 m of penetration, indicating a very loose to loose relative density.

The natural water content measured on samples of this deposit ranges from about 13 percent to 28 percent.

Grain size distribution tests were carried out by Peto on ten (10) samples of this deposit and the results are summarized on the Record of Borehole sheets in Appendix F.

Atterberg limits tests were carried out by Peto on seven (7) samples of the silt deposit. Five of the Atterberg limits tests measured liquid limits ranging from about 20 percent to 22 percent, plastic limits ranging from about 17 percent to 20 percent, and plasticity indices ranging from about 2 percent to 4 percent. The results of these Atterberg limits test are summarized on the Record of Borehole sheet in Appendix F and indicate the material to be silt of low plasticity. Two tests indicate the material to be non-plastic.

### Refusal

In all boreholes and DCPTs, refusal to further sampler and auger advancement or cone penetration, indicative of the potential bedrock surface, was encountered at depths between about 1.1 m and 18.0 m, corresponding to about Elevation 190.1 m and 171.2 m.

### Groundwater Conditions

In general, the samples taken in the boreholes were moist to wet. Water levels observed in the boreholes upon completion of drilling range from about Elevation 189.5 to Elevation 183.4, measured at the ground surface or up to a depth of about 6.1 m below ground surface. Boreholes 306-13, 306-16, 306-19, 306-63 and 306-68 were observed to be dry upon completion of drilling.

## 4.6 Highway 69 SBL – STA 14+425 to 14+500 (Swamp 307 SBL)

The plan and profile along the centreline of the embankment of the new Highway 69 SBL alignment showing the borehole, Dynamic Cone Penetration Test (DCPT) and Cone Penetration Test (CPT) locations and interpreted stratigraphy within the extent of the swamp area considered for the wick drain foundation treatment between in the Township of Mowat are shown on Drawing D1 in Appendix D. The alignment extends across a swamp area and the proposed roadway embankment will be up to about 3 m high above existing grade. Golder advanced one (1) borehole (Borehole 307-1) and two (2) cone penetration tests (CPTs 307-1 and 307-2) and Peto advanced nine (9) boreholes (Boreholes 307-19, 307-21, 307-23, 307-27, 307-28, 307-34, 307-36, 307-37 and 307-40) and four (4) dynamic cone penetration tests (DCPTs 307-22, 307-26, 307-30 and 307-31) to investigate the subsurface conditions in this swamp area. The topography of this section of proposed highway is generally flat, encompassing an open, wet, grassy area and shallow open water, with upward sloping grass-covered terrain towards the northern limit of the swamp.

In general, the subsurface soils along the SBL alignment in this area consist of a surficial deposit of peat and/or organic silt underlain by an upper deposit of silt, which in turn is underlain by a deposit of clayey silt to clay. At some locations, the cohesive deposit is underlain by a deposit of silt to sand. Resistance to dynamic cone penetration, cone penetration and borehole advancement, indicative of the potential bedrock surface, was encountered at greater depth at about STA 14+460. Bedrock outcrops are present to the north and south limits of the swamp.



### Ice / Snow / Water

Ice or snow and water to depths of between about 0.3 m and 0.5 m was encountered in Boreholes 307-1, 307-21, 307-27, 307-28 and 307-34.

### Peat / Organic Silt

A deposit of dark brown root mat / fibrous peat containing roots and trace gravel, and/or organic silt, trace gravel and trace sand was encountered at the ground surface or below the ice/snow and water cover in all boreholes, except in Boreholes 307-36 and 307-40. The top of the peat/organic silt deposit ranges from about Elevation 193.4 m to 192.3 m and its thickness ranges from about 0.1 m to 2.4 m.

The Standard Penetration Test (SPT) 'N'-values recorded within the peat/organic silt deposit are 1 blow and 2 blows per 0.3 m of penetration, indicative of a very soft consistency / very loose relative density.

The natural water content measured on two samples of the peat is about 37 percent and 263 percent and the organic content on these samples is about 4 percent and 27 percent.

### Silt (Upper)

An upper deposit of grey to brown silt, trace to some clay and trace to some sand containing organics and sandy layers within the upper and lower portions of the deposit was encountered below the peat / organic silt in Boreholes 307-21, 307-23, 307-28 and 307-37. The top of this deposit ranges from about Elevation 193.3 m to 191.0 m, and its thickness ranges from about 1.5 m to 4.4 m.

The SPT 'N'-values recorded within this deposit range from 1 blow to 10 blows per 0.3 m of penetration, indicating a very loose to loose relative density.

The natural water content measured on a sample of this deposit is about 19 percent.

A grain size distribution test was performed by Peto on a sample of this deposit and the results are summarized on the Record of Borehole sheets in Appendix F.

### Clayey Silt to Clay

A deposit of reddish brown to grey clayey silt to clay, trace gravel and trace sand was encountered below the organic deposits or silt deposit in all boreholes, except in Boreholes 307-36 and 307-40. The upper portion of this deposit in Boreholes 307-1 and 307-27 contains peat intermixed with the silty clay. The top of this deposit ranges from about Elevation 192.0 m to 188.3 m and its thickness ranges from about 2.3 m to 12.6 m.

DCPT 307-22 was terminated on refusal at the bottom of within this deposit, as inferred from the resistance to cone penetration test, at a depth of about 8 m.

The SPT 'N'-values recorded within the cohesive deposit range from 0 blows (weight of hammer and rod) to 9 blows per 0.3 m of penetration, but are typically between 1 blow and 2 blows per 0.3 m of penetration. In situ field vane tests carried out within this deposit measured undrained shear strengths ranging from about 28 kPa to greater than 95 kPa, typically less than about 40 kPa. The sensitivity is calculated to range from about 2 to 10, but is typically about 6. The field vane test results together with the SPT 'N'-values indicate that the clayey silt to clay deposit has a generally very soft to firm consistency.

The natural water content measured on samples of this deposit ranges from about 22 percent to 79 percent.

Grain size distribution tests were carried out by Peto on ten (10) samples of this deposit and the results are summarized on the Record of Borehole sheets in Appendix F.





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Atterberg limits tests were carried out by Golder on three (3) specimens of this deposit and by Peto on seven (7) specimens of this deposit. The liquid limits range from about 26 percent to 77 percent, the plastic limits range from about 16 percent to 25 percent and the plasticity indices range from about 10 percent to 55 percent. The results of the Atterberg limits tests carried out by Golder are shown on the plasticity chart on Figure D.S307-1 in Appendix D and the results of the Atterberg limits tests carried out by Peto are summarized on the Record of Borehole sheets in Appendix F. The results indicate that the soil ranges from a clayey silt of low plasticity to clay of high plasticity.

A total of two (2) cone penetration tests (CPTs 307-1 and 307-2) were performed in this swamp crossing of which one (1) test was used for determination of the pore pressure dissipation at specific horizons within the clay deposit. The range of the coefficient of consolidation in the horizontal direction ( $c_h$ ) obtained from a total of six (6) CPT pore pressure dissipation tests carried out is summarized below.

| $C_h$ CPT-Field<br>( $\text{cm}^2/\text{s}$ ) |                      |                      |
|---|----------------------|----------------------|
| Upperbound                                    | Lowerbound           | Average              |
| $2.8 \times 10^{-2}$                          | $8.6 \times 10^{-3}$ | $1.2 \times 10^{-2}$ |

Laboratory consolidation tests were carried out by Golder on two (2) specimens of the cohesive deposit obtained from Shelby tube samples in Borehole 307-1. Preconsolidation stresses of about 100 kPa and 90 kPa were estimated from the void ratio versus logarithmic pressure plots and from the total work versus pressure plots. Bulk unit weights of about  $14.9 \text{ kN/m}^3$  and  $15.2 \text{ kN/m}^3$  and specific gravities of about 2.71 and 2.76 were measured on the consolidation test specimens. Details of the test results are shown on Figures D.S307-2 and D.S307-3 in Appendix D and are summarized below, together with the results of one (1) consolidation test performed on this deposit by Peto.

| Borehole<br>Sample No.                     | Sample<br>Depth /<br>Elevation | $\sigma_{vo}'$<br>(kPa) | $\sigma_p'$<br>(kPa) | $\sigma_p' - \sigma_{vo}'$<br>(kPa) | OCR | $C_c$ | $C_r$ | $e_o$ | $c_v^*$<br>( $\text{cm}^2/\text{s}$ ) |
|--|--------------------------------|-------------------------|----------------------|-------------------------------------|-----|-------|-------|-------|---------------------------------------|
| Borehole 307-1<br>Sample 6                 | 5.3 m /<br>187.5 m             | 25                      | 100                  | 75                                  | 4.0 | 1.14  | 0.09  | 2.19  | $7.4 \times 10^{-2}$                  |
| Borehole 307-1<br>Sample 7                 | 8.9 m /<br>183.9 m             | 45                      | 90                   | 45                                  | 2.0 | 1.01  | 0.08  | 1.93  | $8.7 \times 10^{-2}$                  |
| Borehole 307-29<br>Sample 7 <sup>(1)</sup> | 6.4 m /<br>188.6 m             | 60                      | 270                  | 210                                 | 4.5 | 1.21  | 0.14  | 2.07  | $1.7 \times 10^{-3}$                  |

Note: \* For stress range of  $19 \text{ kPa} \leq \sigma_v' \leq 310 \text{ kPa}$  (for Golder test results)  
For stress range of  $35 \text{ kPa} \leq \sigma_v' \leq 557 \text{ kPa}$  (for Peto test results)  
1 Laboratory consolidation test results obtained from Peto

where:  $\sigma_{vo}'$  is the effective overburden stress in kPa  
 $\sigma_p'$  is the preconsolidation stress in kPa  
OCR is overconsolidation ratio  
 $e_o$  is initial void ratio  
 $C_c$  is the compression index  
 $C_r$  is the recompression index  
 $c_v$  is the coefficient of consolidation in  $\text{cm}^2/\text{s}$



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Laboratory consolidated isotropic undrained triaxial compression tests (CIU) with pore pressure measurement were carried out by Golder on two (2) samples of the cohesive deposit obtained from Shelby tube samples in Borehole 307-1. In total, two (2) sets of three (3) specimens were tested at different confining pressures. The details of the test results are shown on Figure D.S307-4 and D.S307-5 in Appendix D, and the results are summarized below.

| Borehole Sample No.     | Sample Depth / Elevation | Effective Cohesion Intercept, $c'$ (kPa) | Effective Angle of Internal Friction, $\phi'$ (degrees) |
|-------------------------|--------------------------|--|---|
| Borehole 307-1 Sample 6 | 5.3 m / 187.5 m          | 0  | 34  |
| Borehole 307-1 Sample 7 | 8.9 m / 183.9 m          | 18                                       | 25  |

Note: Assessed shear strength parameters are only valid over range of stress conditions used in the laboratory test.

The triaxial test samples were consolidated to pressures representative of the estimated in situ effective stresses and maximum effective stresses under the proposed embankment loads, at the respective sample depths. The interpreted effective strength parameters provided above are applicable only to design situations for which the stress conditions during testing are representative. Reference should be made to individual test reports for details of the testing conditions.

### Silt (Lower)

A lower deposit of grey silt, trace to some clay and trace sand was encountered below the clayey silt to silt deposit in Boreholes 307-1, 307-19, 307-27, 307-28, 307-34 and 307-37. The top of this deposit ranges from about Elevation 188.8 m to 179.0 m, and its thickness ranges from about 0.9 m to 3.5 m, and potentially to a thickness of about 5 m in Borehole 307-1 as inferred from the resistance to cone penetration for the DCPT driven from the bottom of the borehole. DCPTs 307-30 and 307-31 were terminated within the silt deposit, as inferred from the resistance to cone penetration, at depths of between about 11.9 m and 18.8 m below ice surface, corresponding to between Elevation 181.1 m and 174.0 m.

The SPT 'N'-values measured within the silt deposit range from 1 blow to 13 blows per 0.3 m of penetration, indicating a very loose to compact relative density.

The natural water content measured on samples of this deposit ranges from about 26 percent to 31 percent.

Grain size distribution tests were carried out by Peto on four (4) samples of this deposit and the results are summarized on the Record of Borehole sheets in Appendix F.

An Atterberg limits test carried out by Peto on a sample of the silt deposit measured a liquid limit of about 21 percent, a plastic limit of about 19 percent and a corresponding plasticity index of about 2 percent. The results of the Atterberg limits test are summarized on the Record of Borehole sheet in Appendix F and indicate the material to be silt of low plasticity.

### Sand

Underlying the silt deposit in Borehole 307-34, an approximately 1.4 m thick deposit of brown sand with gravel and trace silt was encountered at about Elevation 177.1 m.

A single SPT 'N'-value recorded within this deposit is about 20 blows per 0.3 m of penetration, indicating a compact relative density.



The natural water content measured on a sample of this deposit is 18 percent.

A grain size distribution test was performed by Peto on a sample of this deposit and the results are summarized on the record of Borehole sheet in Appendix F.

### Bedrock / Refusal

Bedrock was encountered at ground surface in Boreholes 307-36 and 307-40 at about Elevation 193 m and 193.4 m, respectively. In Boreholes 307-19, 307-21, 307-23, 307-27, 307-28, 307-34 and 307-37, and DCPTS 307-22 and 307-26, refusal to further sampler and/or auger advancement or cone penetration, indicative of the potential bedrock surface, was encountered at depths between about 5.7 m and 17.3 m below ice/ground surface, corresponding to between about Elevation 187.3 m and 175.7 m.

### Groundwater Conditions

In general, the samples taken in the boreholes were moist to wet. The water level observed in the boreholes upon completion of drilling ranges from about Elevation 192.8 m to 191.3 m, measured at the ice surface or up to a depth of 1.7 m below ice/ground surface.

## 4.7 Highway 69 SBL – STA 13+160 to 13+450 (Swamp 310 SBL)

The plan and profile along the centreline of the embankment of the new Highway 69 SBL alignment showing the borehole, Dynamic Cone Penetration Test (DCPT) and Cone Penetration Test (CPT) locations and interpreted stratigraphy within the extent of the swamp area considered for the wick drain foundation treatment in the Township of Mowat are shown on Drawing E1 in Appendix E. The alignment extends across a swamp area and the proposed roadway embankment will be up to about 2 m high above existing grade. Golder advanced two (2) boreholes (Boreholes 310-1 and 310-2) and four (4) cone penetration tests (CPTS 310-1 to 310-4), and based on the information received to date, Peto advanced five (5) boreholes (Boreholes 310-1, 310-4, 310-7, 310-9 and 310-13) and two (2) dynamic cone penetration tests (DCPTS 310-3 and 310-10) to investigate the subsurface conditions at the north end of this swamp. The topography of this section of proposed highway is generally flat to low-lying with surface cover consisting of wet grassy areas, shallow open water and occasional bedrock outcrops, with upward sloping grass-covered terrain towards the northern limit of the swamp.

In general, the subsurface soils along the SBL alignment in this area consist of a surficial deposit of peat underlain by a deposit of clayey silt to clay. At one borehole location, the clayey silt to clay deposit is underlain by a deposit of sand extending to refusal on probable bedrock. Resistance to dynamic cone penetration, cone penetration and borehole advancement, indicative of the potential bedrock surface, was encountered at greater depths at about STA 13+275 and 13+400. Bedrock outcrops are present to the north of the swamp.

### Ice / Snow

Ice and snow to a depth of about 0.3 m was encountered in Borehole 310-9.

### Peat

A deposit of dark brown to black fibrous to amorphous peat containing layers of organic silty clay was encountered at the ground surface or below the ice/snow cover in all boreholes advanced within the swamp limits. The top of the peat deposit varies between about Elevation 195.2 m and 194.6 m and its thickness ranges from about 0.5 m to 4.9 m.



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The Standard Penetration Test (SPT) 'N'-values recorded within the peat deposit are typically 0 blows (weight of hammer and rod) per 0.3 m of penetration, with a single SPT 'N' value of 8 blows per 0.3 m of penetration encountered near the surface in Borehole 310-13, indicating a very soft to firm consistency.

The natural water content measured on samples of the peat ranges from about 89 percent to 988 percent and the organic content measured on samples of this deposit ranges from about 10 percent to 90 percent.

### Clayey Silt to Clay

A deposit of grey, varved, clayey silt to clay, trace sand and containing layers of silt and organic silty clay, seashells and organics, was encountered below the peat deposit in all the boreholes advanced within the swamp limits. The lower portion of this deposit in Boreholes 310-4 and 310-9 contains layers of sandy silt, trace gravel and cobbles. The surface of this deposit ranges from about Elevation 194.7 m to 189.7 m and its thickness ranges from about 3.2 m to 7.2 m.

The SPT 'N'-values recorded within the cohesive deposit range from 0 blows (weight of hammer and rod) to 5 blows per 0.3 m of penetration. In situ field vane tests carried out within this deposit measured undrained shear strengths ranging from about 2 kPa to 38 kPa. The sensitivity is calculated to range from about 1 to 7, and is typically less than 3. The field vane test results together with the SPT 'N'-values indicate that the clayey silt to clay deposit has a very soft to firm consistency.

The natural water content measured on samples of this deposit ranges from about 25 percent to 102 percent.

Grain size distribution tests were carried out by Peto on four (4) specimens of this cohesive deposit and the results are summarized on the Record of Borehole sheets in Appendix F.

Atterberg limits tests were carried out by Golder on four (4) specimens of the clay deposit and by Peto on five (5) specimens of the clayey silt to silty clay deposit. The liquid limits range from about 30 percent to 106 percent, the plastic limits range from about 19 percent to 33 percent, and the plasticity indices range from about 11 percent to 73 percent. The results of the Atterberg limits tests carried out by Golder are shown on the plasticity chart on Figure E.S310-1 in Appendix E and the results of the Atterberg limits tests carried out by Peto are summarized on the Record of Borehole sheets in Appendix F. The results indicate that the soil ranges from clayey silt of low plasticity to clay of high plasticity.

A total of four (4) cone penetration tests (CPTs 310-1 to 310-4) were performed in this swamp area of which two (2) tests were used for the determination of the pore pressure dissipation at specific horizons within the clay deposit. The range of the coefficient of consolidation in the horizontal direction ( $c_h$ ) obtained from a total of six (6) CPT pore pressure dissipation tests carried out is summarized below.

| <b><math>C_h</math> CPT-Field<br/>(<math>\text{cm}^2/\text{s}</math>)</b> |                      |                      |
|---|----------------------|----------------------|
| <b>Upperbound</b>   | <b>Lowerbound</b>    | <b>Average</b>       |
| $5.9 \times 10^{-1}$  | $1.6 \times 10^{-3}$ | $1.4 \times 10^{-2}$ |

### Sand

A deposit of grey sand trace to some silt and trace gravel containing cobbles was encountered underlying the cohesive deposit in Borehole 310-7. The surface of this deposit is at about Elevation 189.2 m and its thickness is about 0.8 m.

A SPT 'N'-value of 10 blows per 0.07 m of penetration was recorded within this deposit, indicating a compact relative density.

A grain size distribution test was performed by Peto on a sample of this deposit and the results are summarized on the Record of Borehole sheet in Appendix F.



## **Refusal**

In all boreholes and DCPTs, refusal to further auger or cone penetration, indicative of the potential bedrock surface, was encountered at depths between about 4.9 m and 10.7 m below ice/ground surface, corresponding to between about Elevation 190.1 m and 184.3 m.

## **Groundwater Conditions**

In general, the samples taken in the boreholes were wet. The water level observed in the boreholes upon completion of drilling ranges from about Elevation 195.2 m to 194.6 m, measured at the ground/ice surface.

## **5.0 CLOSURE**

The field engineer and technician directing the drilling program were Messrs. Matt Kelly and Matt Rhody, respectively. This report was prepared by Mr. Matthew Kelly, P. Eng., and Ms. T. Veronica Ayetan, P. Eng., and was reviewed by Mr. J. Paul Dittrich, Ph.D., P. Eng., a Senior Geotechnical Engineer and Principal with Golder. Mr. Jorge M. A. Costa, P. Eng., Golder's Designated MTO Contact for this project and Principal with Golder, conducted an independent quality control review of the report.



## Report Signature Page

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# **PART B**

## **FOUNDATION DESIGN REPORT**

### **WICK DRAIN FOUNDATION TREATMENT SWAMP AREAS – Phase 3**

#### **HIGHWAY 69 FOUR-LANING – PHASE 3**

#### **FROM 3.5 KM NORTH OF HIGHWAY 522**

#### **NORTHERLY TO 4.5 KM NORTH OF HIGHWAY 64**

#### **MINISTRY OF TRANSPORTATION, ONTARIO**

#### **G.W.P. 5203-06-00**



## **6.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS**

This section of the report provides an interpretation of the geotechnical data obtained during the investigations by Golder Associates Ltd. and by Peto MacCallum Limited (Peto) and presents recommendations on the foundation aspects of design of the proposed works. The recommendations provided are intended for the guidance of the design engineer. Where comments are made on construction, they are provided to highlight aspects of construction that could affect the design of the project. Those requiring information on aspects of construction must make their own interpretation of the subsurface information provided as it affects their proposed construction methods, costs, equipment selection, scheduling and the like.

### **6.1 General**

Golder has been retained by McCormick Rankin, a member of MMM Group Limited (MRC) on behalf of Ministry of Transportation, Ontario (MTO) to carry out a detail foundation design for wick drain foundation treatment of four (4) swamp crossings along the proposed new Highway 69 in support of the Detail Foundation Investigation and Design being carried out by Peto for Highway 69 Four-Laning, from 3.5 km north of Highway 522 northerly to 4.5 km north of Highway 64, under G.W.P. 5378-02-00. Although five (5) swamp crossings were originally identified as potential wick drain treatment areas, we understand that subsequent to the completion of Peto's detailed foundation investigation and analysis, only four (4) swamp crossings have been confirmed as requiring wick drain foundation treatment.

The terms of reference and scope of work for the foundation design services are outlined in MTO's Request for Proposal, dated January 2006. Golder's proposal for foundation engineering services associated with the wick drain areas is contained in Section 6.8 of MRC's Technical Proposal for this assignment and in Golder's letter entitled "Proposal for Additional Foundation Engineering Services, Detail Wick Drain Design (Rev 1)", dated February 2009. The work was carried out in accordance with Golder's Supplemental Specialty Quality Control Plan for foundation engineering services for this project, dated June 2, 2006. The General Arrangement (GA) Drawing for the proposed new alignment of Highway 69 was provided to Golder by MRC on February 11, 2009.

Following completion of additional investigation by Peto and investigation by Golder, four (4) swamp crossings were identified as candidate sites for wick drain foundation treatment. The following sections of this report address the design of the proposed wick drain foundation system to be installed at the swamp crossings listed below:

| <b>Swamp Crossing</b>                          | <b>Designation</b> |
|--|--------------------|
| Highway 69 SBL and NBL<br>STA 17+700 to 18+150 | Swamp 302 SBL/NBL  |
| Highway 69 SBL<br>STA 16+050 to 16+350         | Swamp 305 SBL      |
| Highway 69 SBL<br>STA 15+350 to 15+800         | Swamp 306 SBL      |
| Highway 69 SBL<br>STA 14+425 to 14+500         | Swamp 307 SBL      |

A wick drain system was identified as being the preferred foundation treatment option in each of these four (4) swamp crossings to allow the embankment construction to be completed within an accelerated schedule and to



mitigate long-term, post-construction foundation settlements. The design of the wick drain foundation system addresses the stability and settlement of the proposed embankments during and following construction.

The design has been carried out in accordance with our initial proposal titled "Additional Foundation Engineering Services, Detail Wick Drain Design (Rev. 1)" dated February 2, 2009. The results of the additional field investigation completed by Golder that was carried out as part of this assignment have been included in Part A of this report. In performing the analysis and design of the wick drain foundation treatment Golder has relied on the data as provided by Peto in their Technical Memorandum titled "06TF033C 889 Tech memo Wick Drain Swamps" dated December 14, 2007.

## 6.2 Embankments Over Swamps

Based on the profiles of the new alignments provided to us by MRC on February 11, 2009, it is our understanding that the new highway will require fill embankments ranging in height from about 1.5 m up to about 6.5 m in the wick drain swamp areas.

Sections 6.2.1 and 6.2.3 of this report summarize the methods used for the analysis of stability and settlement for critical sections of embankment construction through the wick drain swamp crossings for the new Highway 69 four-laning. The results of the analyses and recommendations on mitigating stability and time-dependent settlements in conjunction with the wick drain treatment are presented in Section 6.4.

### 6.2.1 Embankment Fill Types and Berm Requirements

Different embankment fill types (i.e. rock fill or granular fill) provide relative advantages and disadvantages in terms of availability, weight (i.e. driving force and applied load to founding subsoils/bedrock), required side slope profile, construction cost and time, ease of construction and post-construction performance.

It is understood that rock fill is the preferred embankment fill material for this project and as such, the stability and settlement analyses discussed in Section 6.4 have been carried out on the basis that the roadway embankments will be constructed with rock fill.

### Rock Fill

The main advantage of constructing embankments using rock fill is the ability to achieve steeper side slopes (1.25H:1V), which is required in areas with limited right-of-way, as well as reducing the overall quantity of material required for the project and for placement of material in sub-excavated areas under water. Rock fill will also likely be available locally, either from excavations in deep cuts through existing bedrock outcrops within other phases of the project alignment or from rock borrow areas close to the project limits. The disadvantage of using rock fill for the construction of high embankments is that some post-construction settlement of the embankment fill itself will occur, although mostly within the first year after construction. Settlement of the rock fill is discussed further in Section 6.2.3.5.

In accordance with MTO Northern Region Pavement Practices and Guidelines (1997) as amended by MTO Memorandum "Use of Mid-Slope Berms for Rockfill Embankments" dated February 8, 2005, 2 m wide berms should be incorporated into the rock fill embankment side slope profile for uninterrupted slopes greater than 10 m high. Given that the proposed new embankments in Phase 3 are less than 10 m high, 2 m wide berms are not required.



### Granular Fill

The main advantage of using granular fill (i.e. sand and gravel) for constructing embankments is the ease of construction and negligible post-construction settlement within the embankment fill itself. However, this option would require a larger volume of fill and potentially wider right-of-way because the required side slopes of granular fill embankments (2H:1V) are flatter than those of rock fill. For this project, acceptable granular fill would be well-graded, locally available and/or imported, granular material.

For granular fill embankments, 2 m wide berms are recommended to be incorporated into the side slope profiles for uninterrupted slopes greater than 8 m high.

### 6.2.2 Stability

The following sections outline the methodology used to evaluate embankment stability at the various wick drain swamp areas. In addition, the parameters used in the analyses for each of the critical section(s) are also presented. The results of the total and effective stress stability analyses are presented in Section 6.4.1 and 6.4.2.

#### 6.2.2.1 Methodology

Stability analyses, in terms of total stress and effective stress conditions, were performed for the critical sections of the proposed fill embankments in each wick drain swamp crossing. The critical sections correspond to the greatest new embankment height and/or the maximum thickness of soft, compressible cohesive soils. The stability of the proposed new embankment section(s) was analyzed using the limit equilibrium method.

All limit equilibrium slope stability analyses were performed using the commercially available program Slide (Version 5.0), produced by Rocscience Inc., employing the Morgenstern-Price method of analysis. For all analyses, the factor of safety of numerous potential failure surfaces was computed in order to establish the minimum factor of safety. The factor of safety is defined as the ratio of the forces tending to resist failure to the driving forces tending to cause failure. A target minimum Factor of Safety of 1.3 is normally adopted for the design of embankment slopes under static conditions. This factor of safety is considered adequate for the embankments at these sites considering the design requirements and the field data available and is based on deep-seated, global failure surfaces that would affect the operation of the roadway. The stability analyses were performed to check that the geometry and proposed rate of construction satisfied the target minimum Factor of Safety of 1.3 at each stage of the embankment construction.

The stability analyses assume that all organic soils will be removed prior to construction of the new embankments and that granular fill (i.e. Granular 'B' Type I) will be used for replacement of sub-excavated material (as discussed in Sections 6.6.1 and 6.6.3). The piezometric conditions required in the analyses were based on the groundwater levels observed during drilling, which were generally located at about the level of the natural ground surface at most locations. The impact of the excess pore pressure development on the stability of the embankments at each stage of construction was assessed as part of the effective stress analysis. The stability analysis was carried out assuming a 1.25H:1V side slope profile for the rock fill embankments.

The use of stability berms at the toe of the embankments to increase the overall rate of construction was considered as a potential option in the design. In general, the addition of stability berms allow higher excess pore pressures to be developed, and therefore faster rates of construction, while maintaining the target Factor of Safety of 1.3. However, given the general absence of stability issues associated with the proposed embankment geometries for the majority of the considered wick drain spacing in the swamp crossings (i.e. construction without delays between lift placements), the use of berms is not considered necessary at these sites.

The total stress analyses using the undrained shear strength parameters were carried out as an additional check to assess the maximum height of embankment that could be constructed instantaneously while still maintaining a Factor of Safety of 1.3. The results of the total stress analysis were compared to and used as an indicator of



the suitability of the strength parameters selected for the effective stress analysis. Both the undrained/total and effective stress strength parameters are summarized in Tables A1, B1, C1 and D1 in Appendix A through D, respectively.

For the effective stress analysis, the excess pore pressure ( $\Delta u$ , kPa) response within the cohesive deposits as a result of the embankment construction was estimated as follows:

$$\Delta u = \bar{B} \Delta \sigma_1 = \bar{B} \gamma \Delta H$$

where

|            |   |  |
|------------|---|--|
| $\bar{B}$  | = | overall (or combined) pore pressure coefficient ( <i>see below</i> )   |
| $\gamma$   | = | bulk unit weight of embankment fill (19 kN/m <sup>3</sup> for rock fill and 21 kN/m <sup>3</sup> for Granular 'B' surcharge) |
| $\Delta H$ | = | change in height of embankment fill (m)  |

The overall pore pressure coefficient ( $\bar{B}$ ) was calculated at regular intervals of depth and lateral distance below and beyond the critical embankment section to create a two-dimensional field of values that were subsequently employed to develop a two-dimensional contour plot of total pore pressures (i.e. initial plus excess) throughout the foundation soil deposits at each stage of embankment construction. The overall pore pressure coefficient ( $\bar{B}$ ), was calculated using the following equation proposed by Skempton (1954):

$$\bar{B} = B \left( 1 - (1 - A) \left( 1 - \frac{\Delta \sigma_3}{\Delta \sigma_1} \right) \right)$$

where

|   |   |  |
|---|---|--|
| A and B                                   | = | Skempton pore pressure parameters estimated from the results of the CIU triaxial tests (as summarized in Section 6.2.2.3). |
| $\frac{\Delta \sigma_3}{\Delta \sigma_1}$ | = | principal stress ratio at point of interest within the foundation soil below the embankment (after Poulos and Davis, 1974) |
| $\Delta H$                                | = | change in height of embankment fill (m)  |

The change in excess pore pressure with time ( $\Delta u(t)$ , kPa) was calculated based on the average degree of consolidation (U) completed at the time of interest (as described above) using the following formula:

$$\Delta u(t) = \Delta u(1 - U)$$

where

|            |   |  |
|------------|---|--|
| $\Delta u$ | = | excess pore pressure due to embankment loading (kPa) |
| U          | = | average degree of consolidation at time (t)          |

As noted above, a two-dimensional field of total pore pressures (i.e. initial plus excess) throughout the foundation soil deposits at critical time periods was developed to better examine the stability of the embankments at the different stages of construction. In addition, different rates of construction (i.e. time periods between construction stages) were also considered in the analyses. The rate of construction influences the excess pore pressure calculated at any time (t) due to the fact that the slower the rate of construction, the larger the degree of consolidation that will be completed within any one construction stage.

For the effective stress analysis, the total pore pressure ( $u_T(t)$ , kPa) within the cohesive deposits at the appropriate time (t) was calculated as follows:



$$u_T(t) = u_o + \Delta u(t)$$

where

$u_o$  = initial pore pressure within the cohesive deposit (assuming groundwater table to be at ground surface) (kPa)

$\Delta u(t)$  = excess pore pressure at time (t)

### 6.2.2.2 Strength Parameters

The simplified stratigraphy together with the associated strength and unit weight employed for the different soil types at the critical sections in each swamp crossing are plotted for the cohesive deposits on Figures A1, B1, C1 and D1 and summarized for all soil layers in Tables A1, B1, C1 and D1 in Appendix A through D for the four swamp crossings, respectively.

The subsoils encountered in the various swamp crossings are composed of a combination of cohesionless deposits (sand to sandy silt) and cohesive deposits (clayey silt to clay). For granular soils, effective stress parameters were employed in the analysis assuming drained conditions. The effective stress parameters (i.e. effective friction angle,  $\phi'$ ) for the granular soils were estimated from empirical correlations using the results of in situ Standard Penetration Tests (SPT) using the method proposed by Schmertmann (1975) and Meyerhof (1956), in conjunction with engineering judgement based on experience on similar soil conditions.

For cohesive deposits, both total stress and effective stress parameters were employed in the analyses assuming undrained and drained conditions, respectively.

The total stress parameters (i.e. average mobilized undrained shear strength –  $s_u$ ) for the cohesive soils were assessed based on the results of in situ field vane shear tests and Cone Penetration Test (CPTs), inferred from the laboratory consolidation tests results, and estimated from correlations with the SPT results and other laboratory test data (natural water content). From the results of the consolidation tests and from estimates of preconsolidation stress ( $\sigma_p'$ , kPa), from the in situ CPT tests (as described in Section 6.2.3.2), the following correlation proposed by Mesri (1975) was employed to estimate the undrained shear strength:

$$s_u = 0.22\sigma_p'$$

where:

$s_u$  = average mobilized undrained shear strength (kPa)

$\sigma_p'$  = preconsolidation stress (kPa)

Where appropriate, Bjerrum's correction factor was employed to estimate the average mobilized undrained shear strength from the results of the in situ field vane tests as follows:

$$s_{u(mob)} = \mu s_{u(FV)} \quad (\text{Bjerrum, 1973})$$

where:

$s_{u(mob)}$  = average mobilized undrained shear strength (kPa)

$s_{u(FV)}$  = undrained shear strength from field vane test (kPa)

$\mu$  = Bjerrum's correction factor based on Plasticity Index, PI

When developing area-specific correlations and/or assessing the engineering parameters based on laboratory or field test data, the results from all swamp crossings were combined, where appropriate, to provide a larger set of parameters to evaluate. It was considered that all the swamp crossings exhibited sufficiently similar soil mineralogy and geology that correlations based on all of the data would be justified. Having developed the





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area-specific correlations, the test results for each individual swamp crossing were examined and the design lines developed accordingly.

The effective stress parameters (effective friction angle ( $\phi'$ ) and cohesion ( $c'$ )) for the cohesive deposits were assessed based on the results of eleven (11) sets of consolidated isotropic undrained (CIU) triaxial tests with pore pressure measurements. The results of the triaxial testing are shown in Appendix A through D for the four swamp crossings, respectively. The effective friction angle and cohesion estimated directly from the results of the triaxial tests are summarized below.

### Laboratory Testing

| Borehole / Sample Number | Effective Cohesion $c'$ (kPa) | Effective Friction Angle $\phi'$ (°) |
|--------------------------|-------------------------------|--------------------------------------|
| Borehole 302-1 Sample 6  | 6                             | 34                                   |
| Borehole 302-1 Sample 7  | 0                             | 35                                   |
| Borehole 302-2 Sample 3  | 0                             | 34                                   |
| Borehole 302-2 Sample 5  | 4                             | 33                                   |
| Borehole 305-1 Sample 7  | 7                             | 30                                   |
| Borehole 305-2 Sample 2  | 0                             | 30                                   |
| Borehole 305-3 Sample 1  | 3                             | 45                                   |
| Borehole 306-1 Sample 5  | 7                             | 25                                   |
| Borehole 306-2 Sample 3  | 5                             | 25                                   |
| Borehole 307-1 Sample 6  | 0                             | 34                                   |
| Borehole 307-1 Sample 7  | 18                            | 25                                   |

These results were compared with estimates of effective friction angle from the empirical correlations with plasticity index (PI) proposed by Mitchell (1993), Ladd et al. (1977) and Kulhawy and Mayne (1990) to establish the appropriate design values for the cohesive deposits at each swamp crossing. The range of effective friction angle for each swamp crossing based on empirical correlations is summarized below.

### Empirical Correlations

| Swamp Crossing | Effective Friction Angle, $\phi'$ (°) |            |         |
|----------------|---------------------------------------|------------|---------|
|                | Upperbound                            | Lowerbound | Average |
| Swamp 302      | 52                                    | 27         | 34      |
| Swamp 305      | 53                                    | 22         | 33      |
| Swamp 306      | 47                                    | 24         | 32      |
| Swamp 307      | 47                                    | 24         | 31      |

It can be seen that the results of the triaxial tests are generally near the middle of the range of effective friction angle estimated from the empirical correlations with plasticity index (PI). When selecting the design strength parameters, the results of the laboratory triaxial tests were considered in combination with the lowerbound estimates from the empirical corrections. In the stability analysis, the effective strength parameters for the



cohesive soils were defined using a shear-normal strength envelope based on the results of the CIU triaxial test data at stress levels between about 0 kPa and 200 kPa which is considered to be the operative range of stresses for the proposed embankment heights. The inset plot in Tables A1, B1, C1 and D1 in Appendix A through D, respectively, shows the Mohr's circles based on the triaxial testing from each swamp crossing with the fully defined Mohr-Coulomb failure envelope employed in the stability analysis.

### 6.2.2.3 Pore Pressure Parameters

The average pore pressure coefficients (A and B) used in the analyses of the excess pore pressure response in the foundation soil deposits due to embankment construction at the critical sections are given below.

| Swamp Crossing    | Pore Pressure Coefficient |               |      |
|-------------------|---------------------------|---------------|------|
|                   | $A_{(elastic)}$           | $A_{(yield)}$ | B    |
| Swamp 302 SBL/NBL | 0.33                      | 0.8           | 0.98 |
| Swamp 305 SBL     | 0.33                      | 0.9           | 0.98 |
| Swamp 306 SBL     | 0.33                      | 0.8           | 0.98 |
| Swamp 307 SBL     | 0.33                      | 0.8           | 0.98 |

The pore pressure coefficients were assessed from the results of the CIU triaxial tests with pore pressure measurement performed on specimens of the cohesive deposits. The values of  $A_{(elastic)}$  were estimated from the initial straight line portions of the deviator stress and excess pore pressure versus strain curves at low strain levels. The values of  $A_{(yield)}$  were estimated at higher strain levels on the non-linear portions of the deviator stress versus strain curves, but at strain levels less than failure.

### 6.2.3 Settlement

The following sections outline the methods used to conduct the settlement analyses in each wick drain swamp area. In addition, the parameters used in the analyses for each of the critical section(s) are also presented. The results of the analyses are presented in Section 6.4.

#### 6.2.3.1 Methodology

To estimate the magnitude of the expected settlements, analyses were carried out on the critical sections of the proposed fill embankments using the commercially available program Settle3D (Version 2.0) produced by Rocscience Inc. The critical sections correspond to the greatest new embankment height and/or the maximum thickness of soft, compressible cohesive soils.

The sources of settlement were considered to include:

- Immediate settlement of the granular drainage blanket and of the replacement fill materials in sub-excavation areas;
- primary time-dependent consolidation of the cohesive deposits;
- secondary time-dependent (creep) consolidation of the cohesive deposits (long-term); and,



- immediate settlement of the native granular soils.

The self-weight compression of the embankment rock fill materials was also considered (as described in Section 6.2.3.5) but not included in the criteria used to assess the required duration of embankment surcharging.

The thickness of the compressible granular drainage blanket fill, foundation soil deposits and the height of the embankments vary along the proposed alignments within each swamp crossing and as such the settlements along the length of a given alignment will similarly vary. Given that the analyses were carried out at the critical sections of each swamp crossing, the settlements estimated will generally represent the maximum value along a given alignment.

The settlement analyses assume that all organic soils within the wick drain limits will be removed prior to construction of the new embankments and that granular fill (i.e. Granular 'B') will be used for replacement of sub-excavated material (as discussed in Section 6.6.1 and 6.6.3). The piezometric conditions required in the analyses were based on the groundwater levels noted during drilling and were essentially located at about the level of the natural ground surface at most locations.

To estimate the rate of excess pore pressure dissipation and consolidation, analyses were carried out to assess the effect of different wick drain spacings on the response of the foundation soil deposits to the proposed embankment fills. The analyses employed the analytical solutions for assessing the degree of consolidation by radial (or horizontal) drainage ( $U_h$ ) proposed by Barron (1948), including the extended solutions of Hansbo (1979) developed specifically to assess the use of prefabricated geosynthetic (wick) drains for the consolidation of compressible cohesive deposits. The extended solutions by Hansbo (1979) permit including the effects of the wick drain well resistance/discharge capacity and the effects of smear of the soil along the wick drain (due to installation) on the rate of excess pore pressure dissipation/consolidation.

The average degree of horizontal consolidation ( $\bar{U}_h$ ) within the cohesive soils was calculated using the following formula (after Hansbo, 1979):

$$\begin{aligned} \bar{U}_h &= 1 - e^{-\frac{8C_h t}{\mu D^2}} \\ \text{where } \mu &= \ln\left(\frac{n}{s}\right) + \frac{k_h}{k_s} \ln(s) - 0.75 + \pi z(2L - z) \frac{k_h}{q_w} \\ n &= \frac{D}{d} \\ s &= \frac{d_s}{d} \end{aligned}$$

and

$$\begin{aligned} t &= \text{time of consolidation (s)} \\ C_h &= \text{horizontal coefficient of consolidation (cm}^2/\text{s)} \\ D &= \text{diameter of zone of influence of vertical drain (m)} \\ d &= \text{equivalent diameter of vertical drain (m)} \\ d_s &= \text{diameter of disturbed zone (m)} \\ k_h &= \text{horizontal permeability (m/s)} \\ k_s &= \text{permeability of disturbed zone (m/s)} \\ L &= \text{initial effective length of drain (m)} \\ z &= \text{distance from open end of drain to worst location of well resistance (m)} \\ q_w &= \text{factored discharge capacity of well (m}^3/\text{s)} \end{aligned}$$

It should be noted that the general equation for the consolidation of cohesive foundation soil deposits includes both the horizontal consolidation ( $U_h$ ) and vertical consolidation ( $U_v$ ) component as follows:



$$U = 1 - (1 - U_v)(1 - U_h)$$

where

$$\begin{aligned} U_v &= \text{average degree of consolidation from vertical drainage only (from Terzaghi's 1-D consolidation theory)} \\ U_h &= \text{average degree of consolidation from radial drainage only (to the wick drains).} \end{aligned}$$

However, considering the thickness of the cohesive deposits and potential drain spacings that is normally adopted for similar MTO wick drain foundation project, the vertical consolidation component is expected to be relatively small in comparison to the horizontal component and in this case, the general consolidation equation will reduce to  $U = U_h$  (i.e. the majority of the consolidation will occur horizontally to the wick drains).

The primary consolidation settlement with time ( $s(t)$ , m) was calculated based on the average degree of consolidation ( $U$ ) completed at the time of interest (as described above) using the following formula:

$$s(t) = s_c U(t)$$

where

$$\begin{aligned} s_c &= \text{total primary consolidation settlement (m)} \\ U(t) &= \text{average degree of consolidation at time (t)} \end{aligned}$$

The secondary consolidation settlements ( $s_s$ , m) of the cohesive deposits were calculated using the appropriate values of  $C_{\alpha(\varepsilon)}$  for both the over-consolidated (O/C) and normally-consolidated (N/C) portions of the deposits in conjunction with the following formula:

$$s_s = c_{\alpha\varepsilon} H_o \Delta \log(t)$$

where

$$\begin{aligned} c_{\alpha\varepsilon} &= \text{coefficient of secondary consolidation (for both O/C and N/C portions of the cohesive deposits)} \\ H_o &= \text{initial thickness of the O/C and N/C portions of the compressible cohesive deposit (m)} \\ \Delta \log(t) &= \text{the logarithm of the time period of interest following 90 percent of primary consolidation} \end{aligned}$$

### 6.2.3.2 Deformation Parameters

The simplified stratigraphy together with the associated deformation, time-rate consolidation parameters and unit weights employed for the different native soil types for the critical sections in each swamp crossing are plotted on Figures A1, B1, C1 and D1 and are summarized in Tables A1, B1, C1 and D1 in Appendix A through D for the four swamp crossings, respectively.

The immediate compression of the granular drainage blanket/replacement fills and the very loose to very dense silt, sandy silt to silty sand, sand and gravel native deposits was modeled by estimating an elastic modulus of deformation based on the SPT 'N'-values (where applicable) and using correlations proposed by Bowles (1984) and Kulhawy and Mayne (1990). These estimated values were compared with the typical range of expected values for similar soil types, as outlined in CHBDC (2006) and adjusted based on precedent experience, if necessary.

The deformation parameters and stress history of the cohesive deposits were assessed based on the results of the laboratory consolidation tests, in situ field vane tests and CPTs. In addition, the results of consolidation tests were supplemented with estimates of deformation parameters (i.e. recompression and compression indices) using empirical correlations proposed in literature. The correlation by Koppula (1986) relating the natural water content and liquid limit to the compression index was found to be the most consistent with the results of laboratory consolidation tests for the cohesive deposits at these sites and is reflected in the summary plots shown on Figures A1, B1, C1 and D1 in Appendix A through D for the four swamp crossings, respectively.



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The preconsolidation stress ( $\sigma_p'$ , kPa) was evaluated from the results of the consolidation tests using the methods proposed by Casagrande (1936) and Becker et al. (1987).

The following correlation relating undrained shear strength (as measured in situ by the field vane) to preconsolidation stress (Mesri, 1975) was also employed:

$$\sigma_p' = \frac{s_{u(mob)}}{0.22}$$

where

$$\begin{aligned} s_{u(mob)} &= \mu s_{u(FV)} \\ \sigma_p' &= \text{preconsolidation stress (kPa)} \\ s_{u(mob)} &= \text{average mobilized undrained shear strength (kPa)} \\ s_{u(FV)} &= \text{undrained shear strength from field vane test (kPa)} \\ \mu &= \text{Bjerrum's correction factor based on Plasticity Index} \end{aligned}$$

The preconsolidation pressure was also estimated from the results of the CPTs (Demer and Leroueil, 2002):

$$\sigma_p' = \frac{q_t - \sigma_{vo}}{3.4}$$

where

$$\begin{aligned} q_t &= q_c - u_2(1 - A_n) \text{ (kPa)} \\ q_c &= \text{tip stress measured by the CPT (kPa)} \\ u_2 &= \text{pore pressure measured at cone 'shoulder' (kPa)} \\ A_n &= \text{cone constant} \\ \sigma_{vo} &= \text{total vertical stress (kPa)} \end{aligned}$$

The initial void ratio ( $e_o$ ) within the cohesive deposits was evaluated based on measurements from the trimmed specimens used for the laboratory consolidation and triaxial tests and based on the water contents measured on specimens from the SPT and Shelby Tube samples obtained during the field investigation using the following correlation:

$$e_o = w_n G_s \quad (\text{assuming 100 percent saturation})$$

where

$$\begin{aligned} w_n &= \text{natural water content (\%)} \\ G_s &= \text{specific gravity (2.75 based on 12 laboratory consolidation test results)} \end{aligned}$$

The results of the laboratory consolidation tests are presented in Appendix A to D. The void ratio versus log stress curves from the consolidation test results generally show a curvilinear relation at stresses beyond the preconsolidation pressure (i.e. the slope of the curve is steep immediately after the preconsolidation pressure and then becomes flatter at higher stress levels). This phenomenon can be attributed to a partial collapse of the soil structure (and therefore large changes in void ratio) immediately after the effective stresses in the sample exceed the maximum past pressure experienced by the soil. At higher cumulative stresses, relatively smaller changes in void ratio occur because the soil structure can not experience any further collapse. The values of the compression index ( $C_c$ ) employed in the analysis have been assessed based on the steeper portions of the void ratio versus log-pressure curves since this represents the range of operational stresses expected to occur in the field under the proposed embankment loading.

The recompression index ( $C_r$ ) and compression index ( $C_c$ ) for the cohesive deposits was evaluated based on the results of the laboratory consolidation tests. The results from the consolidation tests were supplemented with estimates of  $C_c$  based on the Atterberg limits and water content testing using the following empirical correlations:



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$$C_c = 0.009w_n + 0.005w_L \quad (\text{Koppula, 1986})$$

where

$$\begin{aligned} w_n &= \text{natural water content (percent, \%)} \\ w_L &= \text{liquid limit (percent, \%)} \end{aligned}$$

$$C_c = 0.009(w_L - 10) \quad (\text{Terzaghi and Peck, 1967})$$

where

$$w_L = \text{liquid limit (percent, \%)}$$

$$C_c = \frac{PI}{74} \quad (\text{Kulhawy and Mayne, 1990})$$

where

$$PI = \text{plasticity index (percent, \%)}$$

Based on the laboratory consolidation tests carried out for this project, the results indicate an approximate ratio between the compression index and the recompression index of about 10. As such, the above noted correlations between the index properties and the compression index were utilized to obtain an estimate of the recompression index as follows:

$$C_r = \frac{C_c}{10}$$

The secondary consolidation compression index ( $C_{\alpha(\varepsilon)}$ ) for the cohesive deposits was assessed from the results of the 24 hour load increment, consolidation tests (considering the appropriate stress level anticipated in the field under embankment loading as well as the stress history of the cohesive deposits) and from estimates based on the results of the index testing (i.e. water contents) using the empirical correlation proposed by Mesri (1973). The range of values of  $C_{\alpha(\varepsilon)}$  for the normally consolidated portions of the cohesive deposits estimated using these methods are summarized below.

| Swamp Crossing    | Laboratory Consolidation Test   |            |         | Empirical Correlations          |            |         |
|-------------------|---------------------------------|------------|---------|---------------------------------|------------|---------|
|                   | $C_{\alpha(\varepsilon)} (N/C)$ |            |         | $C_{\alpha(\varepsilon)} (N/C)$ |            |         |
|                   | Upperbound                      | Lowerbound | Average | Upperbound                      | Lowerbound | Average |
| Swamp 302 SBL/NBL | 1.41                            | 0.21       | 0.63    | 0.79                            | 0.01       | 0.46    |
| Swamp 305 SBL     | 1.34                            | 0.79       | 1.06    | 0.85                            | 0.24       | 0.51    |
| Swamp 306 SBL     | 1.60                            | 1.34       | 1.47    | 0.97                            | 0.28       | 0.66    |
| Swamp 307 SBL     | 1.72                            | 0.30       | 1.17    | 0.79                            | 0.22       | 0.45    |

It can be seen that the values of  $C_{\alpha(\varepsilon)} (N/C)$  from the laboratory test results are generally higher than the estimated values from the empirical correlations. Values obtained from the upperbound of the laboratory tests were given more weight when selecting the design values based on precedent experience on other MTO wick drain design and monitoring projects on Highway 69. Values of  $C_{\alpha(\varepsilon)} (O/C)$  were estimated as being equal to one-fifth the normally consolidated values.





### 6.2.3.3 Rate of Consolidation Parameters

The values of the coefficient of consolidation in the horizontal direction ( $c_h$ ,  $\text{cm}^2/\text{s}$ ) were assessed primarily from the results of the pore pressure dissipation tests carried out as part of the CPT testing performed in each swamp crossing. A total of forty-eight (48) pore pressure dissipation tests were performed and the results are shown on Figures A2, B2, C2 and D2 in Appendix A through D for the four swamp crossings, respectively. Based on these data,  $c_h$  was estimated using the following method proposed by Robertson et al. (1992):

$$C_h = \left(\frac{m}{M}\right)^2 \sqrt{I_r r^2}$$

where:

- $m$  = gradient of the initial linear portion of the CPT pore pressure dissipation curve
- $M$  = 1.15 (for CPT pore pressure sensor at position  $u_2$ )
- $I_r$  = rigidity index,  $\frac{G}{s_u}$  (ranges from about 40 to 50 for these sites)
- $R$  = radius of CPT probe (17.8 mm)

The gradient of the initial portion of the dissipation curves ( $m$ ) selected to represent the estimated average horizontal coefficient of consolidation was based on the average value of the gradient of the initial linear portion of the CPT pore pressure dissipation ( $m$ ) from all the CPT dissipation tests carried out in the cohesive deposit in a particular swamp crossing. The gradient of the initial linear portion used to calculate the estimated average horizontal coefficient of consolidation is shown as the 'mean' line on Figures A2, B2, C2 and D2 in Appendix A through D for the four swamp crossings, respectively.

The rigidity index is defined as the ratio of the shear modulus to the undrained shear strength of the cohesive deposit (i.e.  $\frac{G}{s_u}$ ). The shear modulus ( $G$ , MPa) is calculated as a function of the elastic modulus ( $E$ , MPa) and the Poisson's ratio ( $\nu$ ) and is defined as follows:

$$G = \frac{E}{2(1+\nu)}$$

The elastic moduli for the cohesive deposits, based on the results of the laboratory consolidation tests (i.e. estimated from the constrained modulus  $D = \frac{1}{m_v}$ ), Poisson's ratio, and the average design undrained shear strength ( $s_u$ ) for calculating the coefficient of consolidation in the horizontal direction are summarized below:

| Swamp Crossing    | Elastic Modulus, E (MPa) | Poisson's Ratio, $\nu$ | Undrained Shear Strength, $s_u$ (kPa) |
|-------------------|--------------------------|------------------------|---------------------------------------|
| Swamp 302 SBL/NBL | 3.1                      | 0.3                    | 25                                    |
| Swamp 305 SBL     | 2.5                      | 0.3                    | 25                                    |
| Swamp 306 SBL     | 2.5                      | 0.3                    | 20                                    |
| Swamp 307 SBL     | 2.0                      | 0.3                    | 17                                    |

A value of  $c_h$  was also assessed from the results of the laboratory consolidation tests performed on a vertically trimmed specimen (VTO) of the cohesive deposit.

The coefficient of consolidation in the vertical direction ( $c_v$ ,  $\text{cm}^2/\text{s}$ ) was primarily assessed from the results of the laboratory consolidation tests performed on horizontally trimmed specimens (HTO) of the cohesive soils.



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However, values of  $c_v$  were also compared with estimates based on the results of the Atterberg limits testing (i.e. liquid limit) and the empirical correlation proposed by U.S. Navy (1986).

The results of the horizontally trimmed (HTO) and vertically trimmed (VTO) laboratory consolidation tests were used to assess the ratio between the horizontal and vertical coefficient of consolidation ( $c_h/c_v$ ) employed in the analyses. The coefficients of consolidation ( $c_v$  and  $c_h$ ) from the CPT dissipation tests as well as the laboratory tests are summarized below.

| Swamp Crossings   | $C_h$ CPT-Field ( $\text{cm}^2/\text{s}$ ) |                      |                      | $C_h$ VTO-Lab ( $\text{cm}^2/\text{s}$ ) |                      |                      | $C_v$ HTO-Lab ( $\text{cm}^2/\text{s}$ ) |                      |                      |
|-------------------|--|----------------------|----------------------|--|----------------------|----------------------|--|----------------------|----------------------|
|                   | Upper-bound                                | Lower-bound          | Average              | Upper-bound                              | Lower-bound          | Average              | Upper-bound                              | Lower-bound          | Average              |
| Swamp 302 SBL/NBL | $1.2 \times 10^{-1}$                       | $1.1 \times 10^{-2}$ | $3.0 \times 10^{-2}$ | $1.1 \times 10^{-1}$                     | $4.5 \times 10^{-2}$ | $7.5 \times 10^{-2}$ | $1.0 \times 10^{-1}$                     | $1.3 \times 10^{-2}$ | $6.5 \times 10^{-2}$ |
| Swamp 305 SBL     | $6.2 \times 10^{-2}$                       | $1.9 \times 10^{-3}$ | $4.6 \times 10^{-3}$ | --                                       | --                   | --                   | $1.3 \times 10^{-2}$                     | $2.0 \times 10^{-3}$ | $6.2 \times 10^{-3}$ |
| Swamp 306 SBL     | $3.0 \times 10^{-2}$                       | $3.1 \times 10^{-3}$ | $6.8 \times 10^{-3}$ | --                                       | --                   | --                   | $2.5 \times 10^{-2}$                     | $2.5 \times 10^{-3}$ | $8.4 \times 10^{-3}$ |
| Swamp 307 SBL     | $2.8 \times 10^{-2}$                       | $8.6 \times 10^{-3}$ | $1.2 \times 10^{-2}$ | --                                       | --                   | --                   | $8.9 \times 10^{-2}$                     | $1.7 \times 10^{-3}$ | $5.4 \times 10^{-2}$ |

Note:  $C_h$ -VTO lab results based on Golder's laboratory tests.

The average coefficient of horizontal consolidation ( $c_h$ ) used in the analysis for estimating the rate of excess pore pressure dissipation and consolidation settlement of the cohesive deposits at the critical sections of the embankments are given in Tables A1, B1, C1 and D1 in Appendix A through D for the four swamp crossings, respectively.

Values of  $c_h$  that have either been back-calculated from case histories or derived from the field data on other MTO wick drain projects are summarized below for comparison with the values discussed above.

| MTO Project                              | $C_h$ ( $\text{cm}^2/\text{s}$ ) |                      |                      |
|--|----------------------------------|----------------------|----------------------|
|  | Upperbound                       | Lowerbound           | Average              |
| Highway 17 – Trap Rock (Sault Ste Marie) | --                               | --                   | $1.4 \times 10^{-3}$ |
| Red Hill Valley Parkway (Hamilton)       | $2.2 \times 10^{-2}$             | $1.6 \times 10^{-3}$ | $2.4 \times 10^{-3}$ |
| Highway 69 (Estaire)                     | $6.3 \times 10^{-2}$             | $6.3 \times 10^{-3}$ | $6.4 \times 10^{-3}$ |
| Highway 69 (Sudbury)                     | $5.7 \times 10^{-2}$             | $1.9 \times 10^{-3}$ | $5.0 \times 10^{-3}$ |
| Highway 69 (French River)                | $9.1 \times 10^{-3}$             | $3.5 \times 10^{-3}$ | $5.9 \times 10^{-3}$ |

### 6.2.3.4 Smear Ratio

The horizontal permeability of the cohesive deposits immediately adjacent to the wick drain is generally less than the permeability measured or estimated for the overall cohesive deposits as a result of localized disturbance/smearing of the soil caused by insertion of the steel mandrel into the subsurface during installation of the wick drains. The ratio of the horizontal permeability of the undisturbed soil ( $k_h$ ,  $\text{cm}^2/\text{s}$ ) to the permeability



of the soil in the smear zone ( $k_s$ ,  $\text{cm}^2/\text{s}$ ) adjacent to the wick is termed the smear ratio ( $k_r/k_s$ ). This parameter is difficult to select for analysis as it is site specific, cannot be evaluated directly from any field or laboratory testing and there are no empirical correlations available for its estimation.

Based on published information in literature, the smear ratio ( $k_r/k_s$ ) can reportedly vary from 3 to 10 as suggested by Rankine et al. (2008), Xiao (2002), Crawford et al. (1992), Bergado et al. (1990, 1993) and Rixner et al. (1986). Many researchers recommend that the smear ratio is best evaluated by carrying out back-analysis of the rate of consolidation below an embankment on a wick drain foundation based on a comparison of the estimated and actual field measured excess pore pressure dissipation and/or settlement data. By fixing the other known variables in the analysis, the smear ratio can be varied until a reasonable correlation is obtained. Using field foundation monitoring data collected at several wick drain project sites along Highway 69 north of Parry Sound, this approach has been followed revealing that the smear ratio can vary from as low as about 3 to as high as about 15, even within a single swamp crossing/wick drain treatment area. Given this, it appears that there can be significant localized variability that will affect the actual value of smear ratio. As such, although a low value of smear ratio (such as 3) may be valid at some locations, it may be conservatively low at other locations. Conversely, a high value (such as 10 or even 15) may be valid at some locations, but conservatively high at others. Considering the above, a smear ratio ( $k_r/k_s$ ) of 5 has been employed for the design of the wick drain foundation systems for the current sites. However, it should be noted that because of the likely variability in the subsurface conditions, when using a smear ratio of 5, it is possible that in some swamp crossings, at some locations, the actual rate of consolidation in the field may be slower than that estimated by the analyses, therefore, requiring a slower rate of construction and/or longer surcharge period.

### 6.2.3.5 Settlement of Embankment Rock Fill

Where rock fill is to be used for the construction of the proposed embankments, there will be settlement due to compression of the rock fill itself under self weight, in addition to the settlement of the underlying foundation soil deposits as described above. The magnitude of settlement of the rock fill depends on the following factors:

- type of rock/strength of particles;
- size and shape of rock particles;
- gradation of rock fill;
- total height/thickness of rock fill (stress level); and,
- method of construction and sequence of placement (including lift thickness, compactive effort and state of packing).

The settlement of rock fill occurs as a result of re-arrangement of rock particles under load and wetting and as a result of localized crushing of rock particles at point contacts. The magnitude of both the short-term and long-term post-construction settlement of the rock fill is a function of the height of fill as well as the method of fill placement (i.e. compacted versus dumped rock fill) as outlined in MTO Foundations Guideline, MTO Guideline for Rock Fill Settlement and Rock Fill Quantity Estimates, dated September 2010.

Rock fill should be placed, whenever possible, in a controlled manner (i.e. not end-dumped) in accordance with Special Provision 206S03. Blading, dozing and 'chinking' the rock fill to form a dense, compact mass is required to minimize voids and bridging and reduce settlements and should be used to construct rock fill embankments above the existing groundwater table. Where rock fill cannot be placed in a controlled manner (i.e. below the groundwater table), the post-construction settlement of the rock fill is expected to be greater.

### Short-Term Rock Fill Settlement

The magnitude of short-term post-construction settlement associated with compacted and end-dumped rock fill may be estimated in accordance with the MTO Foundations Guideline (September 2010), as follows:



| Total Height of<br>Rock Fill, H | Short-Term Rock Fill Settlement (m) |                  |
|---------------------------------|-------------------------------------|------------------|
|                                 | Compacted Rock Fill                 | Dumped Rock Fill |
| Up to 5 m                       | 0.5%·H                              | 1.0%·H           |
| >5 m to 10 m                    | 0.75%·H                             | 1.5%·H           |
| >10 m to 15 m                   | 1.0%·H                              | 2.0%·H           |

It should be noted that approximately 90 percent of the short-term rockfill settlement may be expected to occur within the first six (6) months following construction of the embankment to full height. The short-term settlement is expected to be fully completed within one (1) year following the completion of embankment construction to full height.

### Long-Term Rock Fill Settlement

The magnitude of long-term post-construction settlement for compacted and end-dumped rock fill may be estimated in accordance with the MTO Foundations Guideline (September 2010), as follows:

| Total Height of<br>Rock Fill, H | Long-Term Rock Fill Settlement (m) |                  |
|---------------------------------|------------------------------------|------------------|
|                                 | Compacted Rock Fill                | Dumped Rock Fill |
| Up to 15 m                      | 0.1%·H                             | 0.2%·H           |

The long-term rock fill settlement is expected to occur from one (1) year following the completion of construction to over the life of the embankment.

## 6.3 Settlement Performance Requirements

The following criterion was developed, in consultation with MTO and MRC, for the long-term performance of the embankments at these sites and considered in the selection of the wick drain spacing and duration of the embankment surcharge period as part of the design of the wick drain foundation systems:

- Post-construction settlements of the foundation soil deposits should be 60 mm or less over a 10-year period following completion of construction.

As discussed in Section 6.2.3.5, where rock fill is used for the construction of the proposed embankments, there will be settlement due to compression of the rock fill under self weight. However, for this project, the settlement of the embankment fill is not included as part of the settlement performance criterion.

## 6.4 Results of Analysis

The following sections present the results of the analyses assessing the effect of wick drains (at different spacings) on the stability of the embankments plus surcharge, and the development of excess pore pressure and the rate of settlement in the cohesive foundation soil deposits. Wick drain spacings of 1.5 m, 2.0 m and 2.5 m were analysed to assess the effect that varying the spacing has on the embankment construction. A rate



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of construction equivalent to either 1.5 m of embankment fill placed per 7-day period, and placement of up to 2 m of Granular 'B' surcharge per 7-day period, has been assumed for the construction stages. The following lists the critical sections within each swamp crossing employed in the analysis. Critical sections correspond to the greatest new embankment height and/or the maximum thickness of soft, compressible cohesive soils.

| Swamp Crossing    | Critical Section(s)   |
|-------------------|-----------------------|
| Swamp 302 SBL/NBL | STA 17+850 and 18+050 |
| Swamp 305 SBL     | STA 16+200 and 16+275 |
| Swamp 306 SBL     | STA 15+400 and 15+550 |
| Swamp 307 SBL     | STA 14+460            |

### 6.4.1 Total Stress Stability Analysis

Total stress analysis, using the undrained parameters summarized in Tables A1, B1, C1 and D1 in Appendix A through D, were carried out to assess the maximum height of embankment that could be constructed instantaneously (i.e. without any delays between lift placement) while still maintaining a Factor of Safety of 1.3. The results of the total stress analyses for the maximum embankment heights under undrained loading conditions for each of the swamp crossings are summarized below:

| Swamp Crossing    | Critical Section | Maximum Height <sup>1</sup> of Embankment For a Factor of Safety Greater Than 1.3 (m) |
|-------------------|------------------|---|
| Swamp 302 SBL/NBL | STA 17+850       | 3.5   |
|                   | STA 18+050       | 3.0   |
| Swamp 305 SBL     | STA 16+200       | 6.0 <sup>2</sup>  |
|                   | STA 16+275       | 2.5   |
| Swamp 306 SBL     | STA 15+400       | 2.5   |
|                   | STA 15+550       | 3.0   |
| Swamp 307 SBL     | STA 14+460       | 5.0 <sup>2</sup>  |

Note: 1 Maximum height refers to the embankment height above original ground surface.  
2 Maximum height of embankment for the swamp crossing.

The results of the total stress stability analyses for the maximum stable embankment height with a Factor of Safety greater than or equal to 1.3 are shown on Figures A3-1, A3-2, B3, C3-1, C3-2 and D3 in Appendix A through D, for the four swamp crossings, respectively. The results indicate that the portions of the embankments summarized above can be constructed without any delays between lift placements. The total stress analyses indicates that after the embankment heights (as summarized above) have been reached, the Factor of Safety will decrease with each subsequent lift of fill placed when excess pore pressure dissipation and strength gain of the underlying foundation soils is not considered.

### 6.4.2 Effective Stress Stability Analysis

The impact of staged construction on excess pore pressure development within the cohesive deposit on the stability of the proposed embankments at the critical sections at each stage of the construction was assessed as



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part of the analysis. The overall pore pressure coefficients ( $\bar{B}$ ) and pore pressure change were calculated at a closely spaced intervals (i.e. a grid of points) covering the extent of the foundation soil deposits in order to create a two-dimensional field of total pore pressures (i.e. initial plus excess) below and beyond the footprint of the embankments. This analysis was carried out for each critical time interval to examine the stability of the embankments at the different stages of construction.

In addition, effective stress analyses were also carried out for the conditions in which construction of the embankment to its full (maximum) height allowed in the total stress analyses was completed instantaneously, as opposed to construction of 1.5 m thick lifts of rock fill in a 7-day period, to simulate the effect that would be comparable to the rapid loading, undrained condition in the total stress analyses. This allows an assessment of the suitability of the strength parameters used for the construction sequence for the various wick drain spacing at each swamp crossing. The results of the effective stress analyses for the maximum embankment heights under instant loading conditions for each of the swamp crossings is summarized below (together with the results of the total stress analyses for comparison):

| Swamp Crossing    | Critical Section | Embankment Height <sup>1</sup> (m) | Factor of Safety      |                           |
|-------------------|------------------|------------------------------------|-----------------------|---------------------------|
|                   |                  |                                    | Total Stress Analysis | Effective Stress Analysis |
| Swamp 302 SBL/NBL | STA 17+850       | 3.5                                | 1.4                   | 1.6                       |
|                   | STA 18+050       | 3.0                                | 1.4                   | 1.3                       |
| Swamp 305 SBL     | STA 16+200       | 6.0 <sup>2</sup>                   | 1.4                   | 1.5                       |
|                   | STA 16+275       | 2.5                                | 1.4                   | 1.3                       |
| Swamp 306 SBL     | STA 15+400       | 2.5                                | 1.4                   | 2.0                       |
|                   | STA 15+550       | 3.0                                | 1.4                   | 1.8                       |
| Swamp 307 SBL     | STA 14+460       | 5.0 <sup>2</sup>                   | 1.5                   | 1.4                       |

Note: 1. Maximum height of embankment that can be constructed instantaneously while still maintaining a Factor of Safety greater than 1.3. Embankment construction to the design height will have to be completed in stages. Refer to Section 6.4.1.  
2. Maximum height of embankment for the swamp crossing.

The results of the effective stress analyses are in general agreement with the total stress analyses, implying that the effective stress strength parameters (i.e. fully define shear-normal function) combined with the estimated excess pore pressure development used in the analysis is comparable to the undrained shear strength parameters ( $s_u$ ).

The effective stress analysis at various stages of construction, which considers the effect of dissipation of excess pore pressure with time, is utilized to estimate the time delay required between subsequent lift placements to maintain a minimum Factor of Safety of 1.3. The results of the effective stress analysis on the time required for construction of the embankment to the top of the surcharge level for various wick drain spacings at each of the swamp crossing are summarized below:





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| Swamp Crossing    | Maximum Embankment Height (including Surcharge) (m) | Estimated Time from Start of Embankment Construction to Completion of Surcharge Fill (days) |   |   |
|-------------------|---|---|---|---|
|                   |   | 1.5 m Wick Drain Spacing (with 2 m Surcharge)   | 2 m Wick Drain Spacing (with 2 m Surcharge) | 2.5 m Wick Drain Spacing (with 2 m Surcharge) |
| Swamp 302 SBL/NBL | 8.5   | 38  | 52 <sup>1</sup>                             | 72 <sup>1</sup>                               |
| Swamp 305 SBL     | 6.0   | 26  | 26  | 26  |
| Swamp 306 SBL     | 5.0   | 21  | 21  | 21  |
| Swamp 307 SBL     | 5.0   | 21  | 21  | 21  |

Note: 1. The estimated time for construction includes all hold times (where necessary) between the different stages of construction. Where estimated construction times do not vary with wick drain spacings, hold times are not required between stages to satisfy stability requirements.

It is important to note that the analyses indicate that there is a relatively large difference in the allowable height of embankment for a Factor of Safety greater than 1.3 between the two critical sections in Swamp 305. This is because the embankment stability at STA 16+200 is enhanced by a thick (up to 4.5 m) sand and silt deposit overlying the soft compressible clay to clayey silt deposit, while the embankment stability at STA 16+275 is controlled by localized layers of clay to clayey silt within the near surface sand and silt deposit. Analyses indicate that the localized layers of clay to clayey silt would have an adverse impact on the length of time required for construction of the embankment for Swamp 305 if measures to mitigate instability are not adopted. As a result, it is recommended that the localized layers of clay to clayey silt be sub-excavated so that the time required for construction of the embankment to the top of the surcharge in Swamp 305 can be optimized. Refer to Section 6.6.1 for details on the requirements of sub-excavation of localized compressible soils.

The results of the stability analyses at the time at which the final height of embankment and a 2 m surcharge is completed, at the critical sections, are shown on Figures A4-1, A4-2, B4, C4-1, C4-2 and D4 in Appendix A through D for the four swamp crossings, respectively.

Plots of estimated excess pore pressure below the embankment centerline versus time for each critical section are shown on Figures A5-1, A5-2, B5, C5-1, C5-2 and D5 in Appendix A through D for the four swamp crossings, respectively.

### 6.4.3 Surcharging and Removal of Surcharge

For each swamp crossing, an embankment surcharge was considered as part of the wick drain / staged construction design to accelerate the rate of consolidation and satisfy the post-construction performance criterion. The estimated time for surcharging and surcharge removal for various wick drain spacings, is detailed in Table 3, and summarized below.



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| Swamp Crossing | Maximum Embankment Height (including Surcharge) (m) | Estimated Time to Removal of Surcharge From Start of Construction (and Surcharge Period <sup>1</sup> ) (days) |   |   |
|----------------|---|---|---|---|
|                |   | 1.5 m Wick Drain Spacing (with 2 m Surcharge)   | 2 m Wick Drain Spacing (with 2 m Surcharge) | 2.5 m Wick Drain Spacing (with 2 m Surcharge) |
| Swamp 302 SBL  | 8.5   | 120 (82)  | 175 (123)                                   | 240 (168)                                     |
| Swamp 305 SBL  | 6.0   | 150 (124)   | 200 (174)                                   | 260 (234)                                     |
| Swamp 306 SBL  | 5.0   | 90 (69)   | 125 (104)                                   | 170 (149)                                     |
| Swamp 307 SBL  | 5.0   | 70 (49)   | 95 (74)                                     | 120 (99)                                      |

Note: 1. The estimated surcharge period shown in the parentheses is the time between the completion of surcharge fill placement and the removal of the surcharge.

### 6.4.4 Recommended Wick Drain Spacing and Surcharge Thickness

Based on the results of the time-rate consolidation analyses as summarized above, and in consideration of the preferred target duration of about 6 to 7 months for construction of the embankment including the surcharge period(s), the recommended design layout of the wick drain foundation system and surcharge for each swamp crossings is summarized below and is detailed in Table 4.

| Swamp Crossing    | Longitudinal Extent                                      | Recommendation Wick Drain Foundation System            | Estimated Time from Start of Construction to the Removal of Surcharge (days) |
|-------------------|--|--|--|
| Swamp 302 SBL/NBL | SBL – STA 17+750 to 18+125<br>NBL – STA 17+750 to 18+100 | 2 m triangular wick drain spacing with 2 m surcharge   | 175  |
| Swamp 305 SBL     | SBL – 16+075 to 16+325                                   | 1.5 m triangular wick drain spacing with 2 m surcharge | 150  |
| Swamp 306 SBL     | SBL – STA 15+360 to 15+750                               | 2 m triangular wick drain spacing with 2 m surcharge   | 125  |
| Swamp 307 SBL     | SBL – 14+425 to 14+490                                   | 2.5 m triangular wick drain spacing with 2 m surcharge | 120  |

### 6.4.5 Settlement of Foundation Soils

The thickness of the compressible soil layer(s) used in the settlement analyses, together with the estimated magnitude of elastic settlement, primary consolidation, secondary consolidation, total settlement during construction and the post-construction settlement for the recommended wick drain spacing and surcharge thickness at the critical sections of the embankments are summarized below. Plots of settlement of the cohesive deposits at the embankment centreline versus time for each critical section are shown on Figures A6-1, A6-2, B6, C6-1, C6-2 and D6 in Appendix A through D for the four swamp crossings, respectively.



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| Swamp Crossing    | Critical Section | Height of Embankment Fill including Surcharge <sup>1</sup> (m) | Thickness of Cohesive Deposits (m) | Elastic Settlement <sup>2</sup> (mm) | Primary Consolidation (mm) | Secondary Consolidation (mm) | Total Settlement of Foundation Soils During Construction (mm) | Post-Construction Settlement of Foundation Soils (mm) |
|-------------------|------------------|--|------------------------------------|--------------------------------------|----------------------------|------------------------------|---|---|
| Swamp 302 SBL/NBL | STA 17+850       | 8.5  | 8.0                                | 35                                   | 345                        | 5                            | 385   | 50  |
|                   | STA 18+050       | 6.0  | 6.0                                | 280                                  | 365                        | 5                            | 650   | <5  |
| Swamp 305 SBL     | STA 16+200       | 6.0  | 15.0                               | 105                                  | 250                        | 0                            | 355   | 50  |
| Swamp 306 SBL     | STA 15+400       | 5.0  | 6.5                                | 10                                   | 415                        | 0                            | 425   | 50  |
|                   | STA 15+550       | 4.0  | 11.5                               | 45                                   | 460                        | 0                            | 505   | 45  |
| Swamp 307 SBL     | STA 14+460       | 5.0  | 11.0                               | 75                                   | 65                         | 0                            | 140   | 50  |

Note: 1. Surcharge thickness is 2 m.  
2. The elastic settlement includes the settlement of the cohesionless deposit as well as the granular drainage blanket.

### 6.4.6 Settlement of Embankment Rock Fill

In addition to the settlement of the foundation soils, settlement of the embankment rock fill will occur over the life of the highway embankments. The estimated settlement of the rock fill during and following completion of construction at the critical section(s) of each swamp crossing is summarized below:

| Swamp Crossing    | Critical Section | Height of Embankment Fill (plus Surcharge) (m) | Estimated Settlement of Rock Fill |                                       |   |
|-------------------|------------------|--|-----------------------------------|---------------------------------------|---|
|                   |                  |  | Total (mm)                        | During Construction <sup>1</sup> (mm) | Following Completion of Construction (mm) |
| Swamp 302 SBL/NBL | STA 17+850       | 6.5+2.0  | 55                                | 40                                    | 15  |
|                   | STA 18+050       | 4.0+2.0  | 35                                | 25                                    | 10  |
| Swamp 305 SBL     | STA 16+200       | 4.0+2.0  | 35                                | 25                                    | 10  |
|                   | STA 16+275       | 3.5+2.0  | 30                                | 20                                    | 10  |
| Swamp 306 SBL     | STA 15+400       | 3.0+2.0  | 20                                | 10                                    | 10  |
|                   | STA 15+550       | 2.0+2.0  | 15                                | 10                                    | 5   |
| Swamp 307 SBL     | STA 14+460       | 3.0+2.0  | 20                                | 10                                    | 10  |

Note: 1. "During construction" refers to the surcharge time period (3.5 to 4 months).

## 6.5 Design Recommendations for Embankments on Wick Drain Foundations

Based on the results of the time rate consolidation analyses and in consideration of the preferred target duration of about 6 to 7 months for construction, the recommendations for the design layout of the wick drain foundation system for each swamp crossings are provided in Table 5.



### 6.5.1 Construction / Installation Requirements

The following recommendations are provided as guidelines for good construction practice and to ensure that drainage from the wick drains is facilitated away from the embankment area so that the wick drain foundation functions efficiently during the construction and surcharge periods:

- All topsoil / organic soils to be stripped from within the area of the embankment footprint prior to placement of the granular drainage blanket and embankment fill.
- Where the subgrade extends above the groundwater level and therefore can be shaped, the subgrade should be shaped to 3 percent minimum crossfall to be carried out before placing the granular drainage blanket to provide for drainage efficiency, where possible.
- Shallow ditching to be constructed around the perimeter of the embankment to facilitate drainage away from the embankment area to provide for drainage efficiency.
- A minimum 0.5 m thick granular drainage blanket composed of Granular 'B' Type I fill to be placed on the ground surface following stripping and sub-excavation. A thicker drainage blanket/sub-excavation and replacement will be required at locations where thick organic deposits are present. Pit run Granular 'B' Type I (Special Provision 110S13 Aggregates) with 100 percent passing the 26.5 mm sieve and no more than 5 percent passing the 0.075 mm sieve should be used to minimize difficulties with obstructions that otherwise could occur during wick drain installation through areas where the drainage blanket is thicker.
- Pre-drilling through the compact to very dense sand to silt (up to a depth of about 5 m between STA 17+750 and 17+900 (SBL) and between STA 17+750 and 17+850 (NBL)) may be required to facilitate wick drain installation in Swamp 302.
- The plan area of the wick drain installation should extend at least 2 rows beyond the toes of all embankments.
- The wick drains should fully penetrate the cohesive deposits and be installed to 'refusal' within the cohesionless deposits below the cohesive deposits to the depths (and elevations) listed in Table 4.
- Wick drain installation and fill placement should not be performed during frozen ground conditions to prevent damage to the wick drains and delays in the dissipation of excess pore pressures.

It is noted that grading the subgrade to achieve a 3 percent crossfall and providing perimeter ditching may not be possible or practical at all the sites given the low-lying swamp conditions. The wick drains will still function without implementing these construction practices, but they may not perform at their maximum efficiency in these areas. The reduction in wick drain efficiency due to the lack of crossfall is difficult to estimate and depends on a number of factors including the depth of ponded water that may form at the top of the wick drains (i.e. within the drainage blanket) in the absence of proper drainage, as well as on the length of time that this ponded water may be present. The presence of ponded water at the top of the system could result in a build-up of 'back pressure' on the wick drain system which may have a temporary effect on the development (or continuation) of additional time-dependent settlements. In essence, the presence of ponded water would reduce the hydraulic head and hence the hydraulic gradient that causes flow (dissipation) of excess pore pressure within the cohesive deposits. In turn, this would result in a decrease in the flow rate (dissipation). If this condition occurs, the settlement monitoring may show a delayed response (or premature flattening) of the time-rate consolidation settlement plot. This delay could continue until the 'back pressure' dissipates or until the water level within the swamp crossing decreases.

It should be noted that after removal/stripping of the peat and organic soils, the exposed subgrade may (in places) be soft and unable to support the equipment required for construction. Where soft conditions exist, the following options could be considered to facilitate construction on the subgrade:



- Carry out stripping and grading operations in the summer in a staged manner whereby some drainage is achieved and the work is done by alternatively stripping and grading with excavators over a small area, followed by placement of the granular drainage blanket (by pushing out onto exposed area as a working mat) and then subsequently advancing the excavators out onto the completed portions of the granular drainage blanket/working mat.
- Carry out stripping and grading operations in the winter and rely on frozen ground conditions to minimize the seepage of water through the surficial peat deposits and to provide additional support of the subgrade. Note however that the wick drains should not be installed in frozen ground conditions.

The wick drains must penetrate through the cohesive deposits to practical 'refusal' in order to perform at maximum efficiency. Since the base of the cohesive deposits is variable along the length of the swamp crossings and also varies in cross section, the design tip elevations are to be provided in a table in the specifications.

### 6.5.2 Construction Staging Requirements and Surcharge Removal

In order to maintain a Factor of Safety greater than or equal to 1.3 throughout the construction period, it is essential to allow excess pore pressures to dissipate during and between construction stages (as necessary) such that the total excess pore pressure developed does not exceed the maximum allowable excess pore pressure limit for each stage of construction. In addition, the Granular 'B' surcharge must remain in place for the minimum duration as summarized in Table 5 in order to satisfy the post-construction settlement performance criterion.

An operational constraint should to be included in the Contract Documents that details the requirement for each embankment lift placement such that construction will be carried out in accordance with the recommended schedule rate and thickness of fill specified in the design (refer to Appendix G). It should be noted that the actual pore pressure dissipation timing may differ from the estimated rates and pore pressures will be measured during the recommended monitoring program. The construction schedule and required delays between fill placements/removal of surcharge should be controlled by the actual pore pressures and dissipation rates measured during construction, and the Contract Documents should reflect this.

## 6.6 Subgrade Preparation and Embankment Construction

The following sections discuss general aspects of subgrade preparation and embankment construction for the swamp crossing/wick drain treatment areas, including: removal of surficial and near surface organic materials; excavation and replacement of soft subsoils; staged excavation; groundwater control, where required; and embankment fill placement.

### 6.6.1 Removal of Organic Materials and Localized Compressible Soils

Based on the information from the boreholes advanced during the field investigations, the thickness of the deposits of organic materials (i.e. topsoil, peat, and/or organic silts and clays) in the swamp crossings generally range from about 0.1 m to 4.4 m. After clearing and grubbing of the swamp crossings and prior to the placement of any fill for new construction, all surficial and near surface layers of topsoil and organic materials and localized compressible soils within the swamp crossings should be stripped and/or sub-excavated from the plan limits of the proposed works. The depths of required sub-excavation at the borehole locations for each of the swamps are provided in Table 6. The organic materials and localized compressible soils should be removed using construction procedures in accordance with OPSS 209 Embankments over Swamps and Compressible Soils.

In areas where new embankments are being constructed away from existing highway embankments, the excavation limits should be carried out consistent with OPSD 203.010 Embankments over Swamp for New



Construction, modified to remove the restrictions on the height of the embankment and the depth of excavation (i.e. Note A).

All excavations must be carried out in accordance with Ontario Regulation 213 Ontario Occupational Health and Safety Act for Construction Projects (as amended by Ontario Regulation 443). In addition, provisions for traffic control measures should be included in the Contract Documents to maintain the safe operation of Highway 69 and any associated side roads or detours during excavation operations.

### 6.6.2 Control of Groundwater and Surface Water

Excavation within the plan limits of the proposed works will be required to remove organic deposits prior to embankment fill placement. Groundwater flow into the excavations will occur due to the relatively permeable subsoils, high groundwater levels observed in the swamp crossings and because the excavation for the removal of organic deposits will extend below the groundwater table. Unwatering is not required for the excavations and backfilling in the swamp crossings, however, surface water should be directed away from the excavations at all times.

### 6.6.3 Backfilling

For replacement of the sub-excavated materials, it is assumed that granular fill (i.e. Special Provision 110S13 Granular 'B' Type I, as discussed in Section 6.5.1) will be used. Where sub-excavation of organic materials is to be carried out, it will not likely be possible to place granular fill in accordance with Special Provision 206S03, as discussed in Section 6.6.4. The granular fill is anticipated to be end dumped (typically below the water table) as the excavation advances.

### 6.6.4 Embankment Fill Placement

Placement of rock fill material above the water table for construction of new embankments should be carried out in accordance with the requirements as outlined in Special Provision 206S03. The rock fill should not be dumped in final position, but should be deposited on and pushed forward over the end of the layer being constructed. Voids and bridging should be minimized by blading, dozing and 'chinking' the rock to form a dense, compacted mass. Side slopes for rock fill embankments should be no steeper than 1.25H:1V.

In addition, the crest of the 2 m granular surcharge on top of the embankment should be located at least 5 m beyond the limits of the wick drains.

### 6.6.5 Embankment Platform Widening

In accordance with the requirements of MTO Northern Region Engineering Directive NRE 98-200, Northern Region Embankment Design Guidelines, the construction of the embankments should include an allowance for platform widening (in 0.5 m increments) to accommodate settlements during construction as well as post-construction settlements, so that the minimum standard shoulder widths are maintained if future grade raises on the embankments are required. According to NRE 98-200, the need for future raises in road grade could occur due to settlement/compression of the embankment fill, settlement of the foundation soils and to accommodate future pavement overlays up to 200 mm thick. It is understood that this directive applies to all rock fill embankments as well as for granular fill embankments where widening restrictions are present (i.e. due to space/property issues, presence of a sensitive body of water and so on). It is further understood that the minimum required platform widening on major highways (i.e. including Highway 69) over swamp crossings is 2 m per side, unless the preferred mitigation option eliminates uncertainty regarding embankment settlement/performance (i.e. full sub-excavation to bedrock and backfilling with granular material). For non-major





highways and roadways (i.e. ramps and side roads) over swamp crossings, the minimum required platform widening is 1 m per side.

The minimum required embankment platform widening (per embankment side) is calculated based on the estimated consolidation settlement of the foundation soils (including creep) and long-term settlement/compression of the embankment fill plus an additional 200 mm for the future pavement overlay, multiplied by the horizontal component of the side slope profile of the pavement structure (4H:1V), but cannot be less than the minimum platform widening requirement as described above.

For the proposed embankment swamp crossings in this project, the minimum required platform widening is summarized below and is detailed in Table 7.

| Swamp Crossing    | Minimum Embankment Platform Widening Per Side (m) |
|-------------------|---|
| Swamp 302 SBL/NBL | 3.0   |
| Swamp 305 SBL     | 2.5   |
| Swamp 306 SBL     | 3.0   |
| Swamp 307 SBL     | 2.0   |

### 6.6.6 Transitions between Wick Drain and Full Sub-Excavation Areas

Where full sub-excavation is to be carried immediately adjacent to a wick drain area, it is recommended that the limit of the full sub-excavation area extend downwards at a 1H:1V slope from the limit of the wick drain area to the base of the sub-excavation. In addition, the crest of the 2 m granular surcharge on top of the embankment should be located at least 1.5 times the sub-excavation depth (but no less than 5 m) beyond the limits of the wick drains, extending over the sub-excavation area.

## 6.7 Wick Drain Specifications

The specification describing the requirements for the supply and installation of the wick drains to be included in the Contract Documents is included in Appendix G for reference.

### 6.7.1 Monitoring Instrumentation Specifications

The specification describing the type, location, supply and installation of the instrumentation required for the monitoring of the embankments to be included in the Contract Documents is included in Appendix H for reference. Drawings showing the typical monitoring sections as well as the typical instrument details are also provided in Appendix H and should form part of the Contract Documents.

### 6.7.2 Monitoring Program

The special provision describing the frequency of monitoring readings, review and alert levels and reporting required for the foundation monitoring program to be included in the Contract Documents as part of the Contract Administration Assignment is provided in Appendix H.



## **7.0 CLOSURE**

This report was prepared by Messrs. Tomasz Zalucki, P. Eng., and Christopher Ng, P. Eng. The technical aspects were reviewed by Mr. J. Paul Dittrich, Ph.D., P. Eng., a senior geotechnical engineer and Principal with Golder. Mr. Jorge M. A. Costa, P. Eng., Golder's Designated MTO Contact for this project and a Principal with Golder, conducted an independent quality control review of the report.



## Report Signature Page

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## REFERENCES

- Barron, R.A. 1948. Consolidation of fine-grained soils by drain wells. ASCE Trans, Paper 2346, Vol. 113, pp. 718-724.
- Becker, D.E., Crooks, J.H.A., Been, K. and Jefferies, M.G. 1987. Work as a criterion for determining in situ and yield stresses in clays. Canadian Geotechnical Journal, Vol. 24, pp. 549-564.
- Bergado, D.T., Enrique, A.S., Sampaco, C.L., Alfaro, M.C., and Balasubramaniam, A.S. (1990). Inverse Analysis of Geotechnic Parameters on Improved Soft Bangkok Clay. Journal of Geotechnical Engineering, Vol. 118, No. 7, pp. 1012-1030.
- Bergado, D.T., Mukherjee, K., Alfaro, M.C. and Balasubramaniam, A.S. (1993). Prediction of vertical band-drain performance by the finite element method. Geotextiles and Geomembranes, Vol. 12, No. 6, pp. 567-586.
- Bjerrum, L. 1973. Problems of Soil Mechanics and Construction on Soft Clays and Structurally Unstable Soils. State-of-the-art Report, Session 4. Proceedings, 8<sup>th</sup> International Conference on Soil Mechanics and Foundation Engineering, Moscow, Vol. 3, pp. 111-159.
- Bowles, J.E. 1984. Physical and Geotechnical Properties of Soils, 2<sup>nd</sup> Edition. McGraw-Hill Book Company, New York.
- Canadian Geotechnical Society. 2006. Canadian Foundation Engineering Manual, 4<sup>th</sup> Edition. The Canadian Geotechnical Society c/o BiTech Publisher Ltd., British Columbia.
- Canadian Highway Bridge Design Code (CHBDC) and Commentary on CAN/CSA-S6-06. 2006. CSA Special Publication, S6.1-06. Canadian Standard Association.
- Casagrande, A. 1936. The determination of pre-consolidation load and its practical significance. Proceedings, 1<sup>st</sup> International Soil Mechanics and Foundation Engineering Conference, Vol. 3, pp. 60-64.
- Chapman, L.J., and Putnam, D.F. 1984. The Physiography of Southern, 3<sup>rd</sup> Edition. Ontario Geological Survey, Special Volume 2. Ontario Ministry of Natural Resources.
- Crawford, C.B., Fannin, R.J., DeBoer, L.J. and Kern, C.B. 1992. Experiences with prefabricated vertical (wick) drains at Vernon, B.C. Canadian Geotechnical Journal. Vol. 29, pp. 67-79.
- Demer, D., Leroueil, S. 2002. Evaluation of preconsolidation pressure and the overconsolidation ratio from piezocone tests of clay deposits in Quebec. Canadian Geotechnical Journal. Vol. 39, pp. 174-192.
- Geology of Ontario. 1991. Ontario Geological Society, Special Volume 4, Part 1. Eds. P.C. Thurston, H.R. Williams, R.H. Sutcliffe and G.M. Stott. Ministry of Northern Development and Mines, Ontario.
- Hansbo, S. 1979. Consolidation of clay by band-shaped prefabricated drains. Ground Engineering, Vol. 12, No. 5, pp. 16-25.
- Koppula, S. D., 1986. "Discussion: Statistical Estimation of Compression Index", Geotechnical Testing Journal, ASTM, Vol. 4, No. 2, pp. 68-73.
- Kulhawy, F.H. and Mayne, P.W. 1990. Manual on Estimating Soil Properties for Foundation Design. EL-6800, Research Project 1493-6. Prepared for Electric Power Research Institute, Palo Alto, California.
- Ladd, C.C, Foott, R., Ishihara, K., Schlosser, F., and Poulos, H.G. 1977. Stress-deformation and strength characteristics. Proceedings of the 9<sup>th</sup> International Conference on Soil Mechanics and Foundation Engineering, Tokyo, Vol. 2, pp. 421-494.



## FOUNDATION REPORT – WICK DRAIN TREATMENT AREAS – PHASE 3 – HIGHWAY 69 G.W.P. 5203-06-00

Mesri, G. 1973. Coefficient of Secondary Compression. Journal of Soil Mechanics and Foundations Division, ASCE, Vol. 99, No. SM1: pp. 123-137.

Mesri, G. 1975. Discussion on new design procedure for stability of soft clays. ASCE Journal of the Geotechnical Engineering Division, Vol. 101, GT4, pp. 409-412.

Meyerhof, G. G., 1956. Penetration Tests and Bearing Capacity of Cohesionless Soils. Journal of Soil Mechanics and Foundations Division, ASCE, Vol. 82, No. SM1: pp. 1-19.

Mitchell, J.K. 1993. Fundamentals of Soil Behaviour. 2<sup>nd</sup> Edition, John Wiley and Sons Inc., New York.

Poulos, H. G., and Davis, E. H. 1974. "Loading over Half the Infinite Surface." Elastic Solution for Soil and Rock Mechanics. Centre for Geotechnical Research, University of Sydney, pp. 41.

Rankine, B.R., Indraratna, B., Sivakugan, N., Wijeyakulasuriya, V. and Rujikiatkamjorn, C. 2008. Foundation Behaviour Below an Embankment on Soft Soils. Geotechnical Engineering 161 Issue GE5, Proceedings of the Institution of Civil Engineers, pp. 259-267.

Rixner, J.J. Kraemer, S.R. and Smith, A.D. 1986. Prefabricated vertical drains, Vol. 1: Engineering Guidelines. Federal Highway Administration, Report No. FHWA-RD-86/168.

Robertson, P.K., Sully, J.P., Woeller, D.J., Lunne T., Powell, J.J.M. and Gillespie, D.G. 1992. Estimating coefficient of consolidation from piezocone tests. Canadian Geotechnical Journal, Vol. 29, pp. 539-550.

Schmertmann, J.H. 1975. Measurement of In-Situ Shear Strength. Proceedings, ASCE Specialty Conference on In-Situ Measurement of Soil Properties, Vol. 2, Raleigh, pp. 57-138.

Skempton, A.W. 1954. The pore-pressure coefficients A and B. Geotechnique, Vol. 4, No. 4: pp. 143-147.

Terzaghi, K. and Peck, R.B. 1967. Soil Mechanics in Engineering Practice, 2<sup>nd</sup> Edition, John Wiley and Sons, New York.

U.S. Navy. 1986. NAVFAC Design Manual 7.02. Soil Mechanics, Foundations and Earth Structures. Alexandria, Virginia.

Xiao, D.P. 2002. Consolidation of soft clay using vertical drains. Ph.D. thesis, Nanyang Technological University, Singapore.

### STANDARDS:

#### ASTM International:

|                |  |
|----------------|--|
| ASTM D1586-08a | Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils  |
| ASTM D1587-08  | Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes           |
| ASTM D2573-08  | Standard Test Method for Field Vane Shear Test in Cohesive Soil                              |
| ASTM D5778-07  | Standard Test Method for Electronic Friction Cone and Piezocone Penetration Testing of Soils |

#### Contract Design Estimating and Documentation (CDED):

|                          |  |
|--------------------------|--|
| Special Provision 110S13 | Amendment to OPSS 1010 – Material Specification for Aggregates. May 2010.. |
| Special Provision 206S03 | Amendment to OPSS 206 – Earth Excavation, Grading. July 2007.              |

#### Ministry of Transportation Ontario:



## REFERENCES

Chapman, L.J., and Putnam, D.F. 1984. The Physiography of Southern, 3<sup>rd</sup> Edition. Ontario Geological Survey, Special Volume 2. Ontario Ministry of Natural Resources.

Geology of Ontario. 1991. Ontario Geological Society, Special Volume 4, Part 1. Eds. P.C. Thurston, H.R. Williams, R.H. Sutcliffe and G.M. Stott. Ministry of Northern Development and Mines, Ontario.

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| ASTM D2573-08  | Standard Test Method for Field Vane Shear Test in Cohesive Soil                              |
| ASTM D5778-07  | Standard Test Method for Electronic Friction Cone and Piezocone Penetration Testing of Soils |

Ontario Water Resources Act:

Ontario Regulation 903/90 Wells





## LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

### I. GENERAL

|             |                                       |
|-------------|---------------------------------------|
| $\pi$       | 3.1416                                |
| $\ln x$ ,   | natural logarithm of x                |
| $\log_{10}$ | x or log x, logarithm of x to base 10 |
| g           | acceleration due to gravity           |
| t           | time                                  |
| FoS         | factor of safety                      |

### II. STRESS AND STRAIN

|                                |  |
|--------------------------------|--|
| $\gamma$                       | shear strain   |
| $\Delta$                       | change in, e.g. in stress: $\Delta \sigma$                                 |
| $\varepsilon$                  | linear strain  |
| $\varepsilon_v$                | volumetric strain  |
| $\eta$                         | coefficient of viscosity   |
| $\nu$                          | Poisson's ratio  |
| $\sigma$                       | total stress   |
| $\sigma'$                      | effective stress ( $\sigma' = \sigma - u$ )                                |
| $\sigma'_{vo}$                 | initial effective overburden stress  |
| $\sigma_1, \sigma_2, \sigma_3$ | principal stress (major, intermediate, minor)                              |
| $\sigma_{oct}$                 | mean stress or octahedral stress<br>$= (\sigma_1 + \sigma_2 + \sigma_3)/3$ |
| $\tau$                         | shear stress   |
| u                              | porewater pressure   |
| E                              | modulus of deformation   |
| G                              | shear modulus of deformation   |
| K                              | bulk modulus of compressibility  |

### III. SOIL PROPERTIES

#### (a) Index Properties

|                    |  |
|--------------------|--|
| $\rho(\gamma)$     | bulk density (bulk unit weight)*   |
| $\rho_d(\gamma_d)$ | dry density (dry unit weight)  |
| $\rho_w(\gamma_w)$ | density (unit weight) of water   |
| $\rho_s(\gamma_s)$ | density (unit weight) of solid particles   |
| $\gamma'$          | unit weight of submerged soil<br>( $\gamma' = \gamma - \gamma_w$ )                                   |
| $D_R$              | relative density (specific gravity) of solid particles ( $D_R = \rho_s / \rho_w$ ) (formerly $G_s$ ) |
| e                  | void ratio   |
| n                  | porosity   |
| S                  | degree of saturation   |

\* Density symbol is  $\rho$ . Unit weight symbol is  $\gamma$  where  $\gamma = \rho g$  (i.e. mass density multiplied by acceleration due to gravity)

#### (a) Index Properties (continued)

|             |  |
|-------------|--|
| w           | water content  |
| $w_l$ or LL | liquid limit   |
| $w_p$ or PL | plastic limit  |
| $I_p$ or PI | plasticity index = $(w_l - w_p)$   |
| $w_s$       | shrinkage limit  |
| $I_L$       | liquidity index = $(w - w_p) / I_p$  |
| $I_C$       | consistency index = $(w_l - w) / I_p$  |
| $e_{max}$   | void ratio in loosest state  |
| $e_{min}$   | void ratio in densest state  |
| $I_D$       | density index = $(e_{max} - e) / (e_{max} - e_{min})$<br>(formerly relative density) |

#### (b) Hydraulic Properties

|   |   |
|---|---|
| h | hydraulic head or potential                             |
| q | rate of flow  |
| v | velocity of flow  |
| i | hydraulic gradient                                      |
| k | hydraulic conductivity<br>(coefficient of permeability) |
| j | seepage force per unit volume                           |

#### (c) Consolidation (one-dimensional)

|              |   |
|--------------|---|
| $C_c$        | compression index<br>(normally consolidated range)    |
| $C_r$        | recompression index<br>(over-consolidated range)      |
| $C_s$        | swelling index  |
| $C_{\alpha}$ | secondary compression index                           |
| $m_v$        | coefficient of volume change                          |
| $c_v$        | coefficient of consolidation (vertical direction)     |
| $c_h$        | coefficient of consolidation (horizontal direction)   |
| $T_v$        | time factor (vertical direction)                      |
| U            | degree of consolidation                               |
| $\sigma'_p$  | pre-consolidation stress                              |
| OCR          | over-consolidation ratio = $\sigma'_p / \sigma'_{vo}$ |

#### (d) Shear Strength

|                  |  |
|------------------|--|
| $\tau_p, \tau_r$ | peak and residual shear strength                         |
| $\phi'$          | effective angle of internal friction                     |
| $\delta$         | angle of interface friction                              |
| $\mu$            | coefficient of friction = $\tan \delta$                  |
| $c'$             | effective cohesion                                       |
| $c_u, s_u$       | undrained shear strength ( $\phi = 0$ analysis)          |
| p                | mean total stress $(\sigma_1 + \sigma_3)/2$              |
| $p'$             | mean effective stress $(\sigma'_1 + \sigma'_3)/2$        |
| q                | $(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$ |
| $q_u$            | compressive strength $(\sigma_1 - \sigma_3)$             |
| $S_t$            | sensitivity  |

Notes: 1  
2

$\tau = c' + \sigma' \tan \phi'$   
shear strength = (compressive strength)/2



## LIST OF ABBREVIATIONS

The abbreviations commonly employed on Records of Boreholes, on figures and in the text of the report are as follows:

### I. SAMPLE TYPE

|    |                     |
|----|---------------------|
| AS | Auger sample        |
| BS | Block sample        |
| CS | Chunk sample        |
| DS | Denison type sample |
| FS | Foil sample         |
| RC | Rock core           |
| SC | Soil core           |
| SS | Split-spoon         |
| ST | Slotted tube        |
| TO | Thin-walled, open   |
| TP | Thin-walled, piston |
| WS | Wash sample         |

### II. PENETRATION RESISTANCE

#### Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) drive open sampler for a distance of 300 mm (12 in.)

#### Dynamic Cone Penetration Resistance; $N_d$ :

The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

|            |   |
|------------|---|
| <b>PH:</b> | Sampler advanced by hydraulic pressure        |
| <b>PM:</b> | Sampler advanced by manual pressure           |
| <b>WH:</b> | Sampler advanced by static weight of hammer   |
| <b>WR:</b> | Sampler advanced by weight of sampler and rod |

#### Piezo-Cone Penetration Test (CPT)

A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm<sup>2</sup> pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance ( $Q_t$ ), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

### III. SOIL DESCRIPTION

#### (a) Cohesionless Soils

| Density Index    | N                        |
|------------------|--------------------------|
| Relative Density | Blows/300 mm or Blows/ft |
| Very loose       | 0 to 4                   |
| Loose            | 4 to 10                  |
| Compact          | 10 to 30                 |
| Dense            | 30 to 50                 |
| Very dense       | over 50                  |

#### (b) Cohesive Soils Consistency

|            | kPa        | $C_u, S_u$ | psf            |
|------------|------------|------------|----------------|
| Very soft  | 0 to 12    |            | 0 to 250       |
| Soft       | 12 to 25   |            | 250 to 500     |
| Firm       | 25 to 50   |            | 500 to 1,000   |
| Stiff      | 50 to 100  |            | 1,000 to 2,000 |
| Very stiff | 100 to 200 |            | 2,000 to 4,000 |
| Hard       | over 200   |            | over 4,000     |

### IV. SOIL TESTS

|          |   |
|----------|---|
| w        | water content   |
| $w_p$    | plastic limit   |
| $w_l$    | liquid limit  |
| C        | consolidation (oedometer) test  |
| CHEM     | chemical analysis (refer to text)   |
| CID      | consolidated isotropically drained triaxial test <sup>1</sup>                                       |
| CIU      | consolidated isotropically undrained triaxial test with porewater pressure measurement <sup>1</sup> |
| $D_R$    | relative density (specific gravity, $G_s$ )   |
| DS       | direct shear test   |
| M        | sieve analysis for particle size  |
| MH       | combined sieve and hydrometer (H) analysis  |
| MPC      | Modified Proctor compaction test  |
| SPC      | Standard Proctor compaction test  |
| OC       | organic content test  |
| $SO_4$   | concentration of water-soluble sulphates  |
| UC       | unconfined compression test   |
| UU       | unconsolidated undrained triaxial test  |
| V        | field vane (LV-laboratory vane test)  |
| $\gamma$ | unit weight   |

**Note:** 1 Tests which are anisotropically consolidated prior to shear are shown as CAD, CAU.

### V. MINOR SOIL CONSTITUENTS

| Percent by Weight | Modifier                              | Example   |
|-------------------|---------------------------------------|---|
| 0 to 5            | Trace                                 | Trace sand  |
| 5 to 12           | Trace to Some (or Little)             | Trace to some sand  |
| 12 to 20          | Some                                  | Some sand   |
| 20 to 30          | (ey) or (y)                           | Sandy   |
| over 30           | And (cohesionless) or With (cohesive) | Sand and Gravel<br>Silty Clay with sand / Clayey Silt with sand |



## FOUNDATION REPORT – WICK DRAIN TREATMENT AREAS – PHASE 3 HIGHWAY 69 G.W.P. 5203-06-00

**TABLE 1 – SUMMARY OF WICK DRAIN SWAMP CROSSINGS**

| <b>Highway</b>         | <b>Approximate Station</b> | <b>Designation</b> | <b>Proposed Embankment Height<sup>1</sup></b> | <b>Golder Boreholes/CPT</b>                              | <b>Peto Boreholes/DCPT</b>   |
|------------------------|----------------------------|--------------------|---|--|--|
| Highway 69 SBL and NBL | 17+700 to 18+150           | Swamp 302 SBL/NBL  | 3.5 m to 6.5 m                                | 4 Boreholes (302-1 to 302-4)<br>8 CPTs (302-1 to 302-8)  | 34 Boreholes (302-19 to 302-21, 302-23 to 302-25, 302-27, 302-29 to 302-35, 302-37, 302-39 to 302-41, 302-43 to 302-45, 302-47, 302-49 to 302-51, 302-53 to 302-55, 302-57, 302-59, 302-60 and 302-63 to 302-65)<br>12 DCPTs (302-22, 302-26, 302-28, 302-36, 302-38, 302-42, 302-46, 302-48, 302-52, 302-56, 302-58 and 302-62) |
| Highway 69 SBL         | 16+050 to 16+350           | Swamp 305 SBL      | 2.0 m to 2.5 m                                | 3 Boreholes (305-1 to 305-3)<br>6 CPTs (305-1 to 305-6)  | 14 Boreholes (305-7, 305-9, 305-13, 305-16, 305-19, 305-21, 305-25, 305-28, 305-31, 305-33, 305-37, 305-39, 305-40 and 305-43)<br>5 DCPTs (305-10, 305-15, 305-22, 305-27, and 305-34)   |
| Highway 69 SBL         | 15+350 to 15+800           | Swamp 306 SBL      | 0.0 m to 3.0 m                                | 2 Boreholes (306-1 and 306-2)<br>6 CPTs (306-1 to 306-6) | 20 Boreholes (306-13, 306-16, 306-19, 306-21, 306-25, 306-28, 306-31, 306-33, 306-37, 306-40, 306-43, 306-45, 306-49, 306-52, 306-55, 306-61, 306-63, 306-64, 306-65 and 306-68)<br>8 DCPTs (306-15, 306-22, 306-27, 306-34, 306-39, 306-46, 306-51 and 306-58)  |
| Highway 69 SBL         | 14+425 to 14+500           | Swamp 307 SBL      | 2.5 m to 3.0 m                                | 1 Borehole (307-1)<br>2 CPTs (307-1 and 307-2)           | 9 Boreholes (307-19, 307-21, 307-23, 307-27, 307-28, 307-34, 307-36, 307-37 and 307-40)<br>4 DCPTs (307-22, 307-26, 307-30 and 307-31)   |



## FOUNDATION REPORT – WICK DRAIN TREATMENT AREAS – PHASE 3 HIGHWAY 69 G.W.P. 5203-06-00

**TABLE 1 – SUMMARY OF WICK DRAIN SWAMP CROSSINGS**

| <b>Highway</b> | <b>Approximate Station</b> | <b>Designation</b> | <b>Proposed Embankment Height<sup>1</sup></b> | <b>Golder Boreholes/CPT</b>                                   | <b>Peto Boreholes/DCPT</b>  |
|----------------|----------------------------|--------------------|---|---|---|
| Highway 69 SBL | 13+160 to 13+450           | Swamp 310 SBL      | 1.5 m to 2.0 m                                | 2 Boreholes (310-1 and 310-2)<br>4 CPTs (CPTS 310-1 to 310-4) | 5 Boreholes (310-1, 310-4, 310-7, 310-9 and 310-13)<br>2 DCPTs (310-3 and 310-10) |

Note: 1. Based on centreline of highway alignments and existing ground surface profiles provided by Callon Dietz on April 23, 2009.

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Prepared By: VA

Reviewed By: JPD/JMAC



# **FOUNDATION REPORT – WICK DRAIN TREATMENT AREAS – PHASE 3** **HIGHWAY 69 G.W.P. 5203-06-00**

**TABLE 2 – SUMMARY OF CONSOLIDATION AND TRIAXIAL TEST RESULTS**

| <i>Location</i>      | <i>Borehole and Sample No.</i>               | <i>Elevation (m)</i> | $\sigma_{vo}'$<br>(kPa) | $\sigma_p'$<br>(kPa) | $\sigma_p' - \sigma_{vo}'$<br>(kPa) | <i>OCR</i> | <i>C<sub>c</sub></i> | <i>C<sub>r</sub></i> | <i>e<sub>o</sub></i> | <i>c<sub>v</sub><sup>*</sup></i><br>(cm <sup>2</sup> /s) | <i>c'</i><br>(kPa) | $\phi'$<br>(degrees) |
|----------------------|--|----------------------|-------------------------|----------------------|-------------------------------------|------------|----------------------|----------------------|----------------------|--|--------------------|----------------------|
| Swamp 302<br>SBL/NBL | Borehole S302-1<br>Sample 6                  | 182.2 m              | 20                      | 140                  | 120                                 | 7.0        | 0.62                 | 0.04                 | 1.50                 | 1.0 x 10 <sup>-1</sup>                                   | 6                  | 34                   |
|                      | Borehole S302-1<br>Sample 7                  | 179.9 m              | 35                      | 135                  | 100                                 | 3.9        | 0.17                 | 0.02                 | 0.87                 | 1.0 x 10 <sup>-1</sup>                                   | 0                  | 35                   |
|                      | Borehole S302-2<br>Sample 3                  | 182.0 m              | 20                      | 140                  | 120                                 | 7.0        | 0.78                 | 0.08                 | 1.82                 | 7.0 x 10 <sup>-2</sup>                                   | 0                  | 34                   |
|                      | Borehole S302-2<br>Sample 4                  | 179.7 m              | 35                      | 110                  | 75                                  | 3.1        | 0.12                 | 0.03                 | 0.69                 | 6.7 x 10 <sup>-2</sup>                                   | -                  | -                    |
|                      | Borehole S302-2<br>Sample 5                  | 176.7 m              | 55                      | 110                  | 55                                  | 2          | 0.22                 | 0.03                 | 1.23                 | 8.1 x 10 <sup>-2</sup>                                   | 4                  | 33                   |
|                      | Borehole S302-2<br>Sample 5 <sup>(2)</sup>   | 176.7 m              | 55                      | 100                  | 45                                  | 1.8        | 0.23                 | 0.02                 | 1.07                 | 7.5 x 10 <sup>-2</sup>                                   | -                  | -                    |
|                      | Borehole S302-29<br>Sample 7 <sup>(1)</sup>  | 181.1 m              | 100                     | 250                  | 150                                 | 2.5        | 0.85                 | 0.06                 | 1.62                 | 9.6 x 10 <sup>-3</sup>                                   | -                  | -                    |
|                      | Borehole S302-44<br>Sample 5 <sup>(1)</sup>  | 181.6 m              | 30                      | 205                  | 175                                 | 6.8        | 0.18                 | 0.02                 | 0.9                  | 2.2 x 10 <sup>-2</sup>                                   | -                  | -                    |
| Swamp 305<br>SBL     | Borehole S305-1<br>Sample 7                  | 172.9 m              | 80                      | 100                  | 20                                  | 1.3        | 0.63                 | 0.06                 | 1.49                 | 1.3 x 10 <sup>-2</sup>                                   | 7                  | 30                   |
|                      | Borehole S305-2<br>Sample 2                  | 181.9 m              | -                       | -                    | -                                   | -          | -                    | -                    | -                    | -  | 0                  | 30                   |
|                      | Borehole S305-3<br>Sample 1                  | 183.8 m              | 20                      | 40                   | 20                                  | 2          | 1.06                 | 0.10                 | 2.30                 | 2.0 x 10 <sup>-3</sup>                                   | -                  | -                    |
|                      | Borehole S305-16<br>Sample 8 <sup>(1)</sup>  | 176.5 m              | 50                      | 180                  | 130                                 | 3.6        | 0.95                 | 0.09                 | 1.79                 | 3.0 x 10 <sup>-3</sup>                                   | -                  | -                    |
|                      | Borehole S305-20<br>Sample 10 <sup>(1)</sup> | 174.3 m              | 115                     | 205                  | 90                                  | 1.8        | 0.70                 | 0.07                 | 1.44                 | 4.0 x 10 <sup>-3</sup>                                   | -                  | -                    |
|                      | Borehole S305-20<br>Sample 17 <sup>(1)</sup> | 167.3 m              | 150                     | 420                  | 270                                 | 2.8        | 1.26                 | 0.08                 | 1.71                 | 9.8 x 10 <sup>-3</sup>                                   | -                  | -                    |
|                      | Borehole S305-23<br>Sample 10 <sup>(1)</sup> | 179.6 m              | 65                      | 290                  | 225                                 | 3.2        | 1.16                 | 0.08                 | 1.89                 | 5.6 x 10 <sup>-3</sup>                                   | -                  | -                    |



# **FOUNDATION REPORT – WICK DRAIN TREATMENT AREAS – PHASE 3** **HIGHWAY 69 G.W.P. 5203-06-00**

**TABLE 2 – SUMMARY OF CONSOLIDATION AND TRIAXIAL TEST RESULTS**

| Location      | Borehole and Sample No.                  | Elevation (m) | $\sigma_{vo}'$ (kPa) | $\sigma_p'$ (kPa) | $\sigma_p' - \sigma_{vo}'$ (kPa) | OCR | $C_c$ | $C_r$ | $e_o$ | $c_v^*$ (cm <sup>2</sup> /s) | $c'$ (kPa) | $\phi'$ (degrees) |
|---------------|--|---------------|----------------------|-------------------|----------------------------------|-----|-------|-------|-------|------------------------------|------------|-------------------|
| Swamp 306 SBL | Borehole S306-1 Sample 5                 | 180.7 m       | 45                   | 65                | 20                               | 1.4 | 1.21  | 0.11  | 2.33  | $1.3 \times 10^{-3}$         | 7          | 25                |
|               | Borehole S306-2 Sample 3                 | 184.5 m       | 25                   | 35                | 10                               | 1.4 | 1.16  | 0.09  | 2.68  | $2.5 \times 10^{-3}$         | 5          | 25                |
|               | Borehole S306-16 Sample 7 <sup>(1)</sup> | 182.6 m       | 50                   | 170               | 120                              | 3.4 | 0.86  | 0.07  | 1.78  | $6.4 \times 10^{-3}$         | -          | -                 |
|               | Borehole S306-55 Sample 5 <sup>(1)</sup> | 185.0 m       | 60                   | 110               | 50                               | 1.8 | 0.99  | 0.08  | 1.94  | $4.1 \times 10^{-3}$         | -          | -                 |
|               | Borehole S306-28 Sample 7 <sup>(1)</sup> | 181.3 m       | 50                   | 170               | 120                              | 3.4 | 0.63  | 0.04  | 1.37  | $4.1 \times 10^{-3}$         | -          | -                 |
| Swamp 307 SBL | Borehole S307-1 Sample 6                 | 187.5 m       | 25                   | 100               | 75                               | 4.0 | 1.14  | 0.09  | 2.19  | $7.4 \times 10^{-2}$         | 0          | 34                |
|               | Borehole S307-1 Sample 7                 | 183.9 m       | 45                   | 90                | 45                               | 2.0 | 1.01  | 0.08  | 1.93  | $8.0 \times 10^{-4}$         | 18         | 25                |
|               | Borehole S307-29 Sample 7 <sup>(1)</sup> | 188.6 m       | 60                   | 270               | 210                              | 4.5 | 1.21  | 0.14  | 2.07  | $1.7 \times 10^{-3}$         | -          | -                 |

Note: \* For stress range of  $19 \leq \sigma_v' \leq 314$  kPa (for Golder test results) <sup>1</sup> Laboratory consolidation test results obtained from Peto  
For stress range of  $17$  kPa  $\leq \sigma_v' \leq 557$  kPa (for Peto test results) <sup>2</sup> VTO sample orientation, measured  $c_h$  (cm<sup>2</sup>/s)  
Assessed shear strength parameters ( $c'$  and  $\phi'$ ) are only valid over range of stress conditions in the test.

where:  $\sigma_{vo}'$  is the effective overburden stress in kPa  
 $\sigma_p'$  is the preconsolidation stress in kPa  
OCR is the overconsolidation ratio  
 $C_c$  is the compression index  
 $C_r$  is the recompression index  
 $e_o$  is the initial void ratio  
 $c_v$  is the coefficient of consolidation in cm<sup>2</sup>/s  
 $c'$  is the effective cohesion intercept in kPa  
 $\phi'$  is the effective angle of internal friction in degrees  
 $\sigma_v'$  is the vertical effective stress in kPa

Prepared By: VA

Reviewed By: JPD/JMAC

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## FOUNDATION REPORT – WICK DRAIN SWAMP AREAS – PHASE 3 HIGHWAY 69 G.W.P. 5203-06-00

**TABLE 3 – SUMMARY OF WICK DRAIN ANALYSES AND CONSTRUCTION DURATIONS  
HIGHWAY 69 FOUR-LANING – PHASE 3**

| <b>Swamp Crossing</b> | <b>Embankment Height (m)</b> | <b>Surcharge Height (m)</b> | <b>Total Embankment Height (m)</b> | <b>Wick Drain Spacing (m)</b> | <b>Estimated Time from Start of Construction to Completion of Surcharge Embankment<sup>1</sup> (days)</b> | <b>Surcharge Period (days)</b> | <b>Estimated Time from Start of Construction to Surcharge Removal (days)</b> |
|-----------------------|------------------------------|-----------------------------|------------------------------------|-------------------------------|---|--------------------------------|--|
| Swamp 302<br>SBL/NBL  | 6.5                          | 2                           | 8.5                                | 1.5                           | 38  | 82                             | 120  |
|                       |                              |                             |                                    | 2.0                           | 52  | 123                            | 175  |
|                       |                              |                             |                                    | 2.5                           | 72  | 168                            | 240  |
| Swamp 305<br>SBL      | 4.0                          | 2                           | 6.0                                | 1.5                           | 26  | 124                            | 150  |
|                       |                              |                             |                                    | 2.0                           | 26  | 174                            | 200  |
|                       |                              |                             |                                    | 2.5                           | 26  | 234                            | 260  |
| Swamp 306<br>SBL      | 3.0                          | 2                           | 5.0                                | 1.5                           | 21  | 69                             | 90   |
|                       |                              |                             |                                    | 2.0                           | 21  | 104                            | 125  |
|                       |                              |                             |                                    | 2.5                           | 21  | 149                            | 170  |
| Swamp 307<br>SBL      | 3.0                          | 2                           | 5.0                                | 1.5                           | 21  | 49                             | 75   |
|                       |                              |                             |                                    | 2.0                           | 21  | 74                             | 90   |
|                       |                              |                             |                                    | 2.5                           | 21  | 99                             | 120  |

Note: <sup>1</sup> The estimated time for construction includes all hold times (where present) between the different stage of construction.

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Prepared By: TZ/CN

Reviewed By: JPD/JMAC



# **FOUNDATION REPORT – WICK DRAIN TREATMENT AREAS – PHASE 3** **HIGHWAY 69 G.W.P. 5203-06-00**

**TABLE 4 – SUMMARY OF RECOMMENDED WICK DRAIN LAYOUT REQUIREMENTS**

| <b>Swamp Crossing</b>          | <b>Wick Drain Details</b> |                     |   |                                    |   |
|--------------------------------|---------------------------|---------------------|---|------------------------------------|---|
|                                | <b>Spacing</b>            | <b>Grid Pattern</b> | <b>Lateral Extent</b>   | <b>Longitudinal Extent</b>         | <b>Vertical Extent</b>  |
| Swamp 302 SBL – Highway 69 SBL | 2.0 m                     | Triangular          | Between embankment toes plus two (2) rows (i.e. 4 m) beyond embankment toes | Approximately STA 17+750 to 18+125 | From a minimum depth of 7.5 m (Elevation 179 m) to a maximum depth of 11 m (Elevation 178 m) <sup>1</sup> |
| Swamp 302 NBL – Highway 69 NBL | 2.0 m                     | Triangular          | Between embankment toes plus two (2) rows (i.e. 4 m) beyond embankment toes | Approximately STA 17+750 to 18+100 | From a minimum depth of 6.5 m (Elevation 180 m) to a maximum depth of 11 m (Elevation 175 m) <sup>1</sup> |
| Swamp 305 SBL – Highway 69 SBL | 1.5 m                     | Triangular          | Between embankment toes plus two (2) rows (i.e. 3 m) beyond embankment toes | Approximately STA 16+075 to 16+325 | From a minimum depth of 13 m (Elevation 174.5 m) to a maximum depth of 24 m (Elevation 161.5 m)           |
| Swamp 306 SBL – Highway 69 SBL | 2.0 m                     | Triangular          | Between embankment toes plus two (2) rows (i.e. 4 m) beyond embankment toes | Approximately STA 15+360 to 15+750 | From a minimum depth of 6 m (Elevation 185 m) to a maximum depth of 13 m (Elevation 176 m)                |
| Swamp 307 SBL – Highway 69 SBL | 2.5 m                     | Triangular          | Between embankment toes plus two (2) rows (i.e. 5 m) beyond embankment toes | Approximately STA 14+425 to 14+490 | From a minimum depth of 12.5 m (Elevation 180.5 m) to a maximum depth of 14 m (Elevation 179 m)           |

Note: <sup>1</sup> Pre-drilling through the compact to very dense sand to silt (up to a depth of about 5 m between about STA 17+750 and 17+900 (SBL) and between STA 17+750 and 17+850 (NBL)) will be required to facilitate wick drain installation.

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Prepared By: TZ/CN

Reviewed By: JPD/JMAC



# **FOUNDATION REPORT – WICK DRAIN TREATMENT AREAS – PHASE 3** **HIGHWAY 69 G.W.P. 5203-06-00**

**TABLE 5 – SUMMARY OF STAGED CONSTRUCTION**

| <i><b>Swamp Crossing</b></i>  | <i><b>Stage No.</b></i> | <i><b>Fill Height (m)</b></i> | <i><b>Total Height of Embankment (m)</b></i> | <i><b>Fill Type</b></i> | <i><b>Unit Weight of Fill (kN/m<sup>3</sup>)</b></i> | <i><b>Estimated Time to Start of Filling (Day)</b></i> | <i><b>Estimated Time to End of Filling (Day)</b></i> | <i><b>Hold Time Before Next Stage (days)</b></i> |
|---|-------------------------|-------------------------------|--|-------------------------|--|--|--|--|
| Swamp 302 SBL/NBL<br><br>Highway 69 SBL–<br>STA 17+750 to 18+125<br>Highway 69 NBL–<br>STA 17+750 to 18+100<br>(2.0 m Triangular Wick<br>Drain Spacing) | 1                       | 1.5                           | 1.5  | Rock Fill               | 19   | 1  | 8  | 0  |
|   | 2                       | 1.5                           | 3  | Rock Fill               | 19   | 8  | 15   | 0  |
|   | 3                       | 1.5                           | 4.5  | Rock Fill               | 19   | 15   | 22   | 0  |
|   | 4                       | 1.5                           | 6  | Rock Fill               | 19   | 22   | 29   | 0  |
|   | 5                       | 0.5                           | 6.5  | Rock Fill               | 19   | 29   | 31.5   | 14.5   |
|   | 6                       | 2.0                           | 8.5  | Granular Fill           | 21   | 46   | 53   | 123  |
| Estimated Time to Surcharge Removal   |                         |                               |  |                         |  | 176  |  |  |
| Swamp 305 SBL<br><br>Highway 69 SBL –<br>STA 16+075 to 16+325<br>(1.5 m Triangular Wick<br>Drain Spacing)   | 1                       | 1.5                           | 1.5  | Rock Fill               | 19   | 1  | 8  | 0  |
|   | 2                       | 1.5                           | 3  | Rock Fill               | 19   | 8  | 15   | 0  |
|   | 3                       | 0.5                           | 4  | Rock Fill               | 19   | 15   | 20   | 0  |
|   | 4                       | 2.0                           | 6  | Granular Fill           | 21   | 20   | 27   | 124  |
| Estimated Time to Surcharge Removal   |                         |                               |  |                         |  | 151  |  |  |
| Swamp 306 SBL<br><br>Highway 69 SBL –<br>STA 15+360 to 15+750<br>(2.0 m Triangular Wick<br>Drain Spacing)   | 1                       | 1.5                           | 1.5  | Rock Fill               | 19   | 1  | 8  | 0  |
|   | 2                       | 1.5                           | 3  | Rock Fill               | 19   | 8  | 15   | 0  |
|   | 3                       | 2.0                           | 5  | Granular Fill           | 21   | 15   | 22   | 104  |
| Estimated Time to Surcharge Removal   |                         |                               |  |                         |  | 126  |  |  |
| Swamp 307 SBL<br><br>Highway 69 SBL –<br>STA 14+425 to 14+490<br>(2.5 m Triangular Wick<br>Drain Spacing)   | 1                       | 1.5                           | 1.5  | Rock Fill               | 19   | 1  | 8  | 0  |
|   | 2                       | 1.5                           | 3  | Rock Fill               | 19   | 8  | 15   | 0  |
|   | 3                       | 2.0                           | 5  | Granular Fill           | 21   | 15   | 22   | 99   |
| Estimated Time to Surcharge Removal   |                         |                               |  |                         |  | 121  |  |  |

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**Prepared By:** TZ/CN **Reviewed By:** JPD/JMAC



# **FOUNDATION REPORT – WICK DRAIN TREATMENT AREAS – PHASE 3** **HIGHWAY 69 G.W.P. 5203-06-00**

**TABLE 6 – SUMMARY OF EXCAVATION OF ORGANICS AND COMPRESSIBLE SOILS**

| <i><b>Borehole / DCPT No.</b></i>                            | <i><b>Station and Offset</b></i> | <i><b>Ground Surface<br/>Elevation<br/>(m)</b></i> | <i><b>Bottom of Excavation<br/>Elevation<br/>(m)</b></i> | <i><b>Depth of<br/>Excavation<br/>(m)</b></i> |
|--|----------------------------------|--|--|---|
| <b>Swamp 302 SBL – Highway 69 SBL – STA 17+750 to 18+125</b> |                                  |  |  |   |
| 302-24   | STA 17+750 CL                    | 188.5  | 187.5  | 1.0   |
| 302-26   | STA 17+775 o/s<br>34.1 m Lt      | 189.0  | 188.0  | 1.0   |
| 302-27   | STA 17+775 CL                    | 189.0  | 187.5  | 1.5   |
| 302-29   | STA 17+800 o/s<br>18.8 m Lt      | 189.0  | 187.5  | 1.5   |
| 302-31   | STA 17+825 o/s<br>40.5 m Lt      | 189.5  | 188.5  | 1.0   |
| 302-32   | STA 17+825 CL                    | 188.4  | 187.4  | 1.0   |
| 302-34   | STA 17+850 o/s<br>18.8 m Lt      | 188.4  | 186.5  | 1.9   |
| 302-36   | STA 17+875 o/s<br>34.1 m Lt      | 188.5  | 187.5  | 1.0   |
| 302-37   | STA 17+875 CL                    | 186.5  | 185.4  | 1.1   |
| 302-39   | STA 17+900 o/s<br>18.8 m Lt      | 186.5  | 185.5  | 1.0   |
| D5-2   | STA 17+901 o/s<br>13.1 m Lt      | 186.3  | 185.3  | 1.0   |
| 302-41   | STA 17+925 o/s<br>34.8 m Lt      | 186.7  | 185.7  | 1.0   |
| 302-42   | STA 17+925 CL                    | 186.5  | 184.5  | 2.0   |
| 302-44   | STA 17+950 o/s<br>18.8 m Lt      | 186.5  | 184.4  | 2.1   |
| 302-46   | STA 17+975 o/s<br>34.1 m Lt      | 186.5  | 185.5  | 1.0   |
| 302-47   | STA 17+975 CL                    | 186.5  | 185.4  | 1.1   |



## FOUNDATION REPORT – WICK DRAIN TREATMENT AREAS – PHASE 3 HIGHWAY 69 G.W.P. 5203-06-00

**TABLE 6 – SUMMARY OF EXCAVATION OF ORGANICS AND COMPRESSIBLE SOILS**

| <i>Borehole / DCPT No.</i>                                   | <i>Station and Offset</i>   | <i>Ground Surface Elevation (m)</i> | <i>Bottom of Excavation Elevation (m)</i> | <i>Depth of Excavation (m)</i> |
|--|-----------------------------|-------------------------------------|---|--------------------------------|
| 302-49   | STA 18+000 o/s<br>18.8 m Lt | 186.5                               | 185.1                                     | 1.4                            |
| 302-51   | STA 18+025 o/s<br>34.0 m Lt | 186.5                               | 185.5                                     | 1.0                            |
| 302-52   | STA 18+025 CL               | 186.5                               | 185.0                                     | 1.5                            |
| 302-54   | STA 18+050 o/s<br>18.8 m Lt | 186.5                               | 185.5                                     | 1.0                            |
| 302-56   | STA 18+075 o/s<br>44.5 m Lt | 186.8                               | 185.8                                     | 1.0                            |
| 302-57   | STA 18+075 CL               | 186.5                               | 185.4                                     | 1.1                            |
| 302-59   | STA 18+100 o/s<br>18.8 m Lt | 186.3                               | 185.3                                     | 1.0                            |
| 302-61   | STA 18+125 o/s 38.0<br>Lt   | 186.2                               | 185.1                                     | 1.1                            |
| 302-62   | STA 18+125 CL               | 186.5                               | 185.0                                     | 1.5                            |
| <b>Swamp 302 NBL – Highway 69 NBL – STA 17+750 to 18+100</b> |                             |                                     |   |                                |
| 302-25   | STA 17+750 o/s<br>18.8 m Rt | 188.5                               | 186.5                                     | 2.0                            |
| 302-27   | STA 17+775 CL               | 189.0                               | 187.5                                     | 1.5                            |
| 302-28   | STA 17+775 o/s<br>34.1 m Rt | 188.2                               | 187.2                                     | 1.0                            |
| 302-30   | STA 17+800 o/s<br>18.8 m Rt | 188.0                               | 187.0                                     | 1.0                            |
| 302-32   | STA 17+825 CL               | 188.4                               | 187.4                                     | 1.0                            |
| 302-33   | STA 17+825 o/s              | 186.5                               | 183.9                                     | 2.6                            |



# **FOUNDATION REPORT – WICK DRAIN TREATMENT AREAS – PHASE 3** **HIGHWAY 69 G.W.P. 5203-06-00**

**TABLE 6 – SUMMARY OF EXCAVATION OF ORGANICS AND COMPRESSIBLE SOILS**

| <i><b>Borehole / DCPT No.</b></i> | <i><b>Station and Offset</b></i> | <i><b>Ground Surface<br/>Elevation<br/>(m)</b></i> | <i><b>Bottom of Excavation<br/>Elevation<br/>(m)</b></i> | <i><b>Depth of<br/>Excavation<br/>(m)</b></i> |
|-----------------------------------|----------------------------------|--|--|---|
|                                   | 35.4 m Rt                        |  |  |   |
| 302-35                            | STA 17+850 o/s<br>18.8 m Rt      | 186.5  | 184.3  | 2.2   |
| 302-37                            | STA 17+875 CL                    | 186.5  | 185.4  | 1.1   |
| 302-38                            | STA 17+875<br>o/s 35.4 m Rt      | 186.5  | 184.5  | 2.0   |
| 302-40                            | STA 17+900 o/s<br>18.8 m Rt      | 186.5  | 184.4  | 2.1   |
| 302-42                            | STA 17+925 CL                    | 186.5  | 184.5  | 2.0   |
| 302-43                            | STA 17+925 o/s<br>34.8 m Rt      | 186.5  | 184.4  | 2.1   |
| 302-45                            | STA 17+950 o/s<br>18.8 m Rt      | 186.5  | 185.5  | 1.0   |
| 302-47                            | STA 17+975 CL                    | 186.5  | 185.4  | 1.1   |
| 302-48                            | STA 17+975 o/s<br>34.1 m Rt      | 186.5  | 185.0  | 1.5   |
| 302-50                            | STA 18+000 o/s<br>18.8 m Rt      | 186.5  | 185.5  | 1.0   |
| D5-3                              | STA 18+001.5 o/s<br>14.1 m Rt    | 186.5  | 185.5  | 1.0   |
| D5-4                              | STA 18+002.5 o/s<br>54.1 m Rt    | 186.3  | 185.1  | 1.2   |
| 302-52                            | STA 18+025 CL                    | 186.5  | 185.0  | 1.5   |





# **FOUNDATION REPORT – WICK DRAIN TREATMENT AREAS – PHASE 3** **HIGHWAY 69 G.W.P. 5203-06-00**

**TABLE 6 – SUMMARY OF EXCAVATION OF ORGANICS AND COMPRESSIBLE SOILS**

| <i><b>Borehole / DCPT No.</b></i>                            | <i><b>Station and Offset</b></i> | <i><b>Ground Surface<br/>Elevation<br/>(m)</b></i> | <i><b>Bottom of Excavation<br/>Elevation<br/>(m)</b></i> | <i><b>Depth of<br/>Excavation<br/>(m)</b></i> |
|--|----------------------------------|--|--|---|
| 302-53   | STA 18+025 o/s<br>24.1 m Rt      | 186.5  | 184.0  | 2.5   |
| 302-55   | STA 18+050 o/s<br>18.8 m Rt      | 186.5  | 185.3  | 1.2   |
| 302-57   | STA 18+075 CL                    | 186.5  | 185.4  | 1.1   |
| 302-58   | STA 18+075 o/s<br>44.5 m Rt      | 186.5  | 185.0  | 1.5   |
| 302-60   | STA 18+100 o/s<br>18.8 m Rt      | 186.5  | 185.3  | 1.2   |
| D5-5   | STA 18+101 o/s<br>31.3 m Rt      | 186.5  | 184.5  | 2.0   |
| <b>Swamp 305 SBL – Highway 69 SBL – STA 16+075 to 16+325</b> |                                  |  |  |   |
| 305-9  | STA 16+075 o/s<br>58.5 m Lt      | 188.1  | 185.9  | 2.2   |
| 305-10   | STA 16+075 o/s<br>20.5 m Lt      | 187.0  | 181.8  | 5.2   |
| D3-2   | STA 16+099 o/s<br>17.5 m Lt      | 185.8  | 184.6  | 1.2   |
| 305-13   | STA 16+100 o/s<br>38.8 m Lt      | 186.6  | 181.8  | 4.8   |
| 305-15   | STA 16+125 o/s<br>58.5 m Lt      | 186.5  | 184.5  | 2.0   |
| 305-16   | STA 16+125 o/s<br>20.5 m Lt      | 186.3  | 183.9  | 2.4   |



## FOUNDATION REPORT – WICK DRAIN TREATMENT AREAS – PHASE 3 HIGHWAY 69 G.W.P. 5203-06-00

**TABLE 6 – SUMMARY OF EXCAVATION OF ORGANICS AND COMPRESSIBLE SOILS**

| <i>Borehole / DCPT No.</i> | <i>Station and Offset</i>   | <i>Ground Surface<br/>Elevation<br/>(m)</i> | <i>Bottom of Excavation<br/>Elevation<br/>(m)</i> | <i>Depth of<br/>Excavation<br/>(m)</i> |
|----------------------------|-----------------------------|---|---|--|
| D3-5                       | STA 16+139 o/s<br>76.0 m Lt | 187.0                                       | 184.0   | 3.0                                    |
| 305-19                     | STA 16+150 o/s<br>38.8 m Lt | 186.9                                       | 183.9   | 3.0                                    |
| D3-4                       | STA 16+152 o/s<br>18.3 m Lt | 186.4                                       | 183.9   | 2.5                                    |
| 305-21                     | STA 16+175 o/s<br>58.5 m Lt | 186.9                                       | 184.0   | 2.9                                    |
| 305-22                     | STA 16+175 o/s<br>20.5 m Lt | 186.3                                       | 184.0   | 2.3                                    |
| D3-6                       | STA 16+181 o/s<br>13.0 m Lt | 186.8                                       | 183.3   | 3.5                                    |
| 305-25                     | STA 16+200 38.8 m Lt        | 187.2                                       | 183.5   | 3.7                                    |
| 305-27                     | STA 16+225 o/s<br>58.5 m Lt | 186.0                                       | 183.0   | 3.0                                    |
| 305-28                     | STA 16+225 o/s<br>20.5 m Lt | 187.2                                       | 183.4   | 3.8                                    |
| 305-29                     | STA 16+225 o/s 2.5 m<br>Lt  | 186.7                                       | 184.0   | 2.7                                    |
| 305-31                     | STA 16+250 o/s<br>38.8 m Lt | 186.9                                       | 182.5   | 4.4                                    |
| D3-9                       | STA 16+251 o/s<br>14.9 m Lt | 186.6                                       | 184.8   | 1.8                                    |
| D3-10                      | STA 16+257 o/s              | 186.4                                       | 183.8   | 2.6                                    |



# **FOUNDATION REPORT – WICK DRAIN TREATMENT AREAS – PHASE 3** **HIGHWAY 69 G.W.P. 5203-06-00**

**TABLE 6 – SUMMARY OF EXCAVATION OF ORGANICS AND COMPRESSIBLE SOILS**

| <i><b>Borehole / DCPT No.</b></i>                            | <i><b>Station and Offset</b></i> | <i><b>Ground Surface<br/>Elevation<br/>(m)</b></i> | <i><b>Bottom of Excavation<br/>Elevation<br/>(m)</b></i> | <i><b>Depth of<br/>Excavation<br/>(m)</b></i> |
|--|----------------------------------|--|--|---|
|  | 90.0 m Lt                        |  |  |   |
| 305-33   | STA 16+275 o/s<br>60.5 m Lt      | 186.0  | 181.4  | 4.6   |
| 305-34   | STA 16+275 o/s<br>18.5 m Lt      | 187.5  | 182.0  | 5.5   |
| 305-37   | STA 16+300 o/s<br>38.8 m Lt      | 187.5  | 182.0  | 5.5   |
| 305-39   | STA 16+325 o/s<br>50.5 m Lt      | 191.5  | 190.9  | 0.6   |
| 305-40   | STA 16+325 o/s<br>28.5 m Lt      | 191.2  | 191.2  | 0.0   |
| <b>Swamp 306 SBL – Highway 69 SBL – STA 15+360 to 15+750</b> |                                  |  |  |   |
| 306-15   | STA 15+375 o/s<br>54.5 m Lt      | 191.2  | 190.1  | 1.1   |
| 306-16   | STA 15+375 o/s<br>14.5 m Lt      | 189.0  | 186.0  | 3.0   |
| 306-17   | STA 15+375 o/s 5.5 m<br>Lt       | 189.1  | 187.6  | 1.5   |
| 306-19   | STA 15+400 o/s<br>38.8 m Lt      | 189.1  | 186.7  | 2.4   |
| 306-21   | STA 15+425 o/s<br>60.5 m Lt      | 190.2  | 188.7  | 1.5   |
| 306-22   | STA 15+425 o/s/<br>18.5 m Lt     | 188.9  | 187.0  | 1.9   |



## FOUNDATION REPORT – WICK DRAIN TREATMENT AREAS – PHASE 3 HIGHWAY 69 G.W.P. 5203-06-00

TABLE 6 – SUMMARY OF EXCAVATION OF ORGANICS AND COMPRESSIBLE SOILS

| <i>Borehole / DCPT No.</i> | <i>Station and Offset</i> | <i>Ground Surface Elevation (m)</i> | <i>Bottom of Excavation Elevation (m)</i> | <i>Depth of Excavation (m)</i> |
|----------------------------|---------------------------|-------------------------------------|---|--------------------------------|
| 306-23                     | STA 15+425 o/s 1.5 m Lt   | 189.0                               | 187.5                                     | 1.5                            |
| 306-25                     | STA 15+450 o/s 38.8 m Lt  | 189.5                               | 186.8                                     | 2.7                            |
| 306-27                     | STA 15+475 o/s 58.5 m Lt  | 189.2                               | 187.0                                     | 2.2                            |
| D2-2                       | STA 15+480 o/s 75 m Lt    | 189.2                               | 187.7                                     | 1.5                            |
| D2-3                       | STA 15+480 o/s 20 m Lt    | 189.3                               | 187.8                                     | 1.5                            |
| 306-28                     | STA 15+475 o/s 20.5 m Lt  | 189.2                               | 187.6                                     | 1.6                            |
| 306-31                     | STA 15+500 o/s 38.8 m Lt  | 189.2                               | 187.7                                     | 1.5                            |
| 306-33                     | STA 15+525 o/s 56.5 m Lt  | 189.2                               | 187.7                                     | 1.5                            |
| 306-34                     | STA 15+525 o/s 22.5 m Lt  | 189.1                               | 187.5                                     | 1.6                            |
| 306-37                     | STA 15+550 o/s 38.8 m Lt  | 189.3                               | 187.8                                     | 1.5                            |
| 306-39                     | STA 15+575 o/s 56.5 m Lt  | 189.2                               | 187.7                                     | 1.5                            |
| 306-40                     | STA 15+575 o/s 22.5 m Lt  | 189.3                               | 187.8                                     | 1.5                            |



## FOUNDATION REPORT – WICK DRAIN TREATMENT AREAS – PHASE 3 HIGHWAY 69 G.W.P. 5203-06-00

**TABLE 6 – SUMMARY OF EXCAVATION OF ORGANICS AND COMPRESSIBLE SOILS**

| <i>Borehole / DCPT No.</i> | <i>Station and Offset</i> | <i>Ground Surface Elevation (m)</i> | <i>Bottom of Excavation Elevation (m)</i> | <i>Depth of Excavation (m)</i> |
|----------------------------|---------------------------|-------------------------------------|---|--------------------------------|
| D2-5                       | STA 15+580 o/s 75 m Lt    | 189.4                               | 187.9                                     | 1.5                            |
| D2-6                       | STA 15+580 o/s 20 m Lt    | 189.4                               | 187.9                                     | 1.5                            |
| 306-43                     | STA 15+600 o/s 38.8 m Lt  | 189.5                               | 188.0                                     | 1.5                            |
| 306-45                     | STA 15+625 o/s 56.5 m Lt  | 190.1                               | 188.6                                     | 1.5                            |
| 306-46                     | STA 15+625 o/s 22.5 m Lt  | 189.6                               | 188.1                                     | 1.5                            |
| 306-49                     | STA 15+650 o/s 38.8 m Lt  | 189.1                               | 187.6                                     | 1.5                            |
| 306-51                     | STA 15+675 o/s 52.5 m Lt  | 190.2                               | 188.7                                     | 1.5                            |
| 306-52                     | STA 15+675 o/s 26.5 m Lt  | 189.8                               | 188.3                                     | 1.5                            |
| 306-55                     | STA 15+700 o/s 38.8 m Lt  | 189.9                               | 188.4                                     | 1.5                            |
| 306-57                     | STA 15+725 o/s 48.5 m Lt  | 190.5                               | 189.0                                     | 1.5                            |
| 306-58                     | STA 15+725 o/s 30.5 m Lt  | 190.0                               | 188.5                                     | 1.5                            |
| 306-61                     | STA 15+750 o/s 38.8 m Lt  | 190.7                               | 189.2                                     | 1.5                            |



# **FOUNDATION REPORT – WICK DRAIN TREATMENT AREAS – PHASE 3** **HIGHWAY 69 G.W.P. 5203-06-00**

**TABLE 6 – SUMMARY OF EXCAVATION OF ORGANICS AND COMPRESSIBLE SOILS**

| <i><b>Borehole / DCPT No.</b></i>                            | <i><b>Station and Offset</b></i> | <i><b>Ground Surface<br/>Elevation<br/>(m)</b></i> | <i><b>Bottom of Excavation<br/>Elevation<br/>(m)</b></i> | <i><b>Depth of<br/>Excavation<br/>(m)</b></i> |
|--|----------------------------------|--|--|---|
| <b>Swamp 307 SBL – Highway 69 SBL – STA 14+425 to 14+490</b> |                                  |  |  |   |
| 307-19   | STA 14+425 o/s<br>38.8 m Lt      | 193.0  | 191.0  | 2.0   |
| 307-21   | STA 14+437.5 o/s<br>52.5 m Lt    | 192.7  | 190.7  | 2.0   |
| 307-22   | STA 14+437.5 o/s<br>38.8 m Lt    | 193.0  | 191.0  | 2.0   |
| 307-23   | STA 14+437.5 o/s<br>22.5 m Lt    | 193.0  | 191.0  | 2.0   |
| 307-26   | STA 14+450 o/s<br>56.5 m Lt      | 193.0  | 191.0  | 2.0   |
| 307-27   | STA 14+450 o/s<br>38.8 m Lt      | 192.7  | 190.7  | 2.0   |
| 307-28   | STA 14+450 o/s<br>22.5 m Lt      | 192.7  | 190.7  | 2.0   |
| 307-30   | STA 14+462.5 o/s<br>56.5 m Lt    | 193.0  | 191.0  | 2.0   |
| 307-31   | STA 14+462.5 o/s<br>22.5 m Lt    | 193.0  | 191.0  | 2.0   |
| 307-32   | STA 14+462.5 o/s/<br>4.0 m Lt    | 193.0  | 191.0  | 2.0   |
| 307-34   | STA 14+475 o/s<br>38.8 m Lt      | 192.7  | 190.3  | 2.4   |
| 307-36   | STA 14+487.5 o/s                 | 193.0  | 193.0  | 0.0   |





## FOUNDATION REPORT – WICK DRAIN TREATMENT AREAS – PHASE 3 HIGHWAY 69 G.W.P. 5203-06-00

**TABLE 6 – SUMMARY OF EXCAVATION OF ORGANICS AND COMPRESSIBLE SOILS**

| <i>Borehole / DCPT No.</i> | <i>Station and Offset</i>     | <i>Ground Surface<br/>Elevation<br/>(m)</i> | <i>Bottom of Excavation<br/>Elevation<br/>(m)</i> | <i>Depth of<br/>Excavation<br/>(m)</i> |
|----------------------------|-------------------------------|---|---|--|
|                            | 58.5 m Lt                     |   |   |  |
| 307-37                     | STA 14+487.5 o/s<br>20.5 m Lt | 193.4                                       | 191.4   | 2.0                                    |

\\mis1-s-filesrv1\data\active\2006\1111\06-1111-025 mrc hwy 69-522 to 64 french river\reporting\wick drain embankments\final\tables\06-1111-025-1 tbl6 summary of excavation of organics and compressible soils.docx

Prepared By: CN

Reviewed By: JPD/JMAC



## FOUNDATION REPORT – WICK DRAIN TREATMENT AREAS – PHASE 3 HIGHWAY 69 G.W.P. 5203-06-00

**TABLE 7 – SUMMARY OF EMBANKMENT PLATFORM WIDENING REQUIREMENTS**

| <b>Swamp Crossing</b>                      | <b>Wick Drain Spacing and Grid Pattern</b> | <b>Time from Start of Construction to Removal of Surcharge (days)</b> | <b>Estimated Settlement From Start of Construction to 10 Years Following Removal of Surcharge<sup>1</sup> (mm)</b> | <b>Assumed Side Slope of Pavement Structure</b> | <b>Minimum Embankment Platform Widening Per Side (m)</b> |
|--|--|---|--|---|--|
| Swamp 302 SBL/NBL – Highway 69 SBL and NBL | 2.0 m Triangular                           | 175   | 400+55   | 4H:1V   | 3.0  |
| Swamp 305 SBL – Highway 69 SBL             | 1.5 m Triangular                           | 150   | 300+35   | 4H:1V   | 2.5  |
| Swamp 306 SBL – Highway 69 SBL             | 2.0 m Triangular                           | 125   | 505+15   | 4H:1V   | 3.0  |
| Swamp 307 SBL – Highway 69 SBL             | 2.5 m Triangular                           | 155   | 115+20   | 4H:1V   | 2.0  |

Note: <sup>1</sup> Estimated settlement includes the primary and secondary (i.e. creep) consolidation of the cohesive deposits plus rock fill settlement, but does not include the immediate settlement of the granular fill/sand blanket and foundation soils.

\\mis1-s-filesrv1\data\active\2006\1111\06-1111-025 mrc hwy 69-522 to 64 french river\reporting\wick drain embankments\final\tables\06-1111-025-1 tbl7 summary of embankment platform widening requirements.docx

Prepared By: CN

Reviewed By: JPD/JMAC





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



CONT No.  
GWP No. 5203-06-00

# HIGHWAY 69 WICK DRAIN FOUNDATION TREATMENT SWAMP AREAS SITE LOCATION PLAN



**Golder Associates Ltd.**  
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN  
NOT TO SCALE

NOTE

APPROXIMATE LOCATION OF SWAMP AREAS  
(REFER TO DRAWING 2)

## REFERENCE

Base Data – MNR NRVIS, obtained 2004, CANMAP v2006.4  
Produced by Golder Associates Ltd under licence from  
Ontario Ministry of Natural Resources, © Queens Printer 2008  
Datum : NAD 83 Projection : MTM Zone 10

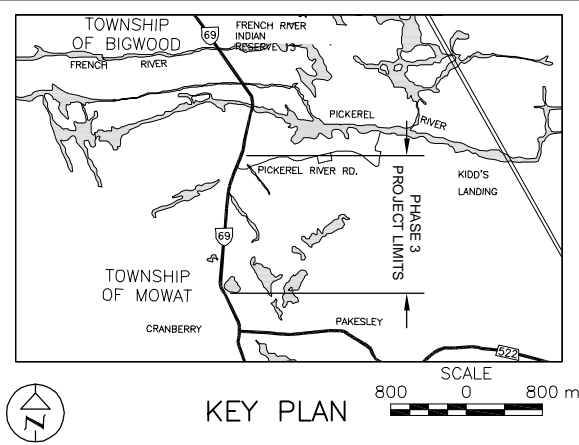
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| NO.                 | DATE     | BY                      | REVISION |        |  |
| Geocres No. 41H-106 |          |                         |          |        |  |
| HWY. 69             |          | PROJECT NO. 06-1111-Q25 |          | DIST.  |  |
| SUBM'D. VA          | CHKD. VA | DATE: Feb. 2012         |          | SITE:  |  |
| DRAWN: DD/RJ        | CHKD. VA | APPD. JPD/JMAC          |          | DWG. 1 |  |







**Golder Associates Ltd.**  
MISSISSAUGA, ONTARIO, CANADA



Base plans provided in digital format by MRC, drawing file no. PHASE 3 Plan 090211 – Golder.dwg, received February 11, 2009. Culverts provided in digital format by MRC, drawing file no. 6454 Culvert xsect Phase 3 – Mainline 090930.dwg received Oct. 02, 2009. KEY PLAN obtained from a digital file provided by CALLON DIETZ drawing file no. C-748-069-2.dwg received April 23, 2009.

|                     |      |          |                         |  |        |
|---------------------|------|----------|-------------------------|--|--------|
|                     |      |          |                         |  |        |
|                     |      |          |                         |  |        |
|                     |      |          |                         |  |        |
|                     |      |          |                         |  |        |
|                     |      |          |                         |  |        |
| NO.                 | DATE | BY       | REVISION                |  |        |
| Geocres No. 41H-106 |      |          |                         |  |        |
| HWY. 69             |      |          | PROJECT NO. 06-1111-025 |  | DIST.  |
| SUBM'D. VA          |      | CHKD. VA | DATE: Feb. 2012         |  | SITE:  |
| DRAWN: JFC/RJ       |      | CHKD. VA | APPD. JPD/JMAC          |  | DWG. 2 |





**APRIL 2012**

## **FOUNDATION INVESTIGATION AND DESIGN REPORT**

**WICK DRAIN FOUNDATION TREATMENT AREAS - PHASE 3  
HIGHWAY 69 FOUR-LANING  
FROM 3.5 KM NORTH OF HIGHWAY 522  
NORTHERLY TO 4.5 KM NORTH OF HIGHWAY 64  
MINISTRY OF TRANSPORTATION, ONTARIO  
G.W.P. 5203-06-00  
VOLUME 2 of 2**

**Submitted to:**

McCormick Rankin, a member of MMM Group Limited  
2655 North Sheridan Way  
Mississauga, Ontario  
L5K 2P8



**REPORT**

**GEOCRES No:** 41H-106

**Report Number:** 06-1111-025-1

**Distribution:**

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| 3 Copies | Ministry of Transportation, Ontario, North Bay, Ontario, (Northeastern Region) |
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| Figure B.S305-5        | Consolidation Test Summary – BH 305-1, SA 7                              |
| Figure B.S305-6        | Consolidation Test Summary – BH 305-3, SA 1                              |
| Figure B.S305-7        | Consolidated Undrained Triaxial Test with PWP – BH 305-1, SA 7           |
| Figure B.S305-8        | Consolidated Undrained Triaxial Test with PWP – BH 305-2, SA 2           |



## FOUNDATION REPORT – WICK DRAIN TREATMENT AREAS – PHASE 3 – HIGHWAY 69 G.W.P. 5203-06-00

|                 |  |
|-----------------|--|
| Figure B.S305-9 | Consolidated Undrained Triaxial Test with PWP – BH 305-3, SA 1         |
| Table B1        | Summary of Foundation Engineering Parameters                           |
| Figure B1       | Summary Plot of Engineering Parameters for Cohesive Deposits           |
| Figure B2       | CPT Pore Pressure Dissipation Tests                                    |
| Figure B3       | Slope Stability – Total Stress Analysis – STA 16+200                   |
| Figure B4       | Slope Stability – Effective Stress Analysis – STA 16+200               |
| Figure B5       | Excess Pore Pressure Response below Embankment Centreline – STA 16+200 |
| Figure B6       | Time-Rate Settlement at Embankment Centreline – STA 16+200             |

### **Appendix C Highway 69 SBL – STA 15+350 to 15+800 (Swamp 306 SBL)**

|                        |  |
|------------------------|--|
| Record of Boreholes    | 306-1 and 306-2  |
| Cone Penetration Tests | 306-1 to 306-6   |
| Drawing C1             | Borehole Location and Soil Strata                                      |
| Figure C.306-1         | Grain Size Distribution – Clay   |
| Figure C.306-2         | Plasticity Chart – Clay to Clayey Silt                                 |
| Figure C.306-3         | Consolidation Test Summary – BH 306-1, SA 5                            |
| Figure C.306-4         | Consolidation Test Summary – BH 306-2, SA 3                            |
| Figure C.306-5         | Consolidated Undrained Triaxial Test with PWP – BH 306-1, SA 5         |
| Figure C.306-6         | Consolidated Undrained Triaxial Test with PWP – BH 306-2, SA 3         |
| Table C1               | Summary of Foundation Engineering Parameters                           |
| Figure C1              | Summary Plot of Engineering Parameters for Cohesive Deposits           |
| Figure C2              | CPT Pore Pressure Dissipation Tests                                    |
| Figure C3-1            | Slope Stability – Total Stress Analysis – STA 15+400                   |
| Figure C3-2            | Slope Stability – Total Stress Analysis – STA 15+550                   |
| Figure C4-1            | Slope Stability – Effective Stress Analysis – STA 15+400               |
| Figure C4-2            | Slope Stability – Effective Stress Analysis – STA 15+550               |
| Figure C5-1            | Excess Pore Pressure Response below Embankment Centreline – STA 15+400 |
| Figure C5-2            | Excess Pore Pressure Response below Embankment Centreline – STA 15+550 |
| Figure C6-1            | Time-Rate Settlement at Embankment Centreline – STA 15+400             |
| Figure C6-2            | Time-Rate Settlement at Embankment Centreline – STA 15+550             |

### **Appendix D Highway 69 SBL – STA 14+425 to 14+500 (Swamp 307 SBL)**

|                        |  |
|------------------------|--|
| Record of Borehole     | 307-1  |
| Cone Penetration Tests | 307-1 and 307-2  |
| Drawing D1             | Borehole Location and Soil Strata                                      |
| Figure D.S307-1        | Plasticity Chart – Clayey Silt to Clay                                 |
| Figure D.S307-2        | Consolidation Test Summary – BH 307-1, SA 6                            |
| Figure D.S307-3        | Consolidation Test Summary – BH 307-1, SA 7                            |
| Figure D.S307-4        | Consolidated Undrained Triaxial Test with PWP – BH 307-1, SA 6         |
| Figure D.S307-5        | Consolidated Undrained Triaxial Test with PWP – BH 307-1, SA 7         |
| Table D1               | Summary of Foundation Engineering Parameters                           |
| Figure D1              | Summary Plot of Engineering Parameters for Cohesive Deposits           |
| Figure D2              | CPT Pore Pressure Dissipation Tests                                    |
| Figure D3              | Slope Stability – Total Stress Analysis – STA 14+460                   |
| Figure D4              | Slope Stability – Effective Stress Analysis – STA 14+460               |
| Figure D5              | Excess Pore Pressure Response below Embankment Centreline – STA 14+460 |
| Figure D6              | Time-Rate Settlement at Embankment Centreline – STA 14+460             |

### **Appendix E Highway 69 SBL – STA 13+160 to 13+450 (Swamp 310 SBL)**

|                        |                                   |
|------------------------|-----------------------------------|
| Record of Boreholes    | 310-1 and 310-2                   |
| Cone Penetration Tests | 310-1 to 310-4                    |
| Drawing E1             | Borehole Location and Soil Strata |
| Figure E.S310-1        | Plasticity Chart – Clay           |



## FOUNDATION REPORT – WICK DRAIN TREATMENT AREAS – PHASE 3 – HIGHWAY 69 G.W.P. 5203-06-00

### Appendix F Investigation by Others

#### Swamp 302 SBL/NBL

|                     |   |
|---------------------|---|
| Record of Boreholes | 302-19 to 302-21, 302-23 to 302-25, 302-27, 302-29 to 302-35, 302-37, 302-39 to 302-41, 302-43 to 302-45, 302-47, 302-49 to 302-51, 302-53 to 302-55, 302-57, 302-59, 302-60 and 302-63 to 302-65 |
| Record of DCPTs     | 302-22, 302-26, 302-28, 302-36, 302-38, 302-42, 302-46, 302-48, 302-52, 302-56, 302-58 and 302-62   |

#### Swamp 305 SBL

|                     |   |
|---------------------|---|
| Record of Boreholes | 305-7, 305-9, 305-13, 305-16, 305-19, 305-21, 305-25, 305-28, 305-31, 305-33, 305-37, 305-39, 305-40 and 305-43 |
| Record of DCPTs     | 305-10, 305-15, 305-22, 305-27, and 305-34  |

#### Swamp 306 SBL

|                     |   |
|---------------------|---|
| Record of Boreholes | 306-13, 306-16, 306-19, 306-21, 306-25, 306-28, 306-31, 306-33, 306-37, 306-40, 306-43, 306-45, 306-49, 306-52, 306-55, 306-61, 306-63, 306-64, 306-65 and 306-68 |
| Record of DCPTs     | 306-15, 306-22, 306-27, 306-34, 306-39, 306-46, 306-51 and 306-58   |

#### Swamp 307 SBL

|                     |   |
|---------------------|---|
| Record of Boreholes | 307-19, 307-21, 307-23, 307-27, 307-28, 307-34, 307-36, 307-37 and 307-40 |
| Record of DCPTs     | 307-22, 307-26, 307-30 and 307-31   |

#### Swamp 310 SBL

|                     |                                       |
|---------------------|---------------------------------------|
| Record of Boreholes | 310-1, 310-4, 310-7, 310-9 and 310-13 |
| Record of DCPTs     | 310-3 and 310-10                      |

### Appendix G Non-Standard Special Provisions and Operational Constraints

Excavation of Organics and Compressible Soils – Item No.  
Drainage Blanket – Item No.  
Wick Drains – Item No.  
Supply and Installation of Embankment Monitoring Equipment – Item No.  
Embankment Construction in Wick Drain Areas – Item No.

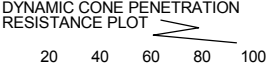
### Appendix H Monitoring Instrumentation Specifications

|   |   |
|---|---|
| Drawing H1  | Embankment Monitoring Program – Plan, Sections – Type A |
| Drawing H2  | Embankment Monitoring Program – Plan, Sections – Type B |
| Drawing H3  | Embankment Monitoring Program – Plan, Sections – Type C |
| Drawing H4  | Typical Instrument Installation Details                 |
| Drawing H5  | Monitoring Section Location Plans – Swamp 302           |
| Drawing H6  | Monitoring Section Location Plans – Swamp 305           |
| Drawing H7  | Monitoring Section Location Plans – Swamp 306           |
| Drawing H8  | Monitoring Section Location Plans – Swamp 307           |
| Foundation Monitoring Program – Item No. (For Contract Administration Assignment) |   |



# **APPENDIX A**

**Highway 69 SBL and NBL – STA 17+700 to 18+150  
(Swamp 302 SBL/NBL)**

| PROJECT 06-1111-025   |   |            | RECORD OF BOREHOLE No 302-1                                    |      |            | 1 OF 1 METRIC           |                 |   |                                 |                               |                                |                  |  |  |
|---|---|------------|--|------|------------|-------------------------|-----------------|---|---------------------------------|-------------------------------|--------------------------------|------------------|--|--|
| G.W.P. 5203-06-00   |   |            | LOCATION N 5093962.4 ; E 221675.2                              |      |            | ORIGINATED BY MWK       |                 |   |                                 |                               |                                |                  |  |  |
| DIST _____ HWY 69   |   |            | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers |      |            | COMPILED BY MWK         |                 |   |                                 |                               |                                |                  |  |  |
| DATUM Geodetic  |   |            | DATE March 2, 2009   |      |            | CHECKED BY VA           |                 |   |                                 |                               |                                |                  |  |  |
| SOIL PROFILE  |   |            | SAMPLES  |      |            | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT<br><br>SHEAR STRENGTH kPa<br>○ UNCONFINED + FIELD VANE<br>● QUICK TRIAXIAL × REMOULDED | PLASTIC LIMIT<br>W <sub>p</sub> | NATURAL MOISTURE CONTENT<br>W | LIQUID LIMIT<br>W <sub>L</sub> | UNIT WEIGHT<br>γ | REMARKS & GRAIN SIZE DISTRIBUTION (%)<br>GR SA SI CL |  |
| ELEV<br>DEPTH   | DESCRIPTION   | STRAT PLOT | NUMBER   | TYPE | "N" VALUES |                         |                 |   |                                 |                               |                                |                  |  |  |
| 186.3<br>0.0  | ICE SURFACE<br>Ice and Snow                         |            |  |      |            |                         | 186             |   |                                 |                               |                                |                  |  |  |
| 185.8<br>0.5  | Organic CLAYEY SILT<br>Very soft<br>Grey<br>Wet     |            | 1  | SS   | WH         |                         | 185             |   |                                 |                               |                                |                  |  |  |
|   |   |            | 2  | SS   | WH         |                         | 184             |   |                                 |                               |                                |                  |  |  |
|   |   |            | 3  | TO   | PH         |                         | 183             |   |                                 |                               |                                |                  |  |  |
| 183.3<br>3.1  | CLAY, some silt<br>Very soft to firm<br>Grey<br>Wet |            | 5  | SS   | WH         |                         | 182             |   |                                 |                               |                                |                  |  |  |
|   |   |            | 6  | TO   | PH         |                         | 181             |   |                                 |                               |                                |                  |  |  |
|   |   |            |  |      |            |                         | 180             |   |                                 |                               |                                |                  |  |  |
| 180.2<br>6.1  | CLAYEY SILT<br>Soft<br>Grey<br>Wet                  |            | 7  | TO   | PH         |                         | 179             |   |                                 |                               |                                |                  |  |  |
|   |   |            |  |      |            |                         | 178             |   |                                 |                               |                                |                  |  |  |
|   |   |            | 8  | TO   | PH         |                         | 177             |   |                                 |                               |                                |                  |  |  |
| 177.2<br>9.1  | SILT, containing sand seams<br>Loose<br>Grey<br>Wet |            | 9  | SS   | 8          |                         |                 |   |                                 |                               |                                |                  |  |  |
| 176.6<br>9.8  | END OF BOREHOLE                                     |            |  |      |            |                         |                 |   |                                 |                               |                                |                  |  |  |
| NOTES:<br>1. Borehole caved at ice surface (Elev. 186.3 m) upon removal of augers.<br>2. Water level inside augers at a depth of 0.5 m below ice surface (Elev. 185.8 m) upon completion of drilling. |   |            |  |      |            |                         |                 |   |                                 |                               |                                |                  |  |  |



| PROJECT 06-1111-025   |  | RECORD OF BOREHOLE No 302-2                                    |        | 1 OF 1 METRIC           |                 |  |            |                                 |                               |                                |                  |                                       |
|---|--|--|--------|-------------------------|-----------------|--|------------|---------------------------------|-------------------------------|--------------------------------|------------------|---------------------------------------|
| G.W.P. 5203-06-00   |  | LOCATION N 5093807.7 ; E 221670.0                              |        | ORIGINATED BY MWK       |                 |  |            |                                 |                               |                                |                  |                                       |
| DIST _____ HWY 69   |  | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers |        | COMPILED BY MWK         |                 |  |            |                                 |                               |                                |                  |                                       |
| DATUM Geodetic  |  | DATE March 2, 2009   |        | CHECKED BY VA/JPD       |                 |  |            |                                 |                               |                                |                  |                                       |
| SOIL PROFILE  |  | SAMPLES  |        | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT |            | PLASTIC LIMIT<br>W <sub>p</sub> | NATURAL MOISTURE CONTENT<br>W | LIQUID LIMIT<br>W <sub>L</sub> | UNIT WEIGHT<br>γ | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
| ELEV<br>DEPTH   | DESCRIPTION  | STRAT PLOT   | NUMBER |                         |                 | TYPE                                     | "N" VALUES |                                 |                               |                                |                  |                                       |
| 186.1   | ICE SURFACE  |  |        |                         |                 |  |            |                                 |                               |                                |                  |                                       |
| 0.0   | Ice and Snow   |  |        |                         |                 |  |            |                                 |                               |                                |                  |                                       |
| 185.3   | PEAT, containing wood fragments, (Fibrous)<br>Very soft<br>Dark brown<br>Wet |  | 1      | SS                      | WH              |  |            |                                 |                               |                                | 524.1            | OC = 36.2%                            |
| 183.6   | CLAY, some silt<br>Very soft to stiff<br>Brown and grey<br>Wet               |  | 2      | SS                      | 2               |  |            |                                 |                               |                                | 65.1             |                                       |
|   |  |  | 3      | TO                      | PH              |  |            |                                 |                               |                                | 85.5             | C/CIU                                 |
| 180.0   | CLAYEY SILT<br>Soft to firm<br>Grey<br>Wet                                   |  | 4      | TO                      | PH              |  |            |                                 |                               |                                | 15.6             |                                       |
| 175.4   |  |  |        |                         |                 |  |            |                                 |                               |                                | 20.4             | C                                     |
| 174.8   |  |  |        |                         |                 |  |            |                                 |                               |                                | 16.6             | C/CIU                                 |
| 174.8   |  |  |        |                         |                 |  |            |                                 |                               |                                | 18.1*            | C                                     |
| 175.4   | SILT, some sand, some clay<br>Loose<br>Grey<br>Wet                           |  | 6      | SS                      | 5               |  |            |                                 |                               |                                |                  |                                       |
| 11.3  | END OF BOREHOLE  |  |        |                         |                 |  |            |                                 |                               |                                |                  |                                       |
| NOTES:<br>1. Borehole caved at ice surface (Elev. 186.1 m) upon removal of augers.<br>2. Water level in open borehole at a depth of 0.8 m below ice surface (Elev. 185.3 m) upon completion of drilling.<br>* Bulk unit weight measured on consolidation test specimen for Vertically Trimmed Oedometer sample orientation. |  |  |        |                         |                 |  |            |                                 |                               |                                |                  |                                       |

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

GTA-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 1/27/12 SAC

| PROJECT 06-1111-025 |   |            |         | <b>RECORD OF BOREHOLE No 302-3</b>                             |            |                            |                 | 1 OF 2 <b>METRIC</b>                        |     |   |  |  |   |  |  |      |
|---------------------|---|------------|---------|--|------------|----------------------------|-----------------|---|-----|---|--|--|---|--|--|------|
| G.W.P. 5203-06-00   |   |            |         | LOCATION N 5093819.2 ; E 221633.7                              |            |                            |                 | ORIGINATED BY MWK                           |     |   |  |  |   |  |  |      |
| DIST _____ HWY 69   |   |            |         | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers |            |                            |                 | COMPILED BY MWK                             |     |   |  |  |   |  |  |      |
| DATUM Geodetic      |   |            |         | DATE March 3, 2009   |            |                            |                 | CHECKED BY VA                               |     |   |  |  |   |  |  |      |
| SOIL PROFILE        |   |            | SAMPLES |  |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |     | PLASTIC NATURAL LIQUID<br>LIMIT MOISTURE LIMIT<br>CONTENT |  |  | UNIT<br>WEIGHT<br>$\gamma$<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |  |      |
| ELEV<br>DEPTH       | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE   | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |     | WATER CONTENT (%)   |  |  |   |  |  |      |
| 188.2<br>0.0        | ICE SURFACE<br>Ice and Snow   |            |         |  |            | ▽                          | 188             |   |     |   |  |  |   |  |  |      |
| 187.6<br>0.6        | SAND, some silt<br>Very loose to compact<br>Brown to grey<br>Wet        |            | 1       | SS   | 18         |                            | 187             |   |     |   |  |  |   |  |  |      |
|                     |   |            |         |  |            |                            | 186             |   |     |   |  |  |   |  |  |      |
|                     |   |            |         |  |            |                            | 185             |   |     |   |  |  |   |  |  |      |
|                     |   |            | 2       | SS   | 6          |                            | 184             |   |     |   |  |  |   |  |  |      |
|                     |   |            | 3       | SS   | 3          |                            | 183             |   |     |   |  |  |   |  |  |      |
| 183.4<br>4.8        | SILTY CLAY<br>Firm to stiff<br>Grey<br>Wet                              |            | 4       | SS   | 3          |                            | 182             |   |     |   |  |  |   | 44.5   |  |      |
|                     |   |            |         |  |            |                            | 181             |   |     |   |  |  |   |  |  |      |
|                     |   |            |         |  | 5          |                            | TO              | PH  | 180 |   |  |  |   |  |  | 63.7 |
|                     |   |            |         |  | 6          |                            | TO              | PH  | 179 |   |  |  |   |  |  | 45.4 |
| 177.6<br>10.6       | SILT, trace to some clay, trace to<br>some sand<br>Loose<br>Grey<br>Wet |            | 7       | TO   | PH         | 178                        |                 |   |     |   |  |  |   |  |  |      |
|                     |   |            |         |  |            | 177                        |                 |   |     |   |  |  |   |  |  |      |
|                     |   |            |         |  | 8          | SS                         | 6               | 176   |     |   |  |  |   |  |  |      |
|                     |   |            |         |  | 9          | SS                         | 9               | 175   |     |   |  |  |   |  |  |      |
| 173.9<br>14.3       |   |            |         |  |            | 174                        |                 |   |     |   |  |  |   |  |  |      |

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

GTA-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 1/27/12 SAC

| PROJECT <u>06-1111-025</u>           |  | <b>RECORD OF BOREHOLE No 302-3</b>                                    |        |      |                            | 2 OF 2 <b>METRIC</b>     |  |                    |  |  |  |   |                                   |  |   |  |  |  |  |  |  |  |  |
|--------------------------------------|--|---|--------|------|----------------------------|--------------------------|--|--------------------|--|--|--|---|-----------------------------------|--|---|--|--|--|--|--|--|--|--|
| G.W.P. <u>5203-06-00</u>             |  | LOCATION <u>N 5093819.2 ; E 221633.7</u>                              |        |      |                            | ORIGINATED BY <u>MWK</u> |  |                    |  |  |  |   |                                   |  |   |  |  |  |  |  |  |  |  |
| DIST <u>          </u> HWY <u>69</u> |  | BOREHOLE TYPE <u>108 mm I.D. Continuous Flight Hollow Stem Augers</u> |        |      |                            | COMPILED BY <u>MWK</u>   |  |                    |  |  |  |   |                                   |  |   |  |  |  |  |  |  |  |  |
| DATUM <u>Geodetic</u>                |  | DATE <u>March 3, 2009</u>   |        |      |                            | CHECKED BY <u>VA</u>     |  |                    |  |  |  |   |                                   |  |   |  |  |  |  |  |  |  |  |
| SOIL PROFILE                         |  | SAMPLES   |        |      | GROUND WATER<br>CONDITIONS | ELEVATION SCALE          | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT  |                    |  |  |  | PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT |                                   |  | UNIT<br>WEIGHT<br><br><b>γ</b><br><br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br><br>GR SA SI CL |  |  |  |  |  |  |  |
| ELEV<br>DEPTH                        | DESCRIPTION  | STRAT PLOT  | NUMBER | TYPE |                            |                          | "N" VALUES   | SHEAR STRENGTH kPa |  |  |  |   | W <sub>p</sub> W   W <sub>L</sub> |  |   |  |  |  |  |  |  |  |  |
|                                      | --- CONTINUED FROM PREVIOUS PAGE ---   |   |        |      |                            |                          | <div style="display: flex; justify-content: space-between;"> <span>20 40 60 80 100</span> <span>20 40 60 80 100</span> </div> <div style="display: flex; justify-content: space-between;"> <span>○ UNCONFINED   + FIELD VANE</span> <span>● QUICK TRIAXIAL   × REMOULDED</span> </div> |                    |  |  |  | WATER CONTENT (%)                                       |                                   |  |   |  |  |  |  |  |  |  |  |
|                                      | END OF BOREHOLE<br><br>NOTES:<br><br>1. Borehole caved at a depth of 4.6 m below ice surface (Elev. 183.6 m) upon removal of augers.<br><br>2. Water level in open borehole at a depth of 0.6 m below ice surface (Elev. 187.6 m) upon completion of drilling. |   |        |      |                            |                          |  |                    |  |  |  |   |                                   |  |   |  |  |  |  |  |  |  |  |

| PROJECT 06-1111-025 |   | <b>RECORD OF BOREHOLE No 302-4</b>                             |         |      |            | 1 OF 2 <b>METRIC</b>                     |                 |   |  |  |  |
|---------------------|---|--|---------|------|------------|--|-----------------|---|--|--|--|
| G.W.P. 5203-06-00   |   | LOCATION N 5093721.8 ; E 221641.3                              |         |      |            | ORIGINATED BY MWK                        |                 |   |  |  |  |
| DIST _____ HWY 69   |   | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers |         |      |            | COMPILED BY MWK                          |                 |   |  |  |  |
| DATUM Geodetic      |   | DATE March 5, 2009   |         |      |            | CHECKED BY VA                            |                 |   |  |  |  |
| SOIL PROFILE        |   |  | SAMPLES |      |            | DYNAMIC CONE PENETRATION RESISTANCE PLOT |                 | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT |  | UNIT WEIGHT<br>$\gamma$<br>kN/m <sup>3</sup> | REMARKS & GRAIN SIZE DISTRIBUTION (%)<br>GR SA SI CL |
| ELEV<br>DEPTH       | DESCRIPTION   | STRAT PLOT   | NUMBER  | TYPE | "N" VALUES | GROUND WATER CONDITIONS                  | ELEVATION SCALE | SHEAR STRENGTH kPa                                  |  |  |  |
| 188.2<br>0.0        | ICE SURFACE<br>Ice and Snow   |  |         |      |            |  | 188             |   |  |  |  |
| 187.4<br>0.8        | Silty SAND<br>Compact<br>Brown<br>Wet   |  | 1       | SS   | 17         |  | 187             |   |  |  |  |
|                     |   |  |         |      |            |  | 186             |   |  |  |  |
|                     |   |  | 2       | SS   | 25         |  | 185             |   |  |  |  |
|                     |   |  |         |      |            |  | 184             |   |  |  |  |
| 183.6<br>4.6        | CLAY, varved<br>Very soft to stiff<br>Grey<br>Wet   |  | 3       | SS   | WH         |  | 183             |   |  |  |  |
|                     |   |  | 4       | TO   | PH         |  | 182             |   |  |  |  |
|                     |   |  |         |      |            |  | 181             |   |  |  |  |
|                     |   |  | 5       | TO   | PH         |  | 180             |   |  |  |  |
| 179.5<br>8.7        | SILT, some sand, some clay,<br>containing layers of clayey silt<br>Compact<br>Grey<br>Wet |  | 6       | TO   | PH         |  | 179             |   |  |  |  |
|                     |   |  |         |      |            |  | 178             |   |  |  |  |
|                     |   |  |         |      |            |  | 177             |   |  |  |  |
|                     |   |  | 7       | SS   | 10         |  | 176             |   |  |  |  |
|                     |   |  |         |      |            |  | 175             |   |  |  |  |
| 174.5<br>13.7       | SAND and SILT<br>Loose<br>Grey<br>Wet   |  | 8       | SS   | 6          |  | 174             |   |  |  |  |
| 173.9<br>14.3       |   |  |         |      |            |  |                 |   |  |  |  |

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

GTA-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 1/27/12 SAC

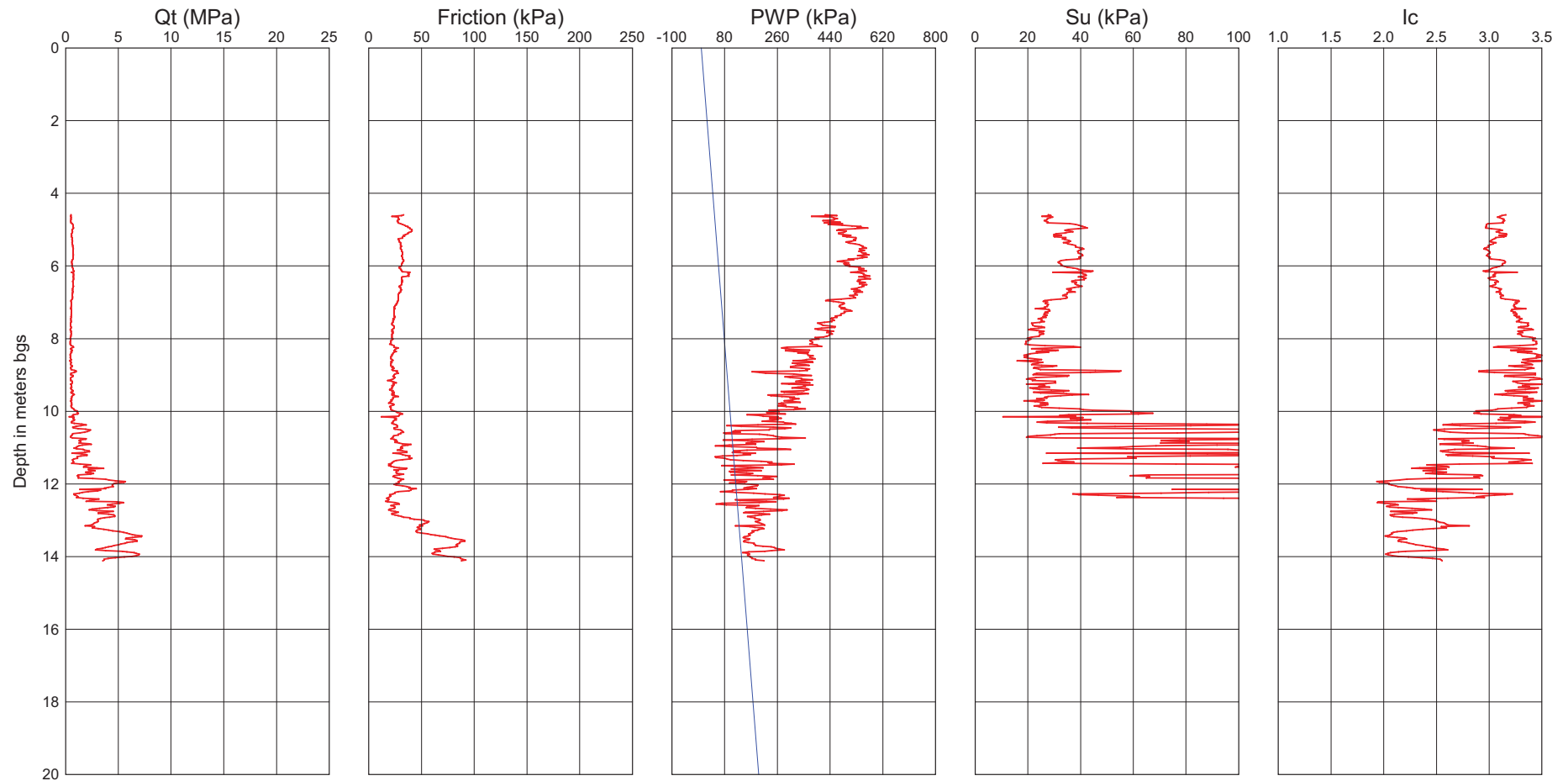
| PROJECT <u>06-1111-025</u>           |   | <b>RECORD OF BOREHOLE No 302-4</b>                                    |        |      |                            | 2 OF 2 <b>METRIC</b>     |  |                    |  |  |  |   |                |   |   |  |                |  |  |  |  |
|--------------------------------------|---|---|--------|------|----------------------------|--------------------------|--|--------------------|--|--|--|---|----------------|---|---|--|----------------|--|--|--|--|
| G.W.P. <u>5203-06-00</u>             |   | LOCATION <u>N 5093721.8 ; E 221641.3</u>                              |        |      |                            | ORIGINATED BY <u>MWK</u> |  |                    |  |  |  |   |                |   |   |  |                |  |  |  |  |
| DIST <u>          </u> HWY <u>69</u> |   | BOREHOLE TYPE <u>108 mm I.D. Continuous Flight Hollow Stem Augers</u> |        |      |                            | COMPILED BY <u>MWK</u>   |  |                    |  |  |  |   |                |   |   |  |                |  |  |  |  |
| DATUM <u>Geodetic</u>                |   | DATE <u>March 5, 2009</u>   |        |      |                            | CHECKED BY <u>VA</u>     |  |                    |  |  |  |   |                |   |   |  |                |  |  |  |  |
| SOIL PROFILE                         |   | SAMPLES   |        |      | GROUND WATER<br>CONDITIONS | ELEVATION SCALE          | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT  |                    |  |  |  | PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT |                |   | UNIT<br>WEIGHT<br><br><b>γ</b><br><br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br><br>GR SA SI CL |                |  |  |  |  |
| ELEV<br>DEPTH                        | DESCRIPTION   | STRAT PLOT  | NUMBER | TYPE |                            |                          | "N" VALUES   | SHEAR STRENGTH kPa |  |  |  |   | W <sub>p</sub> | W |   |  | W <sub>L</sub> |  |  |  |  |
|                                      | --- CONTINUED FROM PREVIOUS PAGE ---  |   |        |      |                            |                          | <div style="display: flex; justify-content: space-between; font-size: small;"> <span>20 40 60 80 100</span> <span>○ UNCONFINED   + FIELD VANE</span> </div> <div style="display: flex; justify-content: space-between; font-size: small;"> <span>● QUICK TRIAXIAL   × REMOULDED</span> <span>20 40 60 80 100</span> </div> |                    |  |  |  |   |                |   |   |  |                |  |  |  |  |
|                                      | END OF BOREHOLE<br><br>NOTE:<br><br>1. Water level in open borehole at ice surface (Elev. 188.2 m) upon completion of drilling. |   |        |      |                            |                          |  |                    |  |  |  |   |                |   |   |  |                |  |  |  |  |

# Cone Penetration Test - CPT302-1

Test Date : March 08, 2009  
Location : Highway 69 - STA 17+761 o/s 19.5 m Right

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 188.20  
Water Table Depth : 0.00



Qt normalized for  
unequal end area effects

$S_u = (Q_t - \sigma_v) / N_k$   
 $N_k = 15.5$   
 $\gamma = 17 \text{ kN/m}^3$

After Robertson and (Fear) Wride (1998)  
 $I_c < 1.31$  - Gravelly sands  
 $1.31 < I_c < 2.05$  - Clean to silty sand  
 $2.05 < I_c < 2.60$  - Silty sand to sandy silt  
 $2.60 < I_c < 2.95$  - Clayey silt to silty clay  
 $2.95 < I_c < 3.60$  - Clays

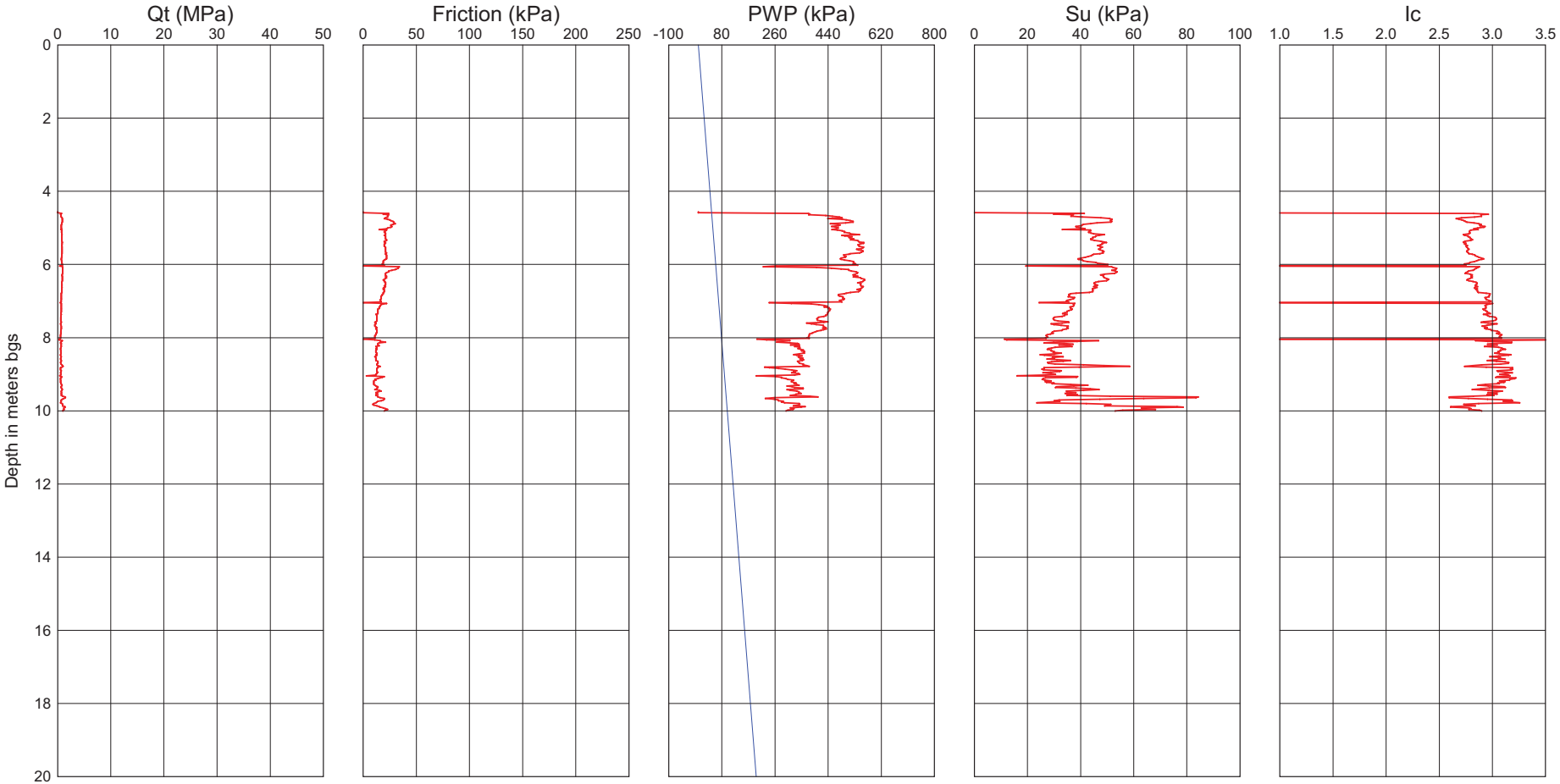


# Cone Penetration Test - CPT302-2

Test Date : March 08, 2009  
Location : Highway 69 - STA 17+761 o/s 18.5 m Right

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 188.20  
Water Table Depth : 0.00



Qt normalized for  
unequal end area effects

$S_u = (Q_t - \sigma_v) / N_k$   
 $N_k = 15.5$   
 $\gamma = 17 \text{ kN/m}^3$

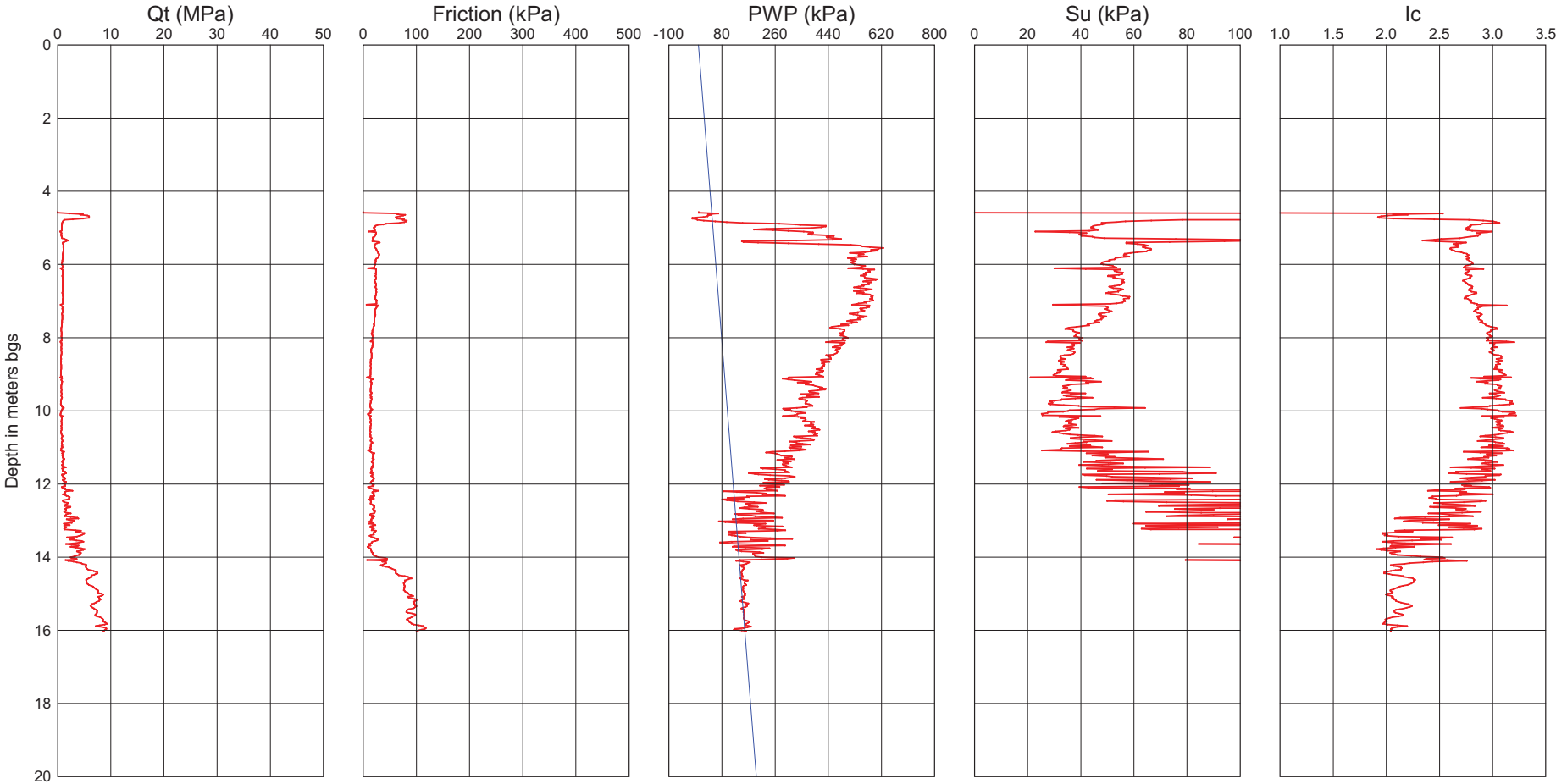
After Robertson and (Fear) Wride (1998)  
Ic < 1.31 - Gravelly sands  
1.31 < Ic < 2.05 - Clean to silty sand  
2.05 < Ic < 2.60 - Silty sand to sandy silt  
2.60 < Ic < 2.95 - Clayey silt to silty clay  
2.95 < Ic < 3.60 - Clays

# Cone Penetration Test - CPT302-3

Test Date : March 08, 2009  
Location : Highway 69 - STA 17+849 o/s 19 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 188.20  
Water Table Depth : 0.00



Qt normalized for  
unequal end area effects

$Su = (Qt - \sigma_v) / N_k$   
 $N_k = 15.5$   
 $\gamma = 17 \text{ kN/m}^3$

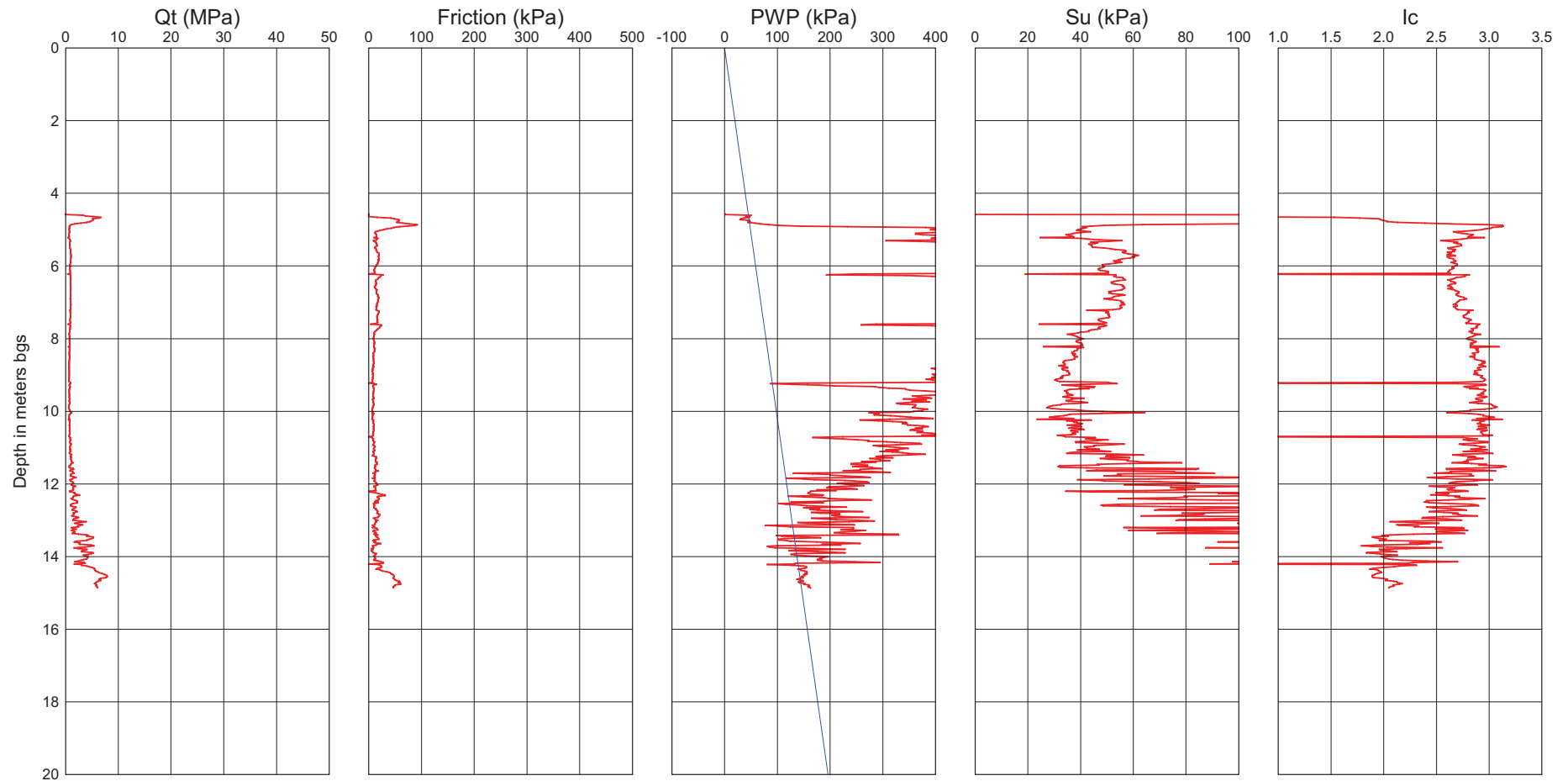
After Robertson and (Fear) Wride (1998)  
Ic < 1.31 - Gravelly sands  
1.31 < Ic < 2.05 - Clean to silty sand  
2.05 < Ic < 2.60 - Silty sand to sandy silt  
2.60 < Ic < 2.95 - Clayey silt to silty clay  
2.95 < Ic < 3.60 - Clays

# Cone Penetration Test - CPT302-4

Test Date : March 08, 2009  
Location : Highway 69 - STA 17+849 o/s 18.5 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 188.20  
Water Table Depth : 0.00



Qt normalized for  
unequal end area effects

$S_u = (Q_t - \sigma_v) / N_k$   
 $N_k = 15.5$   
 $\gamma = 17 \text{ kN/m}^3$

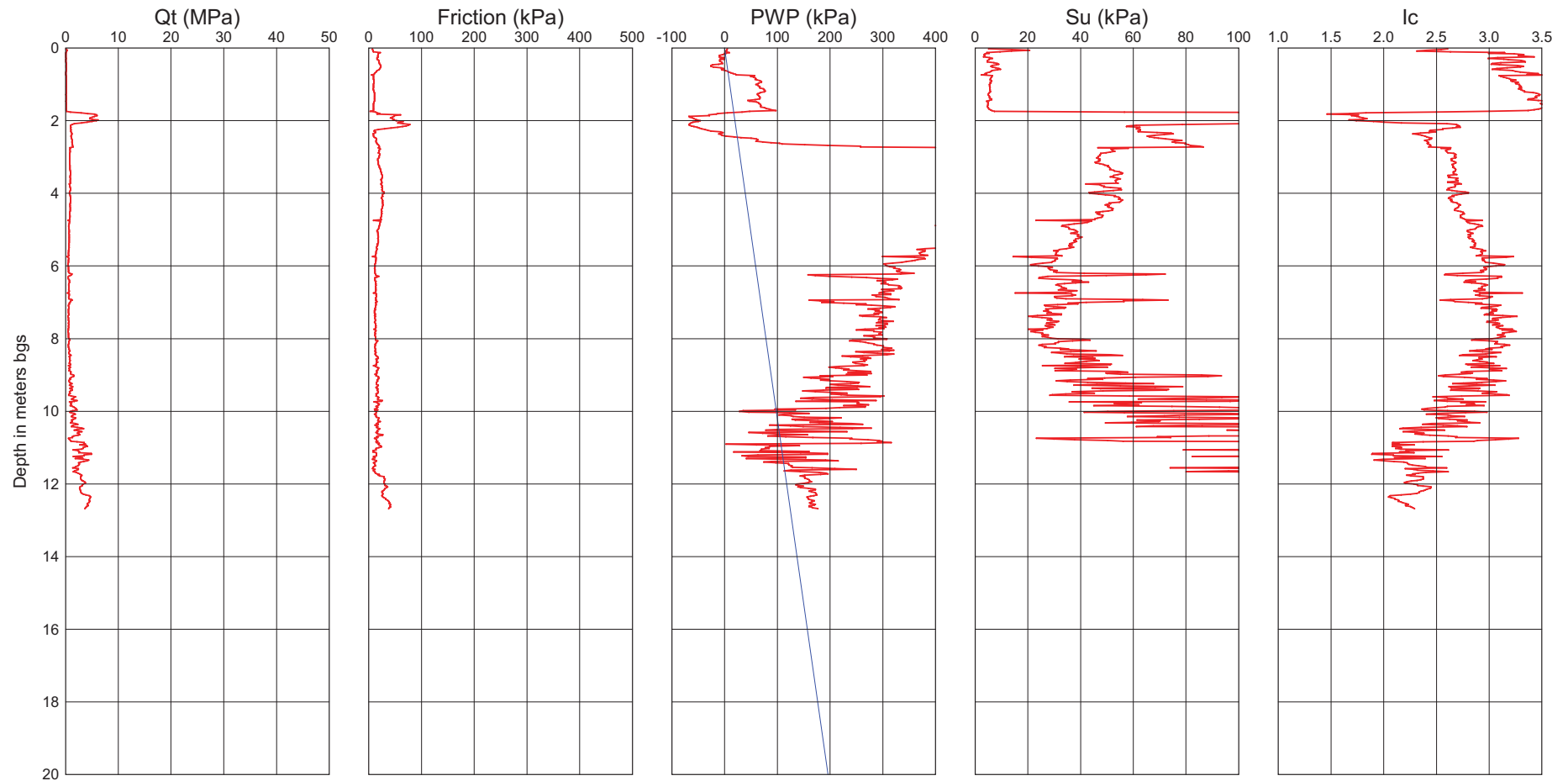
After Robertson and (Fear) Wride (1998)  
 $I_c < 1.31$  - Gravelly sands  
 $1.31 < I_c < 2.05$  - Clean to silty sand  
 $2.05 < I_c < 2.60$  - Silty sand to sandy silt  
 $2.60 < I_c < 2.95$  - Clayey silt to silty clay  
 $2.95 < I_c < 3.60$  - Clays

# Cone Penetration Test - CPT302-5

Test Date : March 08, 2009  
Location : Highway 69 - STA 17+851 o/s 19 m Right

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 186.10  
Water Table Depth : 0.00



Qt normalized for  
unequal end area effects

$S_u = (Q_t - \sigma_v) / N_k$   
 $N_k = 15.5$   
 $\gamma = 17 \text{ kN/m}^3$

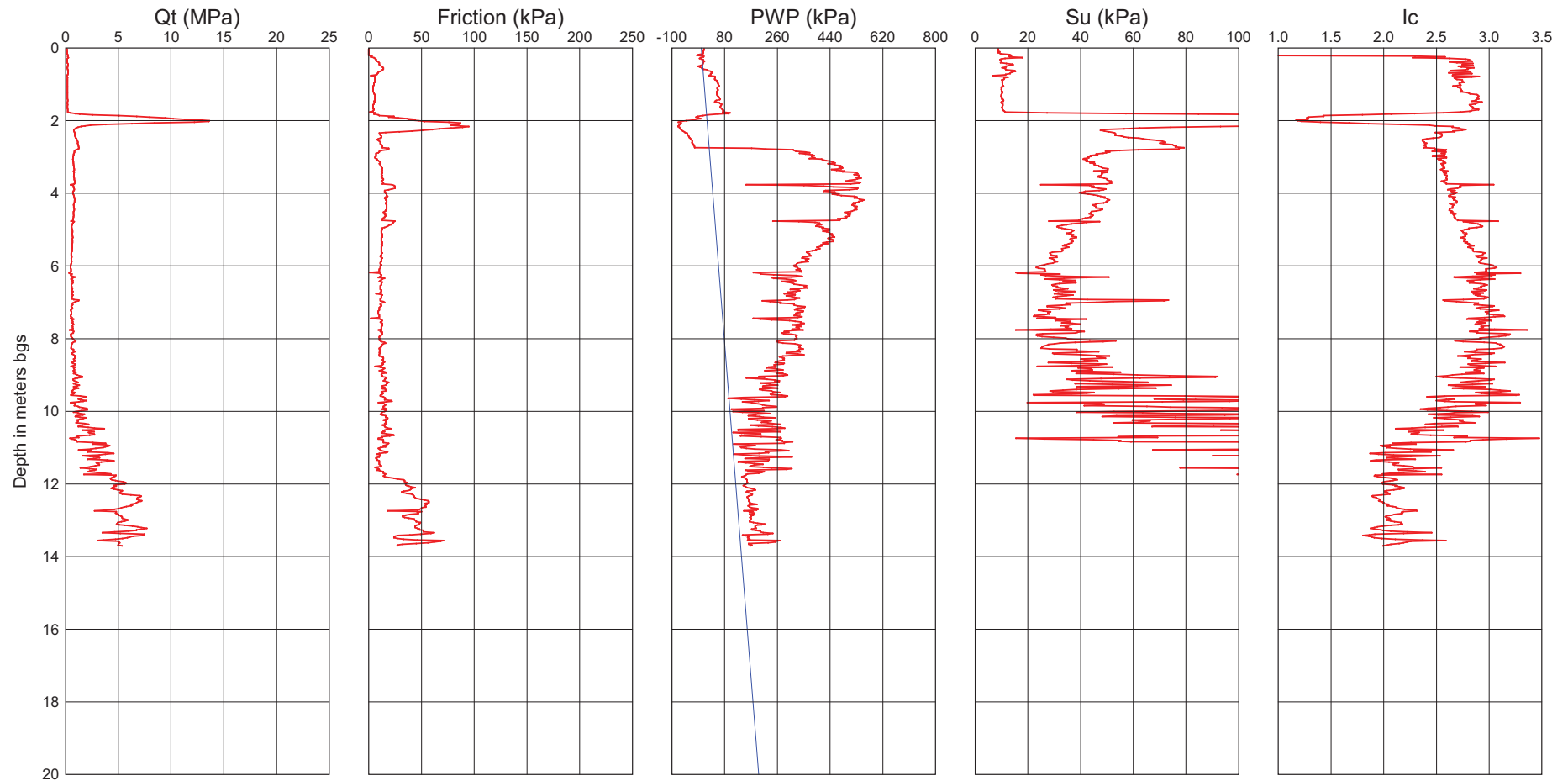
After Robertson and (Fear) Wride (1998)  
 $I_c < 1.31$  - Gravelly sands  
 $1.31 < I_c < 2.05$  - Clean to silty sand  
 $2.05 < I_c < 2.60$  - Silty sand to sandy silt  
 $2.60 < I_c < 2.95$  - Clayey silt to silty clay  
 $2.95 < I_c < 3.60$  - Clays

# Cone Penetration Test - CPT302-6

Test Date : Mach 08, 2009  
Location : Highway 69 - STA 17+852 o/s 19 m Right

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 186.10  
Water Table Depth : 0.00



Qt normalized for  
unequal end area effects

$Su = (Qt - \sigma_v) / N_k$   
 $N_k = 15.5$   
 $\gamma = 17 \text{ kN/m}^3$

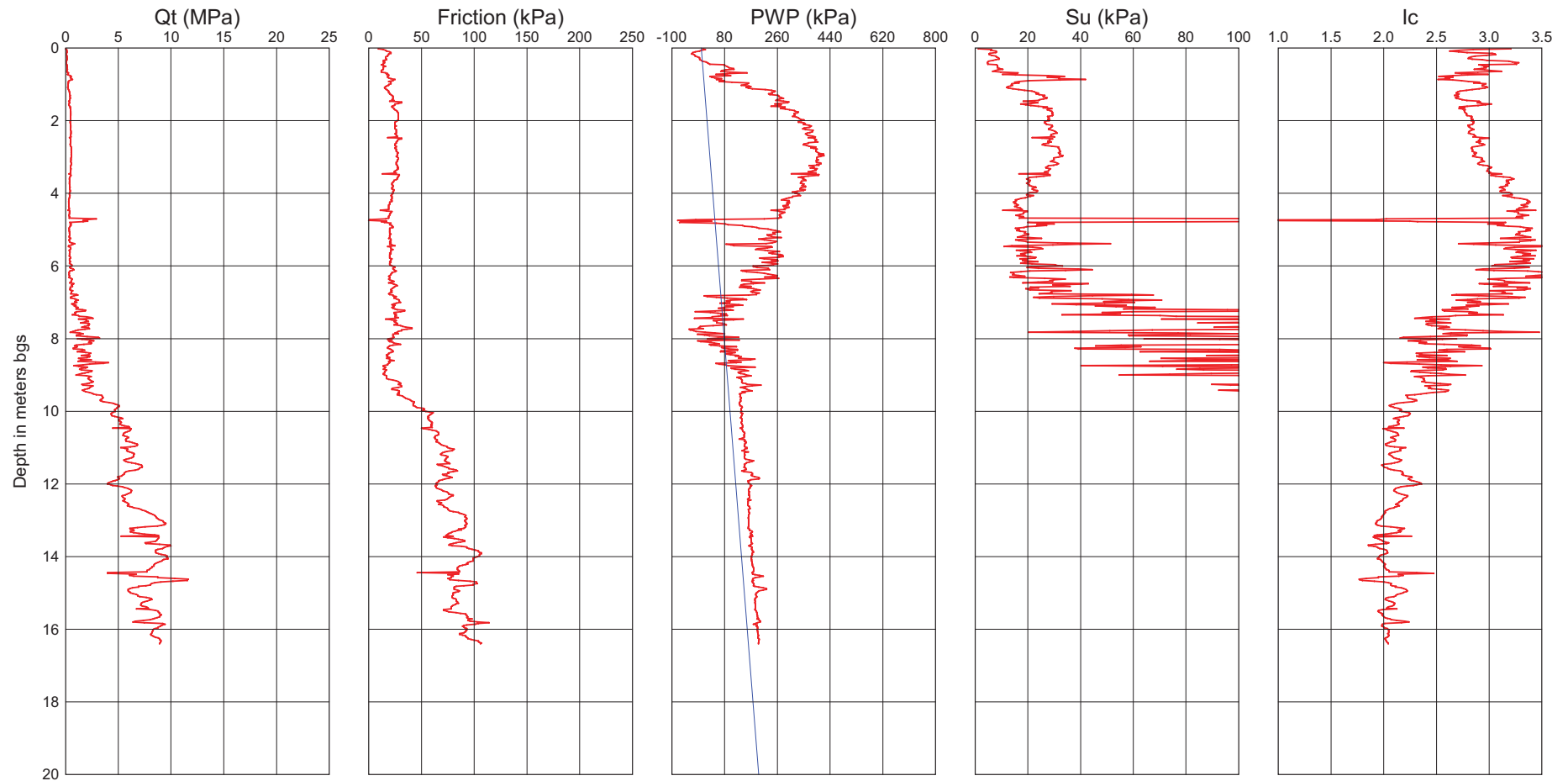
After Robertson and (Fear) Wride (1998)  
 $I_c < 1.31$  - Gravelly sands  
 $1.31 < I_c < 2.05$  - Clean to silty sand  
 $2.05 < I_c < 2.60$  - Silty sand to sandy silt  
 $2.60 < I_c < 2.95$  - Clayey silt to silty clay  
 $2.95 < I_c < 3.60$  - Clays

# Cone Penetration Test - CPT302-7

Test Date : March 08, 2009  
Location : Highway 69 - STA 18+001 o/s 19 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 186.30  
Water Table Depth : 0.00



Qt normalized for  
unequal end area effects

$S_u = (Q_t - \sigma_{vV}) / N_k$   
 $N_k = 15.5$   
 $\gamma = 17 \text{ kN/m}^3$

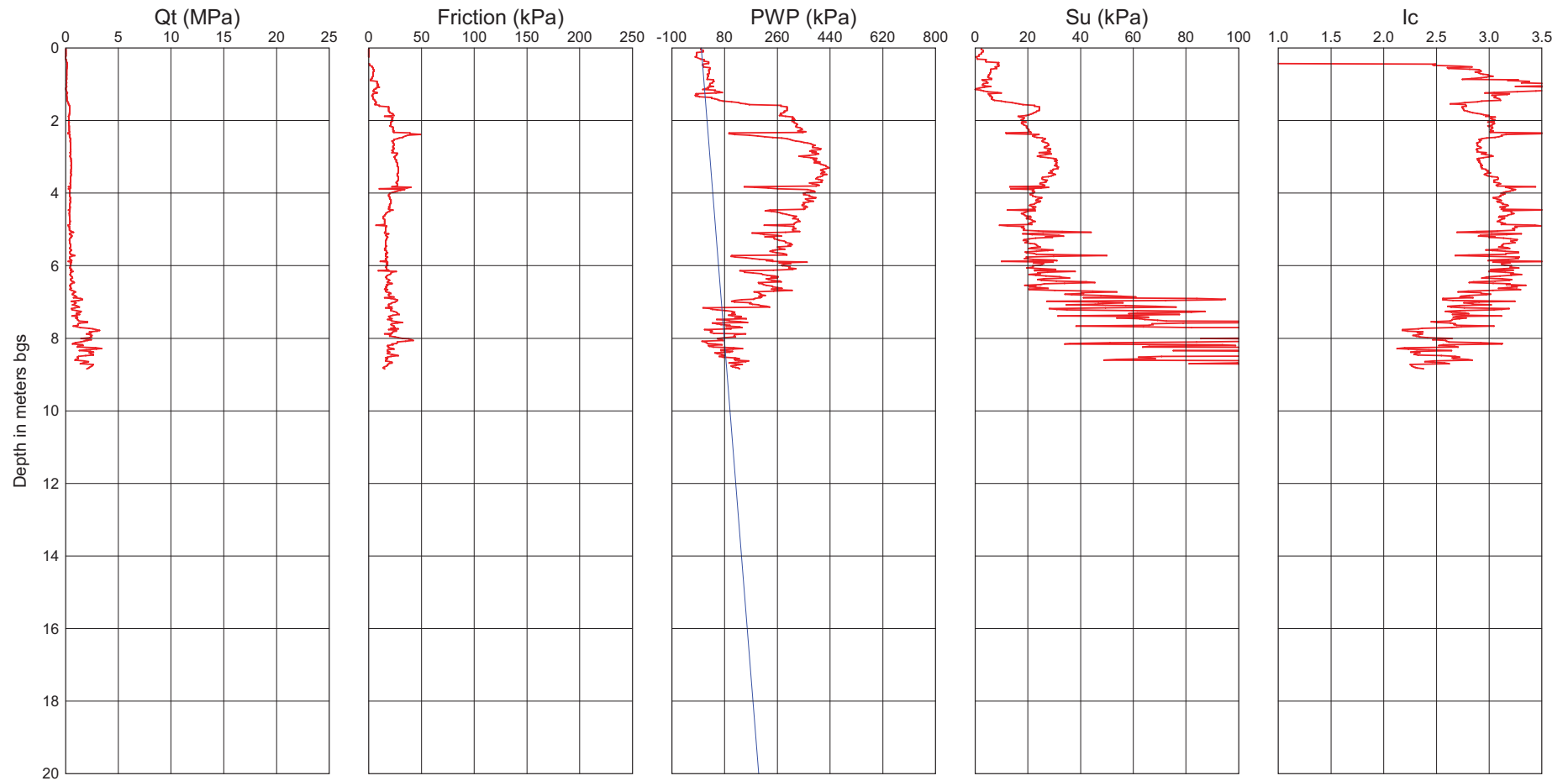
After Robertson and (Fear) Wride (1998)  
 $I_c < 1.31$  - Gravelly sands  
 $1.31 < I_c < 2.05$  - Clean to silty sand  
 $2.05 < I_c < 2.60$  - Silty sand to sandy silt  
 $2.60 < I_c < 2.95$  - Clayey silt to silty clay  
 $2.95 < I_c < 3.60$  - Clays

# Cone Penetration Test - CPT302-8

Test Date : March 08, 2008  
Location : Highway 69 - STA 18+001 o/s 18 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 186.30  
Water Table Depth : 0.00

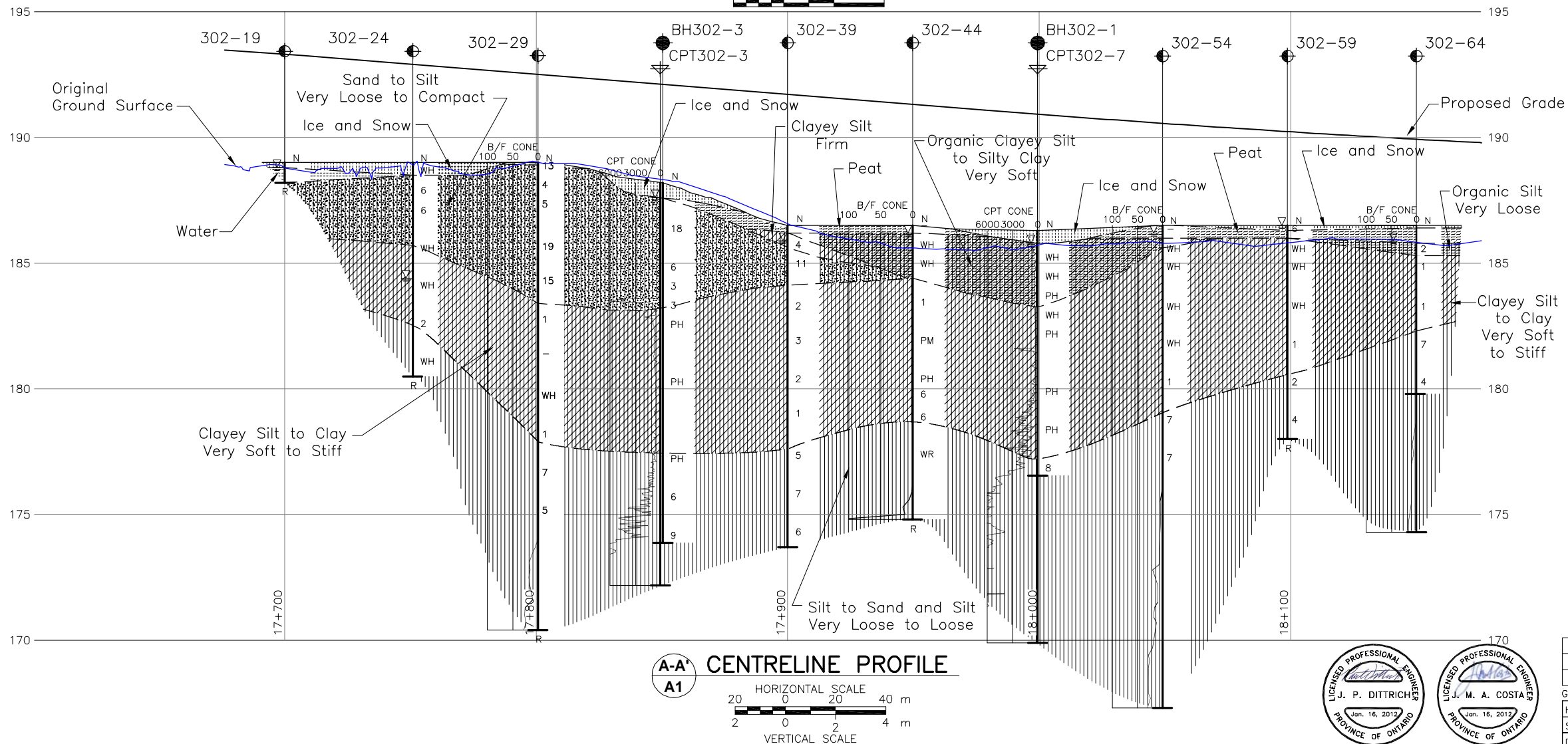
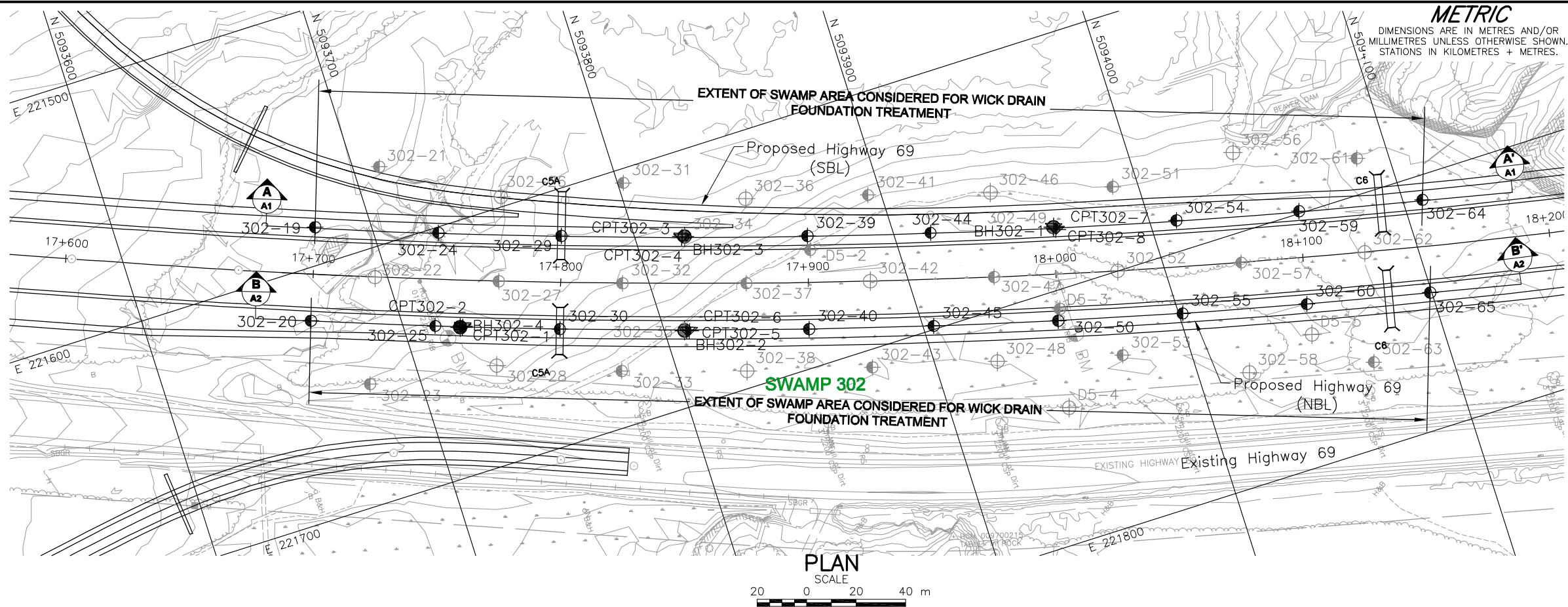


Qt normalized for  
unequal end area effects

$S_u = (Q_t - \sigma_v) / N_k$   
 $N_k = 15.5$   
 $\gamma = 17 \text{ kN/m}^3$

After Robertson and (Fear) Wride (1998)  
 $I_c < 1.31$  - Gravelly sands  
 $1.31 < I_c < 2.05$  - Clean to silty sand  
 $2.05 < I_c < 2.60$  - Silty sand to sandy silt  
 $2.60 < I_c < 2.95$  - Clayey silt to silty clay  
 $2.95 < I_c < 3.60$  - Clays





CONT No.  
GWP No. 5203-06-00

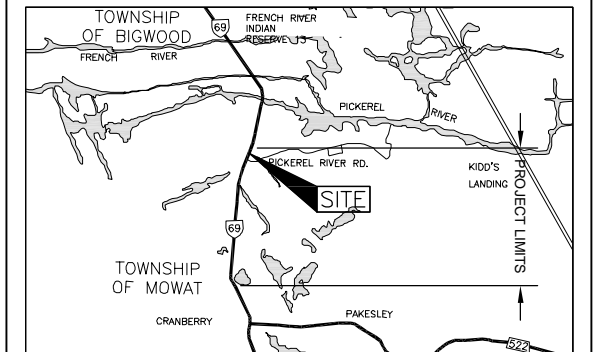


HIGHWAY 69 (SBL) STA 17+700 TO 18+150  
HIGHWAY 69 (NBL) STA 17+700 TO 18+150  
**BOREHOLE LOCATION  
AND SOIL STRATA**

SHEET



**Golder Associates Ltd.**  
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN

SCALE  
800 0 800 m

### LEGEND

- Borehole - Current Investigation
- ⊕ CPT - Current Investigation
- ⊙ Borehole - Previous Investigation (Peto MacCallum Ltd.)
- ⊕ Dynamic Cone Penetration Test - Previous Investigation (Peto MacCallum Ltd.)
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL observed during or upon completion of drilling
- R Refusal

| No.      | ELEVATION | CO-ORDINATES |          |
|----------|-----------|--------------|----------|
|          |           | NORTHING     | EASTING  |
| BH302-1  | 186.3     | 5093962.4    | 221675.2 |
| BH302-2  | 186.1     | 5093807.7    | 221670.0 |
| BH302-3  | 188.2     | 5093819.2    | 221633.7 |
| BH302-4  | 188.2     | 5093721.8    | 221641.3 |
| CPT302-1 | 188.2     | 5093722.8    | 221641.6 |
| CPT302-2 | 188.2     | 5093723.0    | 221641.1 |
| CPT302-3 | 188.2     | 5093818.3    | 221633.4 |
| CPT302-4 | 188.2     | 5093818.1    | 221633.9 |
| CPT302-5 | 186.1     | 5093808.7    | 221670.3 |
| CPT302-6 | 186.1     | 5093809.7    | 221670.6 |
| CPT302-7 | 186.3     | 5093962.4    | 221675.2 |
| CPT302-8 | 186.3     | 5093963.1    | 221676.5 |

### NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

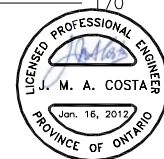
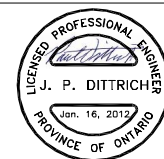
The boundaries between soil strata have been established only at borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

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

### REFERENCE

Base plans and Profile provided in digital format by MRC, drawing file's no. PHASE 3 Plan 090211 - Golder.dwg, received February 11, 2009.  
1-6454\_ Phase3-ML PROFILE-Mar 26-09.dwg, received Sept. 30, 2009.

| NO.                 | DATE                    | BY              | REVISION |
|---------------------|-------------------------|-----------------|----------|
| 1                   |                         |                 |          |
| Geocres No. 41H-106 |                         |                 |          |
| HWY. 69             | PROJECT NO. 06-1111-025 |                 | DIST.    |
| SUBM'D. MWK         | CHKD. MWK               | DATE: Feb. 2012 | SITE:    |
| DRAWN: RJ/JFC       | CHKD. VA                | APPD. JPD/JMAC  | DWG. A1  |



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

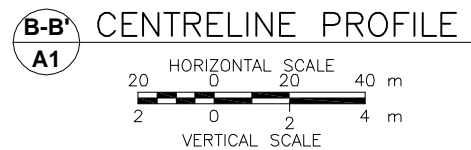
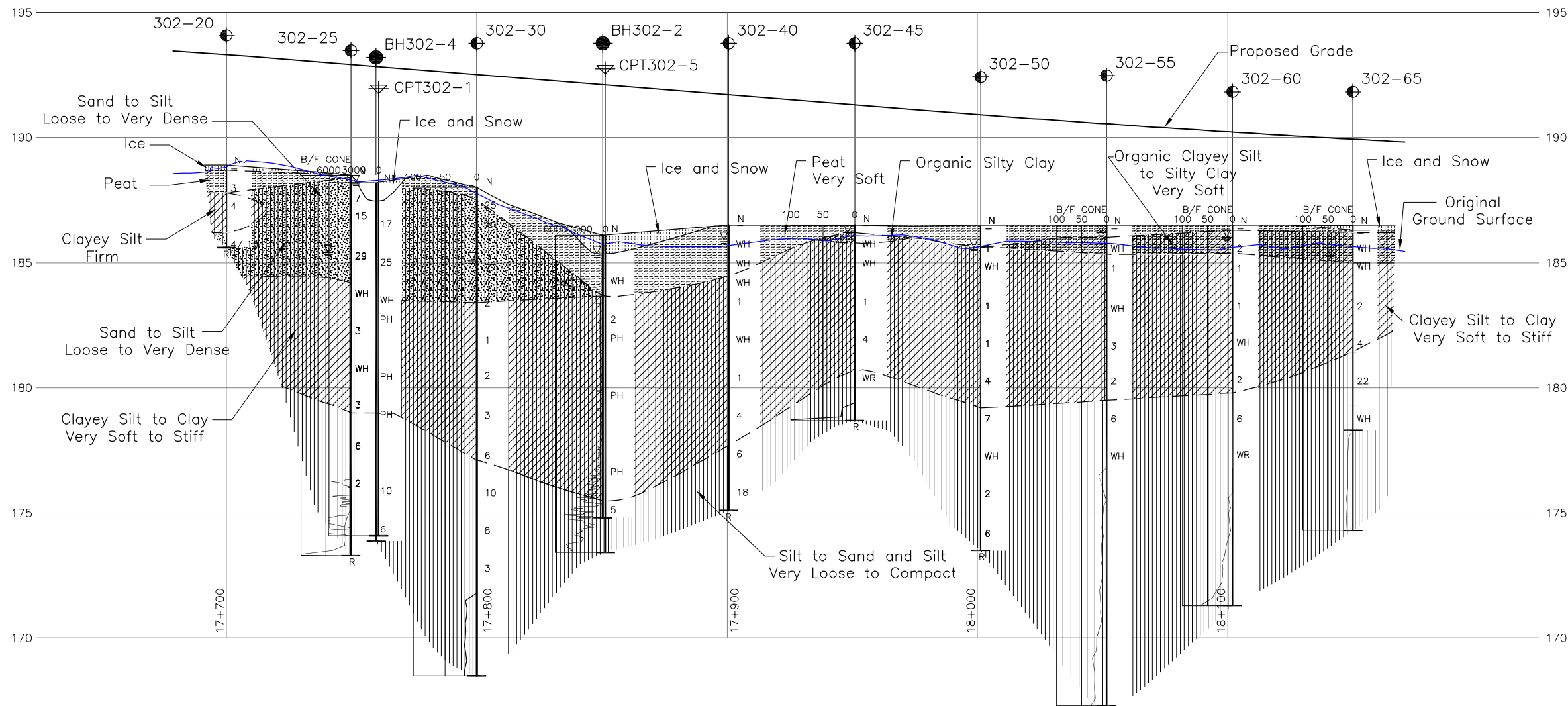
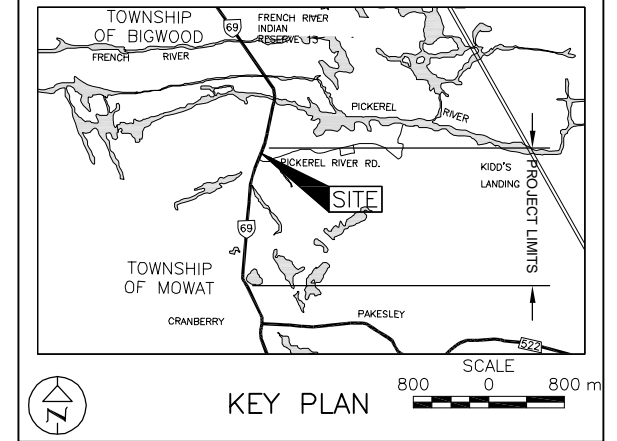
CONT No.  
GWP No. 5203-06-00

HIGHWAY 69 (NBL) STA 17+700 TO 18+150  
SOIL STRATA

SHEET



**Golder Associates Ltd.**  
MISSISSAUGA, ONTARIO, CANADA

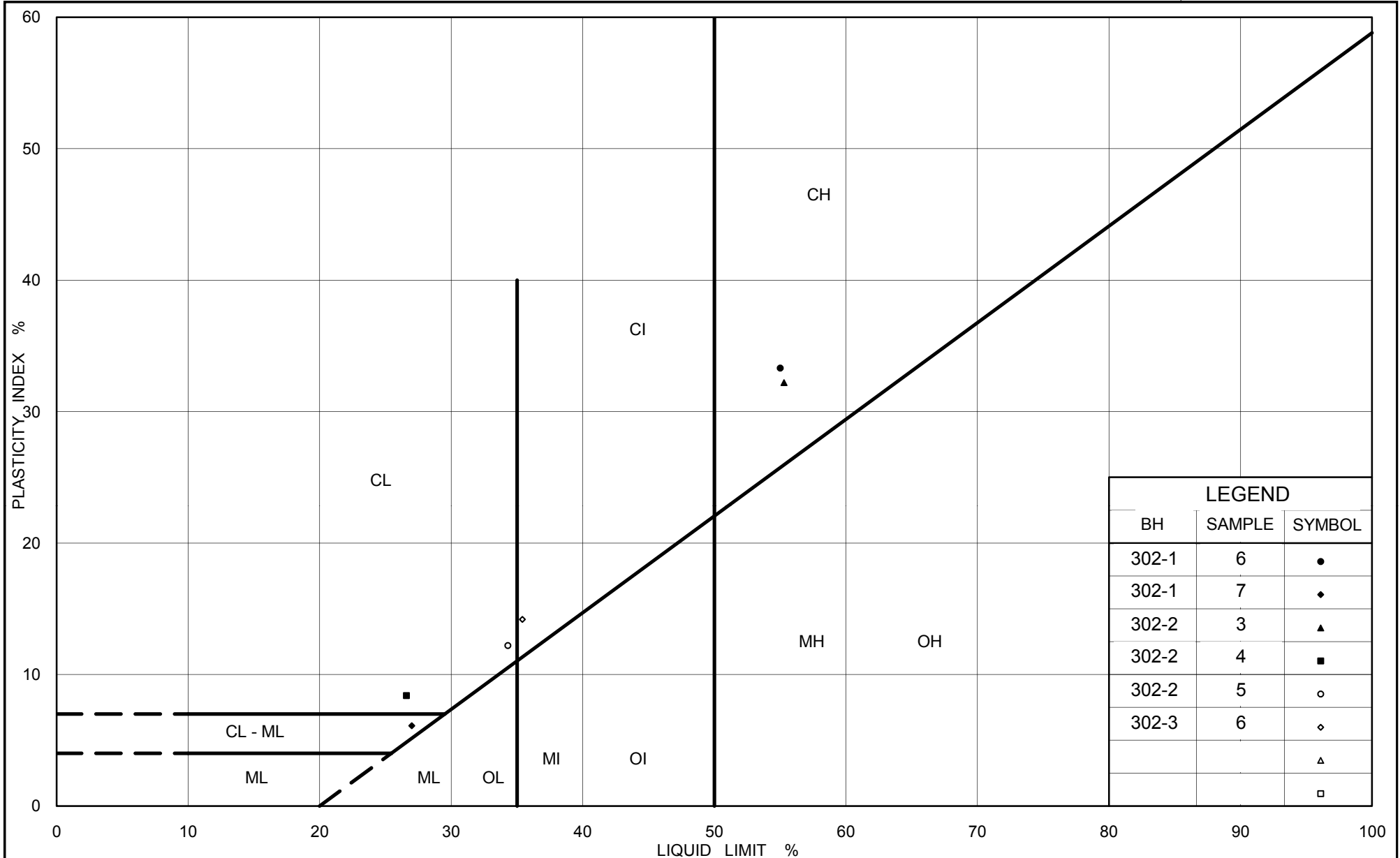


| LEGEND   |  |              |          |
|----------|--|--------------|----------|
|          | Borehole - Current Investigation   |              |          |
|          | CPT - Current Investigation  |              |          |
|          | Borehole - Previous Investigation (Peto MacCallum Ltd.)                      |              |          |
|          | Dynamic Cone Penetration Test - Previous Investigation (Peto MacCallum Ltd.) |              |          |
| N        | Standard Penetration Test Value  |              |          |
| 16       | Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)              |              |          |
|          | WL observed during or upon completion of drilling                            |              |          |
| R        | Refusal  |              |          |
| No.      | ELEVATION  | CO-ORDINATES |          |
|          |  | NORTHING     | EASTING  |
| BH302-2  | 186.1  | 5093807.7    | 221670.0 |
| BH302-4  | 188.2  | 5093721.8    | 221641.3 |
| CPT302-1 | 188.2  | 5093722.8    | 221641.6 |
| CPT302-5 | 186.1  | 5093808.7    | 221670.3 |

| NOTES   |  |
|---|--|
| This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.   |  |
| The boundaries between soil strata have been established only at borehole locations. Between Boreholes the boundaries are assumed from geological evidence.   |  |
| The complete foundation investigation and design report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions. |  |
| REFERENCE   |  |
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| NO.                 | DATE                    | BY              | REVISION |
|---------------------|-------------------------|-----------------|----------|
| Geocres No. 41H-106 |                         |                 |          |
| HWY. 69             | PROJECT NO. 06-1111-025 |                 | DIST.    |
| SUBM'D. MWK         | CHKD. MWK               | DATE: Feb. 2012 | SITE:    |
| DRAWN: DD/RJ        | CHKD. VA                | APPD. JPD/JMAC  | DWG. A2  |



Ministry of Transportation

Ontario

**PLASTICITY CHART**  
 Clayey Silt to Clay  
 Highway 69 (SBL and NBL) STA 17+700 to 18+150

Figure No. A.S302-1

Project No. 06-1111-025

Checked By: TVA

**CONSOLIDATION TEST SUMMARY****Highway 69 (SBL and NBL) STA 17+700 to 18+150****FIGURE A.S302-2****Sheet 1 of 4****SAMPLE IDENTIFICATION**

|                 |             |                 |         |
|-----------------|-------------|-----------------|---------|
| Project Number  | 06-1111-025 | Sample Number   | 6       |
| Borehole Number | 302-1       | Sample Depth, m | 3.8-4.4 |

**TEST CONDITIONS**

|                  |            |                   |    |
|------------------|------------|-------------------|----|
| Test Type        | Standard   | Load Duration, hr | 24 |
| Oedometer Number | 4          |                   |    |
| Date Started     | 04/03/2009 |                   |    |
| Date Completed   | 04/18/2009 |                   |    |

**SAMPLE DIMENSIONS AND PROPERTIES - INITIAL**

|                         |        |                                    |       |
|-------------------------|--------|------------------------------------|-------|
| Sample Height, cm       | 2.54   | Unit Weight, kN/m <sup>3</sup>     | 16.31 |
| Sample Diameter, cm     | 6.34   | Dry Unit Weight, kN/m <sup>3</sup> | 10.83 |
| Area, cm <sup>2</sup>   | 31.57  | Specific Gravity, measured         | 2.76  |
| Volume, cm <sup>3</sup> | 80.19  | Solids Height, cm                  | 1.016 |
| Water Content, %        | 50.58  | Volume of Solids, cm <sup>3</sup>  | 32.09 |
| Wet Mass, g             | 133.35 | Volume of Voids, cm <sup>3</sup>   | 48.10 |
| Dry Mass, g             | 88.56  | Degree of Saturation, %            | 93.1  |

**TEST COMPUTATIONS**

| Pressure<br>kPa | Corr.<br>Height<br>cm | Void<br>Ratio | Average<br>Height<br>cm | t <sub>90</sub><br>sec | cv,<br>cm <sup>2</sup> /s | mv<br>m <sup>2</sup> /kN | k<br>cm/s |
|-----------------|-----------------------|---------------|-------------------------|------------------------|---------------------------|--------------------------|-----------|
| 0.00            | 2.540                 | 1.499         | 2.540                   |                        |                           |                          |           |
| 4.77            | 2.482                 | 1.442         | 2.511                   | 1                      | 1.34E+00                  | 4.79E-03                 | 6.27E-04  |
| 9.58            | 2.472                 | 1.432         | 2.477                   | 9                      | 1.45E-01                  | 8.19E-04                 | 1.16E-05  |
| 19.31           | 2.456                 | 1.416         | 2.464                   | 8                      | 1.61E-01                  | 6.47E-04                 | 1.02E-05  |
| 38.80           | 2.429                 | 1.390         | 2.443                   | 9                      | 1.41E-01                  | 5.45E-04                 | 7.51E-06  |
| 77.64           | 2.386                 | 1.348         | 2.408                   | 10                     | 1.23E-01                  | 4.36E-04                 | 5.25E-06  |
| 155.06          | 2.295                 | 1.258         | 2.341                   | 18                     | 6.45E-02                  | 4.63E-04                 | 2.93E-06  |
| 310.20          | 2.099                 | 1.065         | 2.197                   | 51                     | 2.01E-02                  | 4.97E-04                 | 9.78E-07  |
| 619.87          | 1.927                 | 0.896         | 2.013                   | 63                     | 1.36E-02                  | 2.19E-04                 | 2.92E-07  |
| 1239.98         | 1.796                 | 0.767         | 1.862                   | 22                     | 3.34E-02                  | 8.32E-05                 | 2.72E-07  |
| 2482.66         | 1.686                 | 0.659         | 1.741                   | 32                     | 2.01E-02                  | 3.48E-05                 | 6.86E-08  |
| 1239.98         | 1.694                 | 0.667         | 1.690                   |                        |                           |                          |           |
| 310.20          | 1.754                 | 0.726         | 1.724                   |                        |                           |                          |           |
| 77.64           | 1.785                 | 0.756         | 1.770                   |                        |                           |                          |           |
| 19.34           | 1.785                 | 0.756         | 1.785                   |                        |                           |                          |           |
| 4.77            | 1.799                 | 0.770         | 1.792                   |                        |                           |                          |           |

Note:

k calculated using cv based on t<sub>90</sub> values.**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

|                         |        |                                    |       |
|-------------------------|--------|------------------------------------|-------|
| Sample Height, cm       | 1.80   | Unit Weight, kN/m <sup>3</sup>     | 19.96 |
| Sample Diameter, cm     | 6.34   | Dry Unit Weight, kN/m <sup>3</sup> | 15.29 |
| Area, cm <sup>2</sup>   | 31.57  | Specific Gravity, measured         | 2.76  |
| Volume, cm <sup>3</sup> | 56.79  | Solids Height, cm                  | 1.016 |
| Water Content, %        | 30.50  | Volume of Solids, cm <sup>3</sup>  | 32.09 |
| Wet Mass, g             | 115.57 | Volume of Voids, cm <sup>3</sup>   | 24.71 |
| Dry Mass, g             | 88.56  |                                    |       |

Prepared By: LH

**Golder Associates**

Checked By: MM

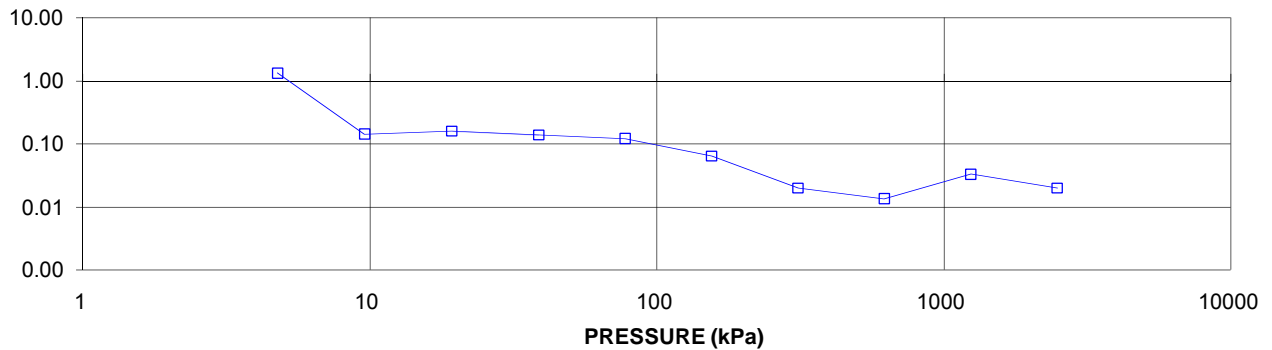
**CONSOLIDATION TEST SUMMARY**  
**Highway 69 (SBL and NBL) STA 17+700 to 18+150**

**FIGURE A.S302-2**

**Sheet 2 of 4**

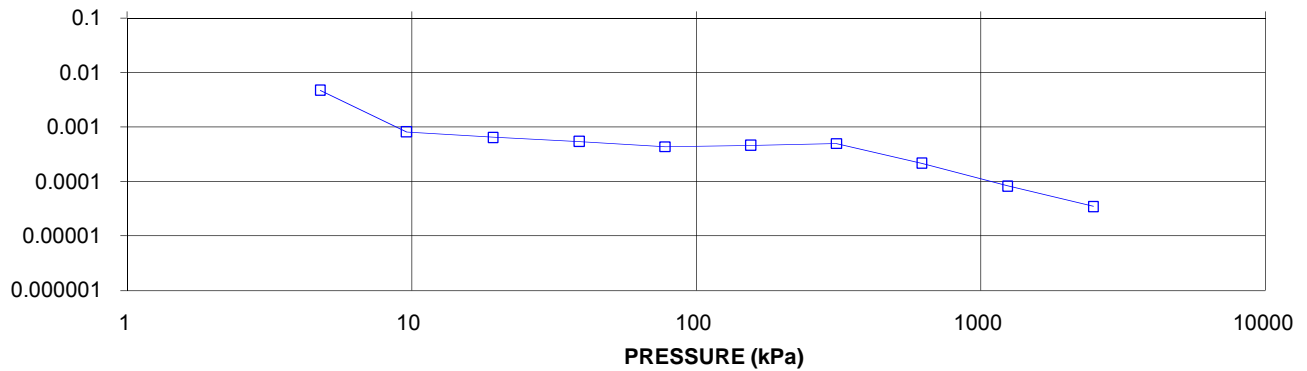
COEFFICIENT OF CONSOLIDATION,  
cm<sup>2</sup>/s

**CONSOLIDATION TEST**  
**CV cm<sup>2</sup>/s VS PRESSURE (kPa)**  
**BH 302-1 SA 6**



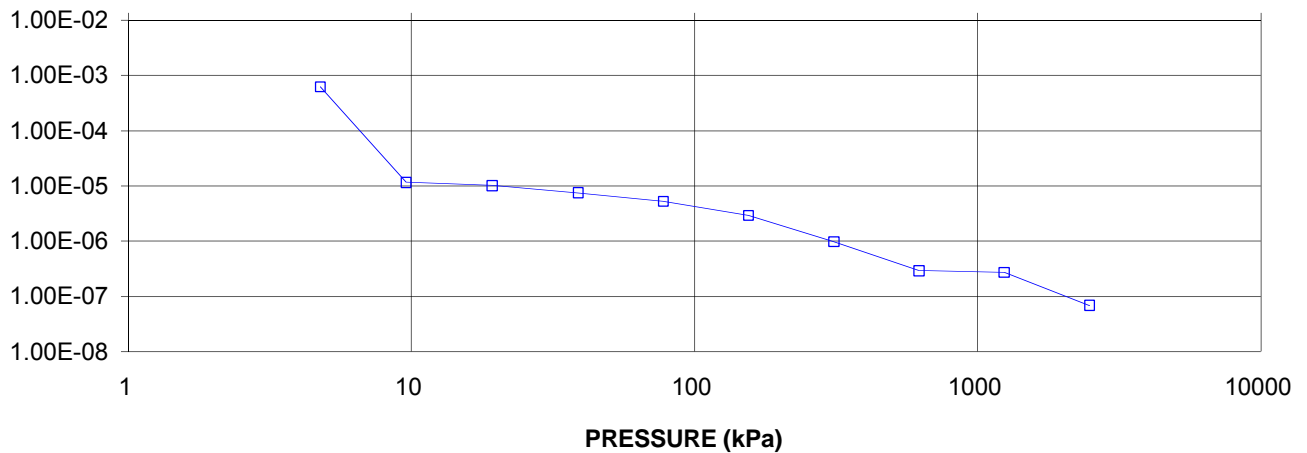
VOLUME COMPRESSIBILITY, m<sup>2</sup>/kN

**CONSOLIDATION TEST**  
**MV m<sup>2</sup>/kN vs PRESSURE (kPa)**  
**BH 302-1 SA 6**



HYDRAULIC CONDUCTIVITY, cm/s

**CONSOLIDATION TEST**  
**HYDRAULIC CONDUCTIVITY vs PRESSURE**  
**BH 302-1 SA 6**

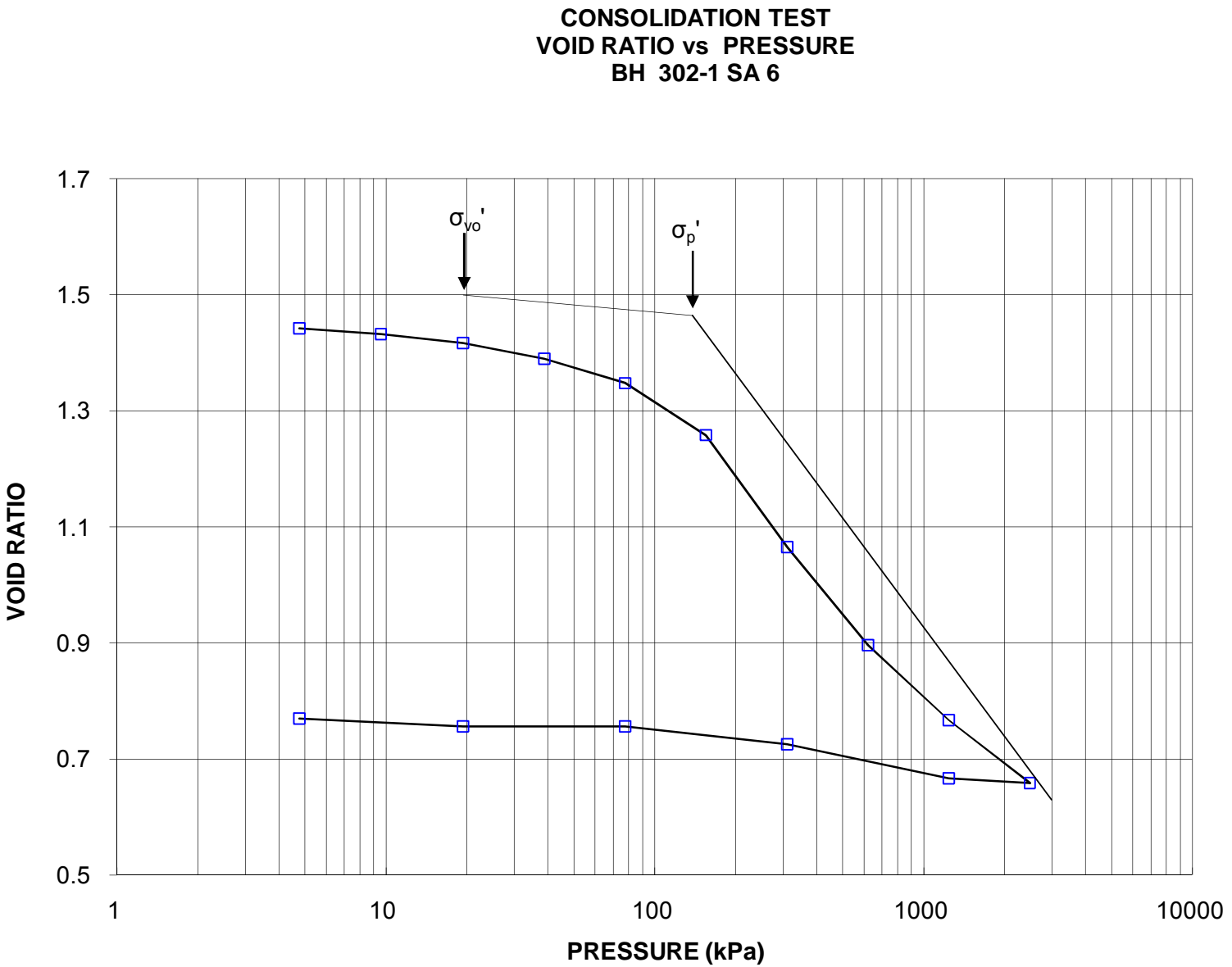


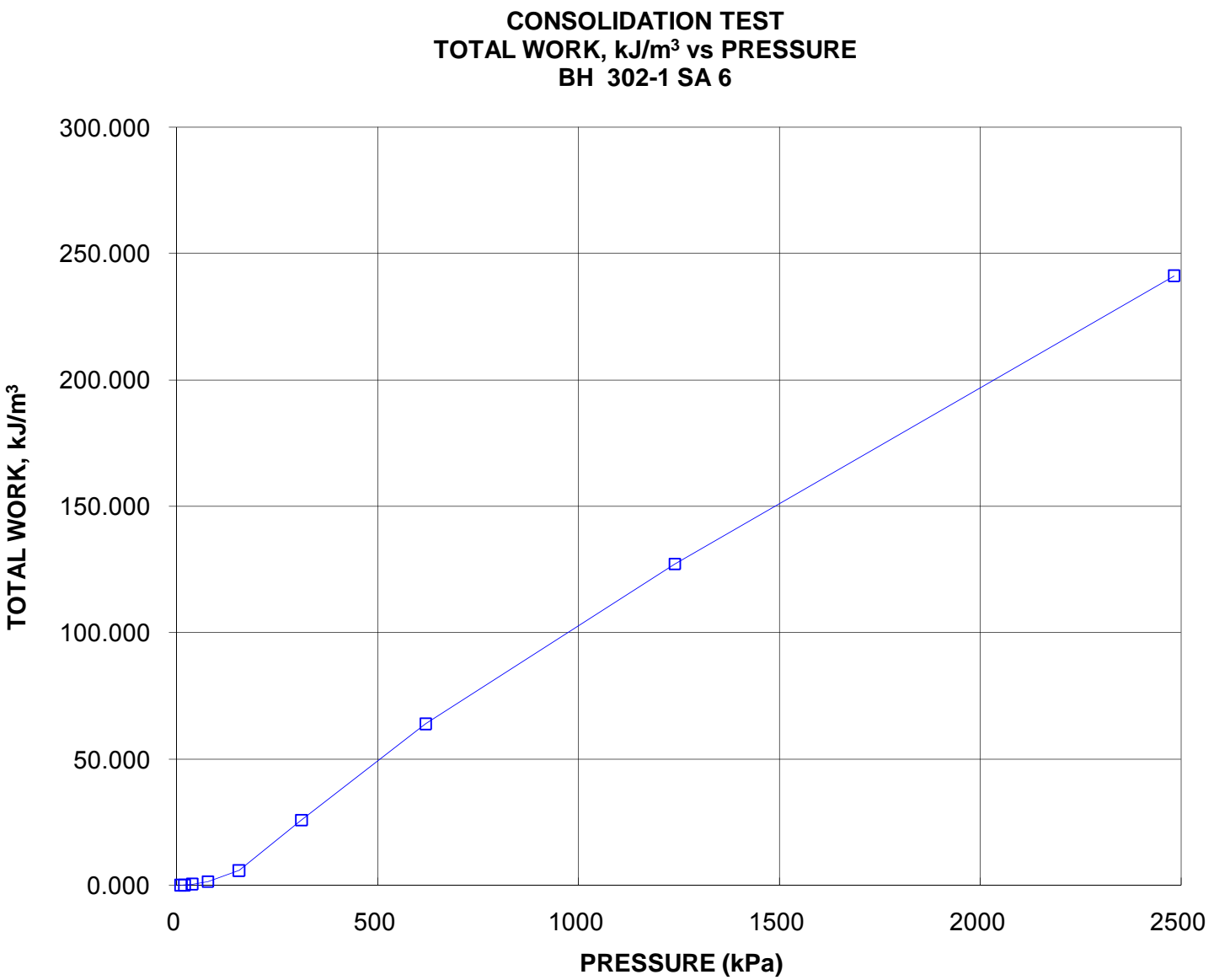
Project No. 06-1111-025

Prepared By: LH

**Golder Associates**

Checked By: MM







**CONSOLIDATION TEST SUMMARY****Highway 69 (SBL and NBL) STA 17+700 to 18+150****FIGURE A.S302-3****Sheet 1 of 4****SAMPLE IDENTIFICATION**

|                 |             |                 |         |
|-----------------|-------------|-----------------|---------|
| Project Number  | 06-1111-025 | Sample Number   | 7       |
| Borehole Number | 302-1       | Sample Depth, m | 6.1-6.7 |

**TEST CONDITIONS**

|                  |            |                   |    |
|------------------|------------|-------------------|----|
| Test Type        | Standard   | Load Duration, hr | 24 |
| Oedometer Number | 1          |                   |    |
| Date Started     | 04/09/2009 |                   |    |
| Date Completed   | 04/24/2009 |                   |    |

**SAMPLE DIMENSIONS AND PROPERTIES - INITIAL**

|                         |        |                                    |       |
|-------------------------|--------|------------------------------------|-------|
| Sample Height, cm       | 2.54   | Unit Weight, kN/m <sup>3</sup>     | 18.84 |
| Sample Diameter, cm     | 6.34   | Dry Unit Weight, kN/m <sup>3</sup> | 14.38 |
| Area, cm <sup>2</sup>   | 31.61  | Specific Gravity, measured         | 2.74  |
| Volume, cm <sup>3</sup> | 80.38  | Solids Height, cm                  | 1.361 |
| Water Content, %        | 30.96  | Volume of Solids, cm <sup>3</sup>  | 43.03 |
| Wet Mass, g             | 154.40 | Volume of Voids, cm <sup>3</sup>   | 37.35 |
| Dry Mass, g             | 117.9  | Degree of Saturation, %            | 97.7  |

**TEST COMPUTATIONS**

| Pressure<br>kPa | Corr.<br>Height<br>cm | Void<br>Ratio | Average<br>Height<br>cm | t <sub>90</sub><br>sec | cv,<br>cm <sup>2</sup> /s | mv<br>m <sup>2</sup> /kN | k<br>cm/s |
|-----------------|-----------------------|---------------|-------------------------|------------------------|---------------------------|--------------------------|-----------|
| 0.00            | 2.543                 | 0.868         | 2.543                   |                        |                           |                          |           |
| 4.70            | 2.495                 | 0.833         | 2.519                   | 2                      | 6.73E-01                  | 4.02E-03                 | 2.65E-04  |
| 9.56            | 2.484                 | 0.824         | 2.489                   | 19                     | 6.91E-02                  | 9.14E-04                 | 6.19E-06  |
| 19.29           | 2.474                 | 0.817         | 2.479                   | 41                     | 3.18E-02                  | 4.00E-04                 | 1.25E-06  |
| 38.75           | 2.459                 | 0.806         | 2.466                   | 14                     | 9.21E-02                  | 3.05E-04                 | 2.75E-06  |
| 77.53           | 2.438                 | 0.791         | 2.448                   | 9                      | 1.41E-01                  | 2.11E-04                 | 2.92E-06  |
| 154.98          | 2.403                 | 0.765         | 2.420                   | 14                     | 8.87E-02                  | 1.77E-04                 | 1.54E-06  |
| 309.92          | 2.332                 | 0.713         | 2.367                   | 15                     | 7.92E-02                  | 1.81E-04                 | 1.40E-06  |
| 620.47          | 2.265                 | 0.664         | 2.298                   | 14                     | 8.00E-02                  | 8.52E-05                 | 6.68E-07  |
| 1240.29         | 2.202                 | 0.618         | 2.233                   | 28                     | 3.78E-02                  | 3.94E-05                 | 1.46E-07  |
| 2478.90         | 2.149                 | 0.578         | 2.175                   | 15                     | 6.69E-02                  | 1.71E-05                 | 1.12E-07  |
| 1240.29         | 2.152                 | 0.581         | 2.150                   |                        |                           |                          |           |
| 309.92          | 2.174                 | 0.597         | 2.163                   |                        |                           |                          |           |
| 77.53           | 2.190                 | 0.609         | 2.182                   |                        |                           |                          |           |
| 19.29           | 2.208                 | 0.622         | 2.199                   |                        |                           |                          |           |
| 4.70            | 2.222                 | 0.633         | 2.215                   |                        |                           |                          |           |

Note:

k calculated using cv based on t<sub>90</sub> values.**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

|                         |        |                                    |       |
|-------------------------|--------|------------------------------------|-------|
| Sample Height, cm       | 2.22   | Unit Weight, kN/m <sup>3</sup>     | 20.39 |
| Sample Diameter, cm     | 6.34   | Dry Unit Weight, kN/m <sup>3</sup> | 16.46 |
| Area, cm <sup>2</sup>   | 31.61  | Specific Gravity, measured         | 2.74  |
| Volume, cm <sup>3</sup> | 70.25  | Solids Height, cm                  | 1.361 |
| Water Content, %        | 23.90  | Volume of Solids, cm <sup>3</sup>  | 43.03 |
| Wet Mass, g             | 146.08 | Volume of Voids, cm <sup>3</sup>   | 27.22 |
| Dry Mass, g             | 117.9  |                                    |       |

Prepared By: LH

**Golder Associates**

Checked By: MM

# CONSOLIDATION TEST SUMMARY

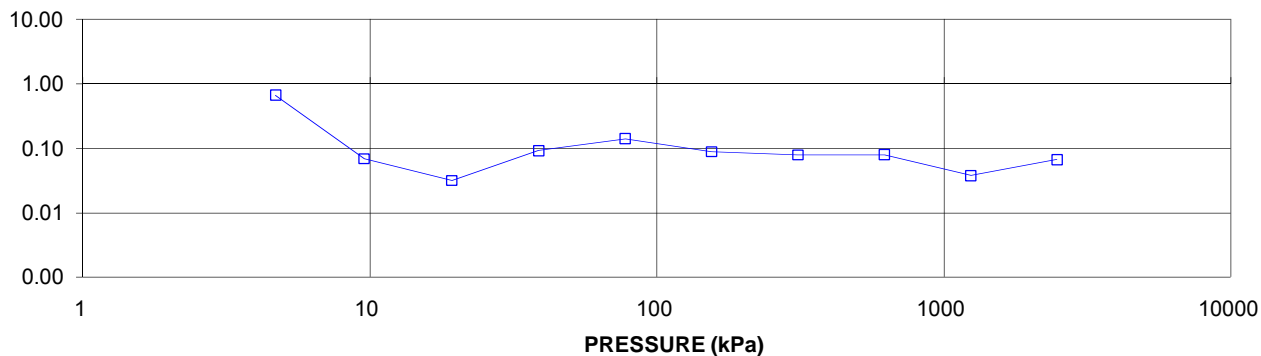
Highway 69 (SBL and NBL) STA 17+700 to 18+150

FIGURE A.S302-3

Sheet 2 of 4

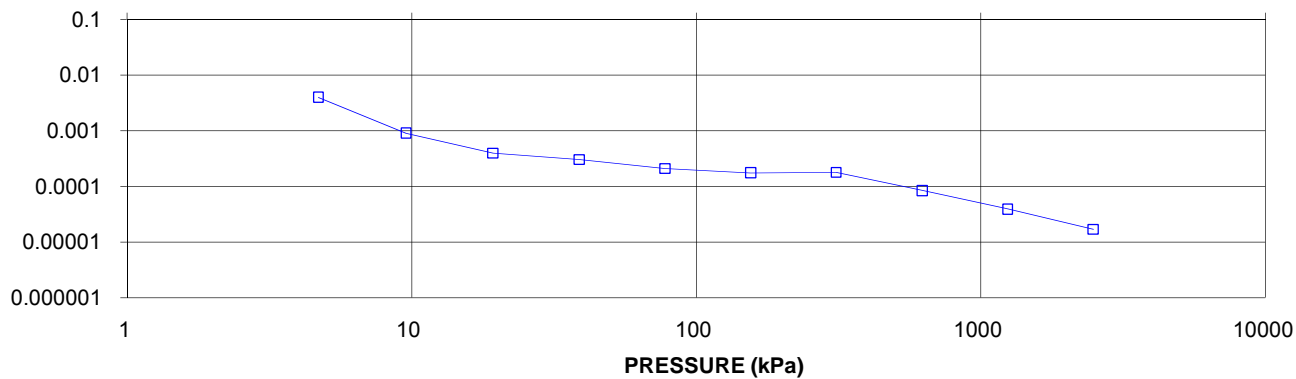
COEFFICIENT OF CONSOLIDATION,  
cm<sup>2</sup>/s

CONSOLIDATION TEST  
CV cm<sup>2</sup>/s VS PRESSURE (kPa)  
BH 302-1 SA 7



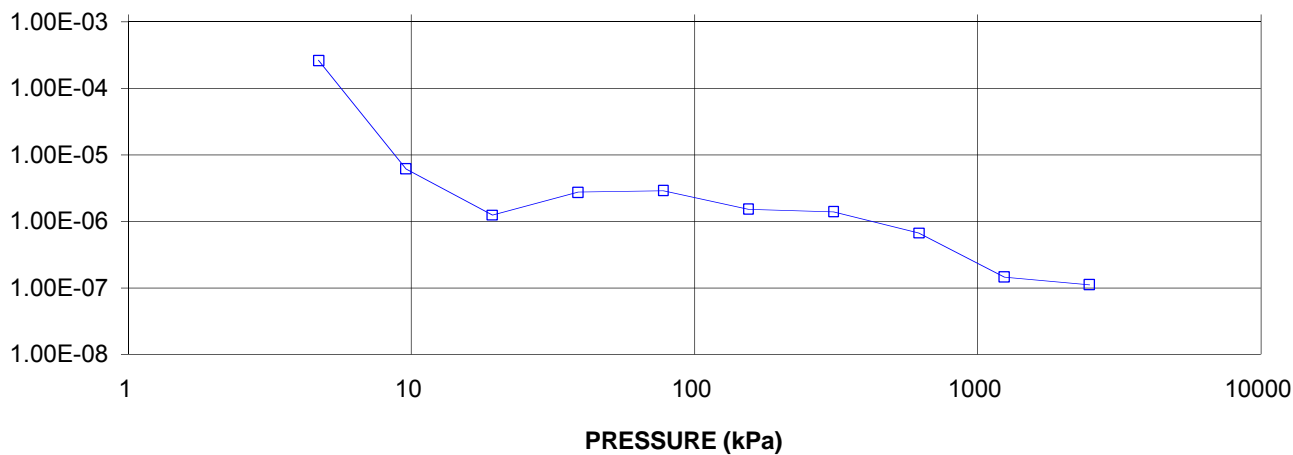
VOLUME COMPRESSIBILITY, m<sup>2</sup>/kN

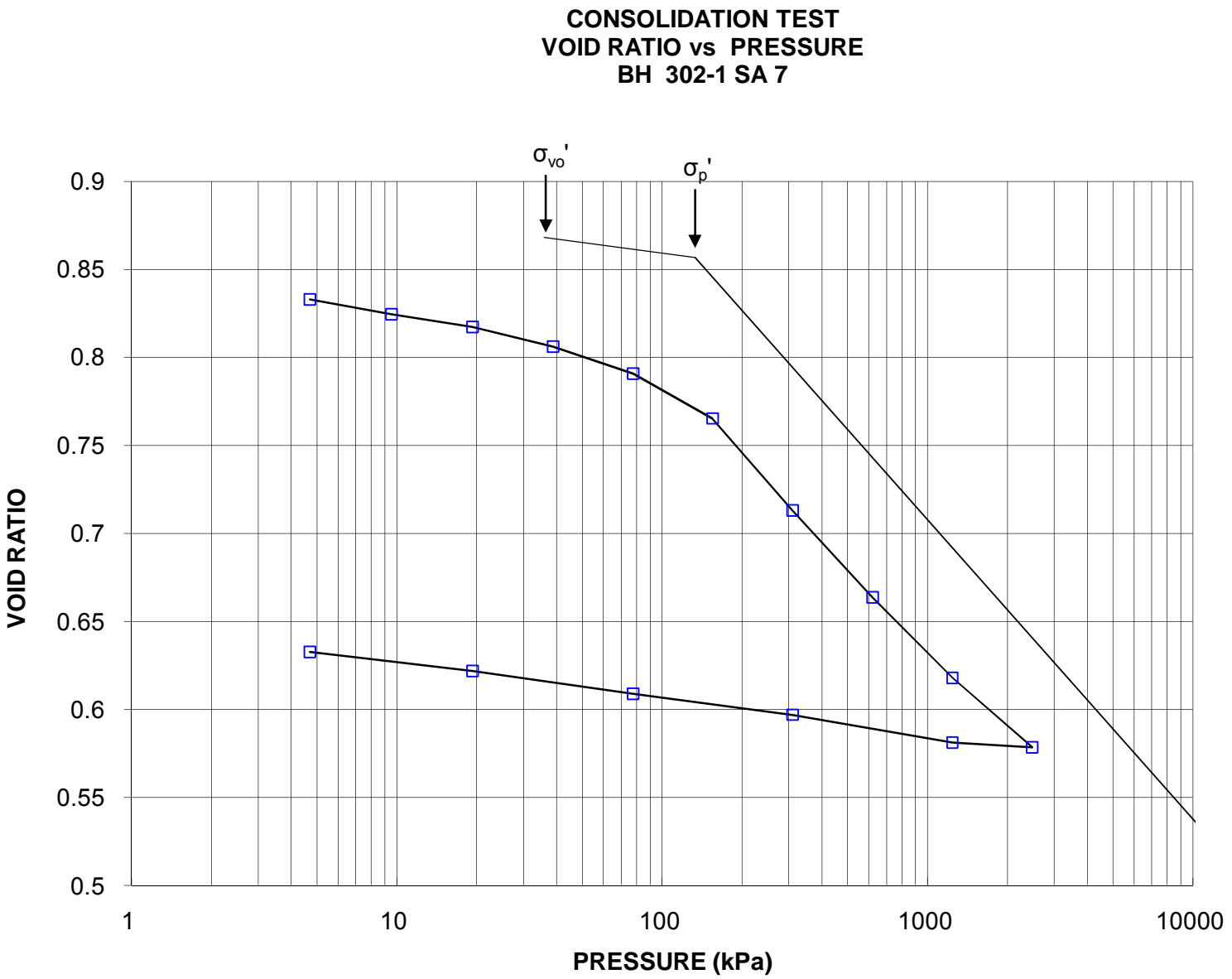
CONSOLIDATION TEST  
MV m<sup>2</sup>/kN vs PRESSURE (kPa)  
BH 302-1 SA 7

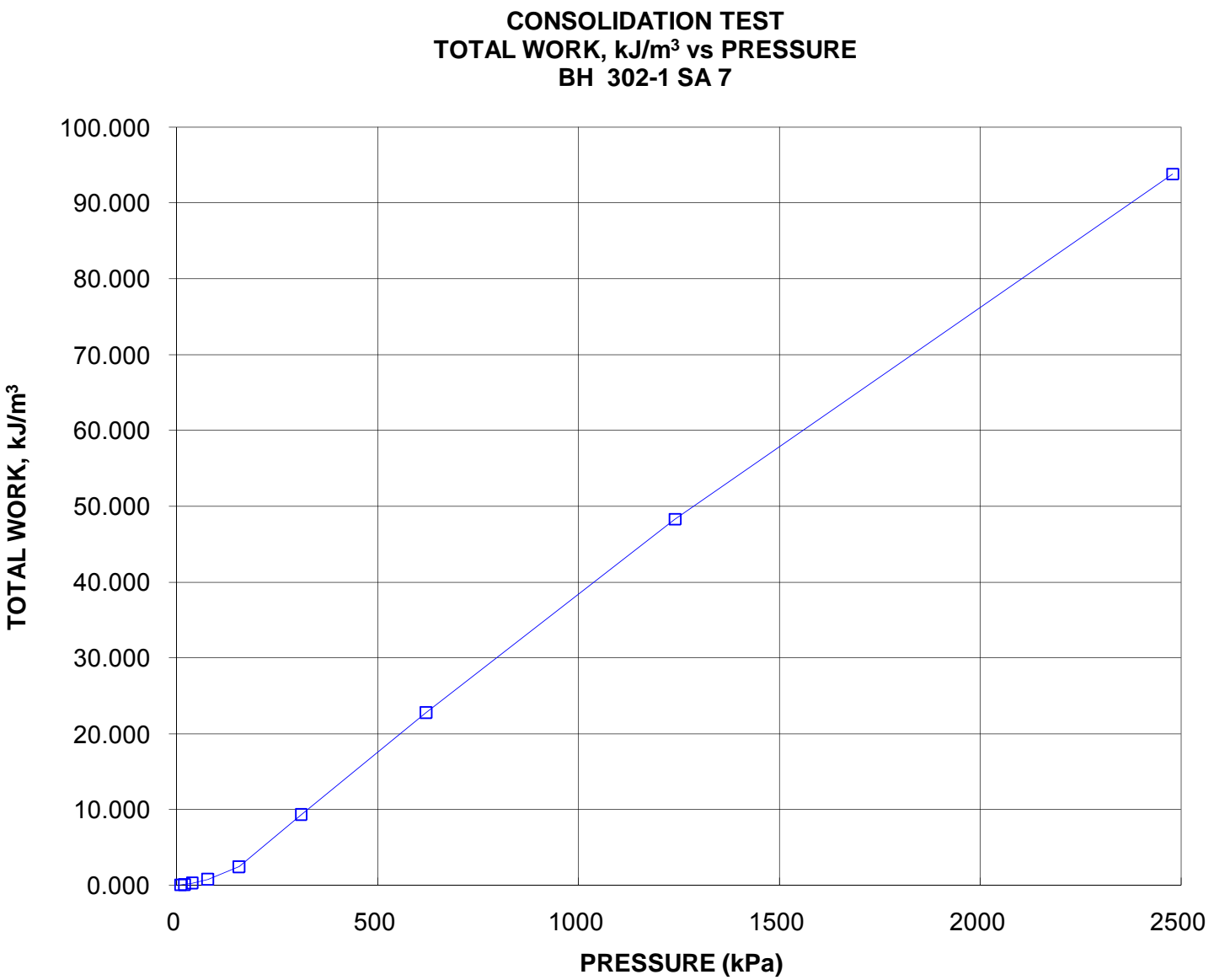


HYDRAULIC CONDUCTIVITY, cm/s

CONSOLIDATION TEST  
HYDRAULIC CONDUCTIVITY vs PRESSURE  
BH 302-1 SA 7







**CONSOLIDATION TEST SUMMARY****Highway 69 (SBL and NBL) STA 17+700 to 18+150****FIGURE A.S302-4****Sheet 1 of 4****SAMPLE IDENTIFICATION**

|                 |             |                 |         |
|-----------------|-------------|-----------------|---------|
| Project Number  | 06-1111-025 | Sample Number   | 3       |
| Borehole Number | 302-2       | Sample Depth, m | 3.8-4.4 |

**TEST CONDITIONS**

|                  |            |                   |    |
|------------------|------------|-------------------|----|
| Test Type        | Standard   | Load Duration, hr | 24 |
| Oedometer Number | 2          |                   |    |
| Date Started     | 04/15/2009 |                   |    |
| Date Completed   | 04/30/2009 |                   |    |

**SAMPLE DIMENSIONS AND PROPERTIES - INITIAL**

|                         |        |                                    |       |
|-------------------------|--------|------------------------------------|-------|
| Sample Height, cm       | 2.54   | Unit Weight, kN/m <sup>3</sup>     | 15.61 |
| Sample Diameter, cm     | 6.34   | Dry Unit Weight, kN/m <sup>3</sup> | 9.39  |
| Area, cm <sup>2</sup>   | 31.57  | Specific Gravity, measured         | 2.75  |
| Volume, cm <sup>3</sup> | 80.28  | Solids Height, cm                  | 0.885 |
| Water Content, %        | 66.32  | Volume of Solids, cm <sup>3</sup>  | 27.94 |
| Wet Mass, g             | 127.80 | Volume of Voids, cm <sup>3</sup>   | 52.34 |
| Dry Mass, g             | 76.84  | Degree of Saturation, %            | 97.4  |

**TEST COMPUTATIONS**

| Pressure<br>kPa | Corr.<br>Height<br>cm | Void<br>Ratio | Average<br>Height<br>cm | t <sub>90</sub><br>sec | cv,<br>cm <sup>2</sup> /s | mv<br>m <sup>2</sup> /kN | k<br>cm/s |
|-----------------|-----------------------|---------------|-------------------------|------------------------|---------------------------|--------------------------|-----------|
| 0.00            | 2.543                 | 1.873         | 2.543                   |                        |                           |                          |           |
| 4.87            | 2.534                 | 1.863         | 2.539                   | 6                      | 2.28E-01                  | 7.27E-04                 | 1.62E-05  |
| 9.56            | 2.525                 | 1.853         | 2.530                   | 21                     | 6.46E-02                  | 7.55E-04                 | 4.78E-06  |
| 19.31           | 2.506                 | 1.831         | 2.516                   | 14                     | 9.58E-02                  | 7.66E-04                 | 7.20E-06  |
| 38.81           | 2.480                 | 1.802         | 2.493                   | 19                     | 6.93E-02                  | 5.24E-04                 | 3.56E-06  |
| 77.62           | 2.441                 | 1.758         | 2.461                   | 17                     | 7.55E-02                  | 3.95E-04                 | 2.92E-06  |
| 155.06          | 2.343                 | 1.647         | 2.392                   | 13                     | 9.33E-02                  | 4.98E-04                 | 4.55E-06  |
| 310.20          | 2.116                 | 1.391         | 2.230                   | 69                     | 1.53E-02                  | 5.75E-04                 | 8.61E-07  |
| 619.74          | 1.903                 | 1.150         | 2.010                   | 240                    | 3.57E-03                  | 2.71E-04                 | 9.46E-08  |
| 1240.00         | 1.741                 | 0.967         | 1.822                   | 120                    | 5.86E-03                  | 1.03E-04                 | 5.90E-08  |
| 2481.00         | 1.605                 | 0.813         | 1.673                   | 32                     | 1.85E-02                  | 4.31E-05                 | 7.83E-08  |
| 1240.00         | 1.615                 | 0.825         | 1.610                   |                        |                           |                          |           |
| 310.20          | 1.655                 | 0.870         | 1.635                   |                        |                           |                          |           |
| 77.62           | 1.712                 | 0.934         | 1.684                   |                        |                           |                          |           |
| 19.31           | 1.759                 | 0.987         | 1.736                   |                        |                           |                          |           |
| 4.87            | 1.796                 | 1.029         | 1.778                   |                        |                           |                          |           |

Note:

k calculated using cv based on t<sub>90</sub> values.**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

|                         |        |                                    |       |
|-------------------------|--------|------------------------------------|-------|
| Sample Height, cm       | 1.80   | Unit Weight, kN/m <sup>3</sup>     | 18.45 |
| Sample Diameter, cm     | 6.34   | Dry Unit Weight, kN/m <sup>3</sup> | 13.29 |
| Area, cm <sup>2</sup>   | 31.57  | Specific Gravity, measured         | 2.75  |
| Volume, cm <sup>3</sup> | 56.70  | Solids Height, cm                  | 0.885 |
| Water Content, %        | 38.79  | Volume of Solids, cm <sup>3</sup>  | 27.94 |
| Wet Mass, g             | 106.65 | Volume of Voids, cm <sup>3</sup>   | 28.76 |
| Dry Mass, g             | 76.84  |                                    |       |

Prepared By: LH

**Golder Associates**

Checked By: MM

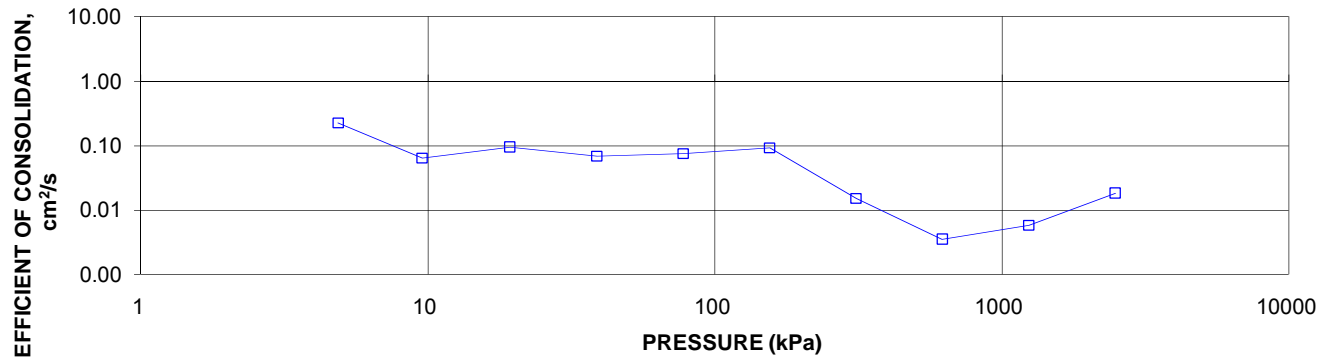
# CONSOLIDATION TEST SUMMARY

Highway 69 (SBL and NBL) STA 17+700 to 18+150

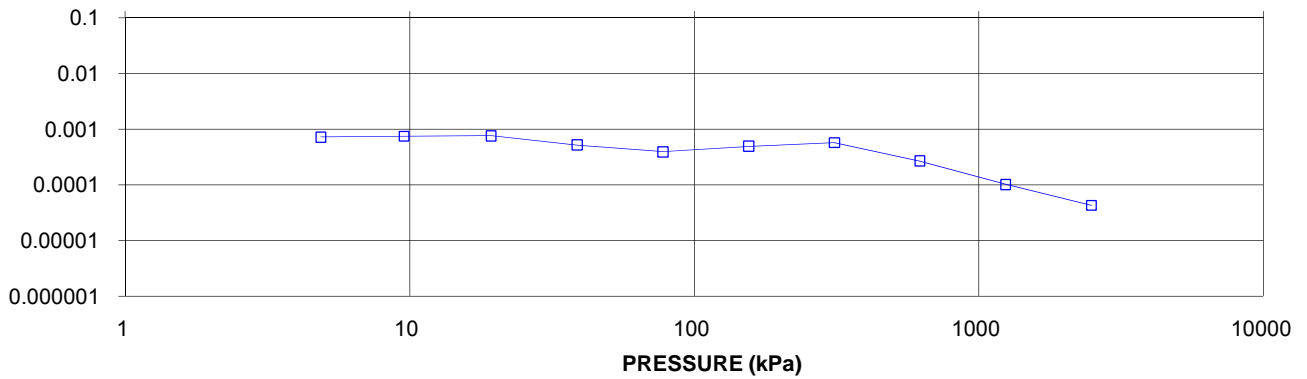
FIGURE A.S302-4

Sheet 2 of 4

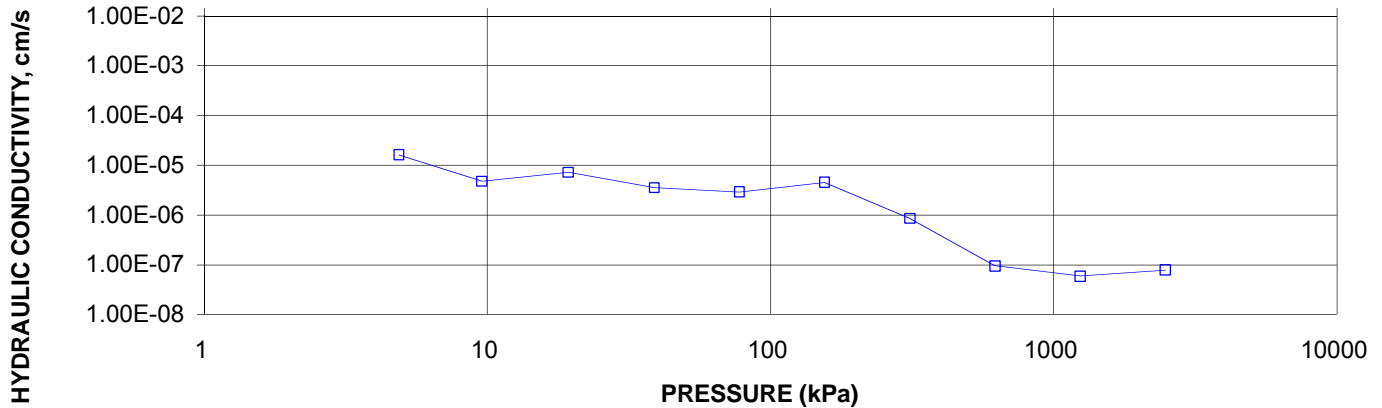
CONSOLIDATION TEST  
CV cm<sup>2</sup>/s VS PRESSURE (kPa)  
BH 302-2 SA 3



CONSOLIDATION TEST  
MV m<sup>2</sup>/kN vs PRESSURE (kPa)  
BH 302-2 SA 3



CONSOLIDATION TEST  
HYDRAULIC CONDUCTIVITY vs PRESSURE  
BH 302-2 SA 3

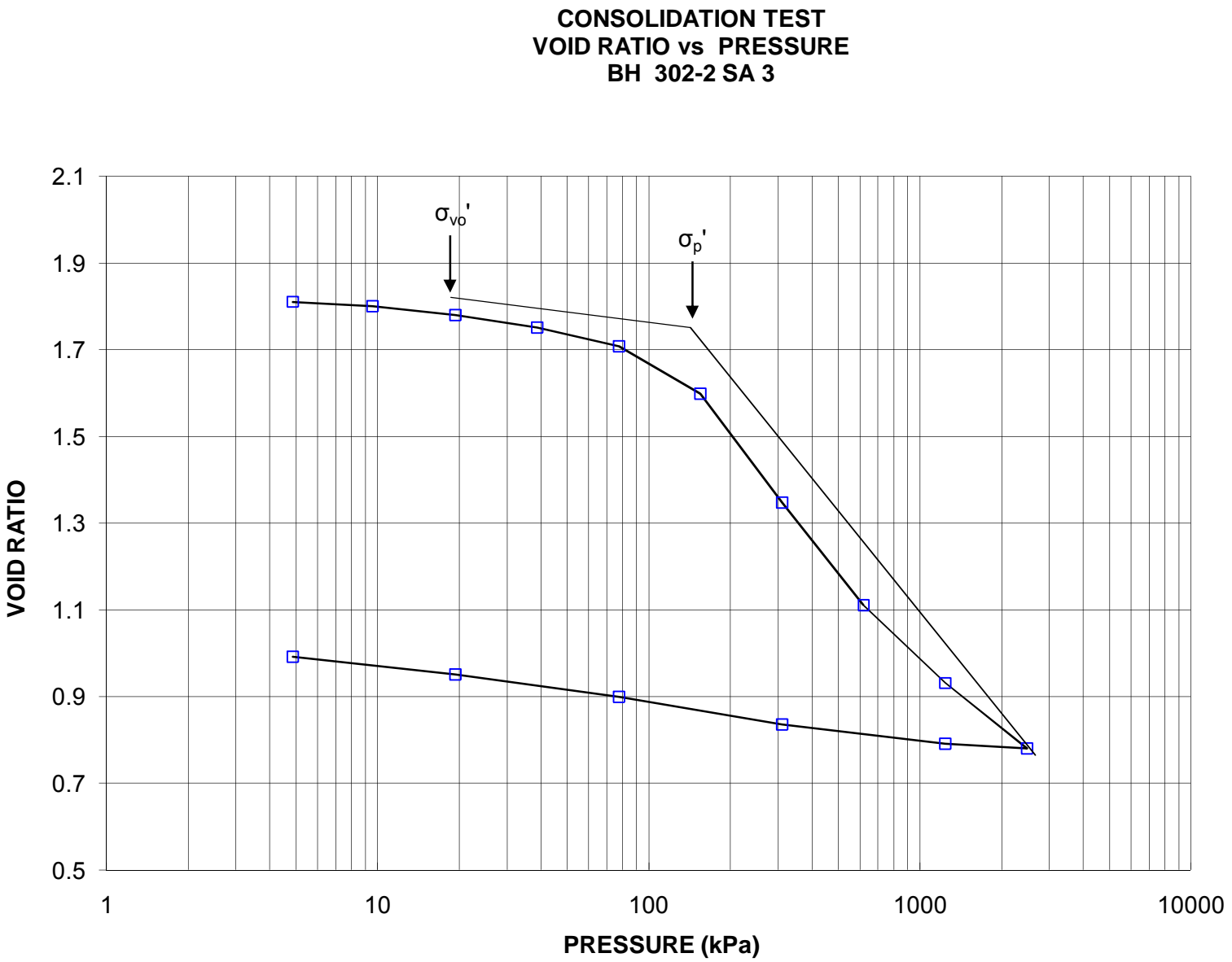


Project No. 06-1111-025

Prepared By: LH

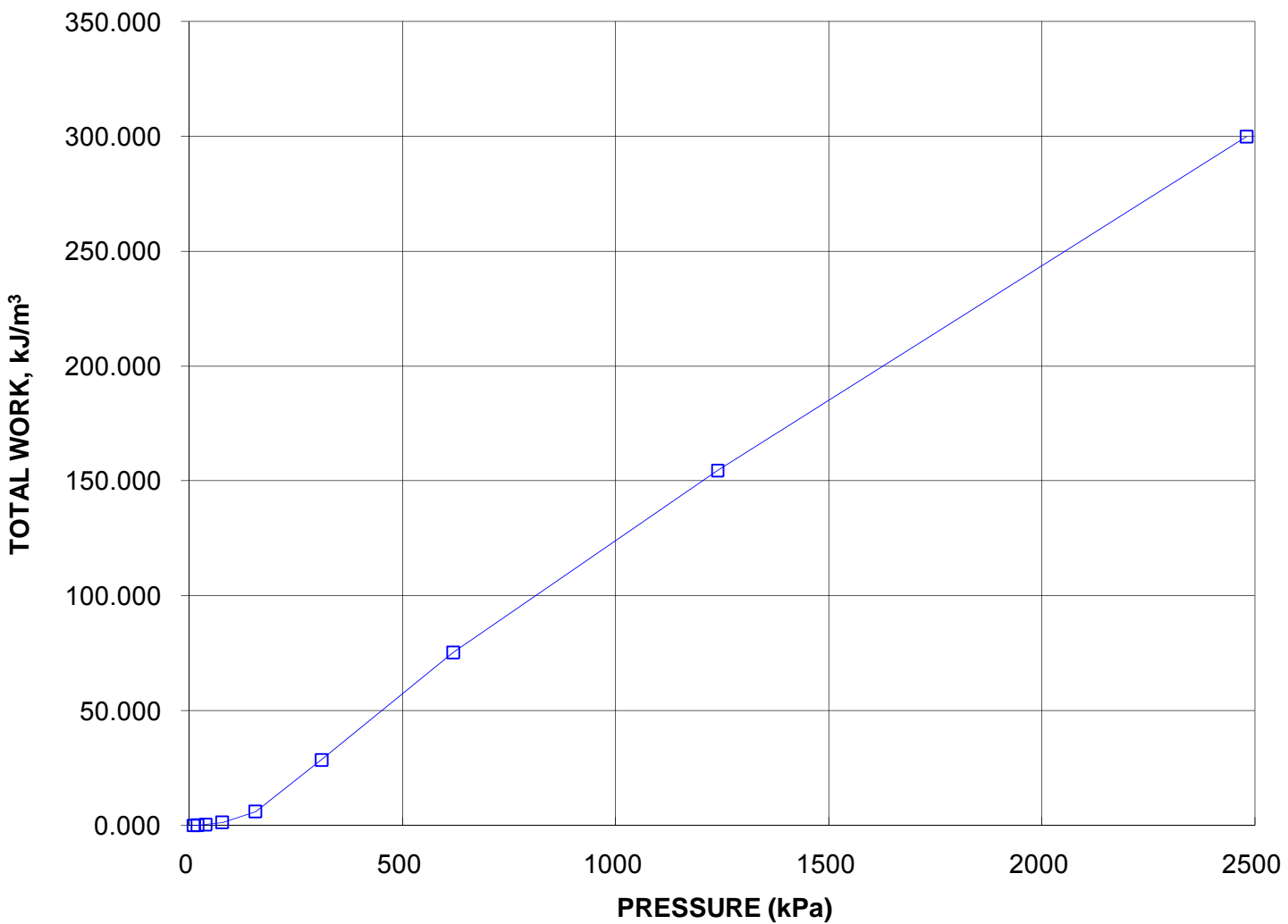
Golder Associates

Checked By: MM





CONSOLIDATION TEST  
TOTAL WORK,  $\text{kJ/m}^3$  vs PRESSURE  
BH 302-2 SA 3



| <b>CONSOLIDATION TEST SUMMARY</b><br><b>Highway 69 (SBL and NBL) STA 17+700 to 18+150</b>  |                       |                                    |                         |                        | <b>FIGURE A.S302-5</b><br><b>Sheet 1 of 4</b> |                          |           |
|--|-----------------------|------------------------------------|-------------------------|------------------------|---|--------------------------|-----------|
| <b>SAMPLE IDENTIFICATION</b>   |                       |                                    |                         |                        |   |                          |           |
| Project Number   | 06-1111-025           | Sample Number                      | 4                       |                        |   |                          |           |
| Borehole Number  | 302-2                 | Sample Depth, m                    | 6.1-6.7                 |                        |   |                          |           |
| <b>TEST CONDITIONS</b>   |                       |                                    |                         |                        |   |                          |           |
| Test Type  | Standard              | Load Duration, hr                  | 24                      |                        |   |                          |           |
| Oedometer Number   | 7                     |                                    |                         |                        |   |                          |           |
| Date Started   | 06/25/2009            |                                    |                         |                        |   |                          |           |
| Date Completed   | 07/10/2009            |                                    |                         |                        |   |                          |           |
| <b>SAMPLE DIMENSIONS AND PROPERTIES - INITIAL</b>  |                       |                                    |                         |                        |   |                          |           |
| Sample Height, cm  | 1.89                  | Unit Weight, kN/m <sup>3</sup>     | 20.36                   |                        |   |                          |           |
| Sample Diameter, cm  | 6.34                  | Dry Unit Weight, kN/m <sup>3</sup> | 15.80                   |                        |   |                          |           |
| Area, cm <sup>2</sup>  | 31.55                 | Specific Gravity, measured         | 2.72                    |                        |   |                          |           |
| Volume, cm <sup>3</sup>  | 59.76                 | Solids Height, cm                  | 1.122                   |                        |   |                          |           |
| Water Content, %   | 28.83                 | Volume of Solids, cm <sup>3</sup>  | 35.40                   |                        |   |                          |           |
| Wet Mass, g  | 124.04                | Volume of Voids, cm <sup>3</sup>   | 24.36                   |                        |   |                          |           |
| Dry Mass, g  | 96.28                 | Degree of Saturation, %            | 114.0                   |                        |   |                          |           |
| <b>TEST COMPUTATIONS</b>   |                       |                                    |                         |                        |   |                          |           |
| Pressure<br>kPa  | Corr.<br>Height<br>cm | Void<br>Ratio                      | Average<br>Height<br>cm | t <sub>90</sub><br>sec | cv.<br>cm <sup>2</sup> /s                     | mv<br>m <sup>2</sup> /kN | k<br>cm/s |
| 0.00   | 1.894                 | 0.688                              | 1.894                   |                        |   |                          |           |
| 4.84   | 1.865                 | 0.662                              | 1.880                   | 234                    | 3.20E-03                                      | 3.15E-03                 | 9.89E-07  |
| 9.57   | 1.859                 | 0.657                              | 1.862                   | 86                     | 8.55E-03                                      | 6.59E-04                 | 5.52E-07  |
| 19.32  | 1.845                 | 0.644                              | 1.852                   | 79                     | 9.21E-03                                      | 7.69E-04                 | 6.94E-07  |
| 38.83  | 1.829                 | 0.630                              | 1.837                   | 17                     | 4.21E-02                                      | 4.25E-04                 | 1.75E-06  |
| 77.69  | 1.813                 | 0.615                              | 1.821                   | 8                      | 8.79E-02                                      | 2.28E-04                 | 1.97E-06  |
| 155.23   | 1.786                 | 0.592                              | 1.799                   | 11                     | 6.24E-02                                      | 1.82E-04                 | 1.12E-06  |
| 313.87   | 1.756                 | 0.565                              | 1.771                   | 9                      | 7.39E-02                                      | 9.98E-05                 | 7.23E-07  |
| 624.22   | 1.721                 | 0.534                              | 1.738                   | 6                      | 1.07E-01                                      | 5.97E-05                 | 6.25E-07  |
| 1244.13  | 1.691                 | 0.507                              | 1.706                   | 10                     | 6.17E-02                                      | 2.54E-05                 | 1.53E-07  |
| 2486.90  | 1.657                 | 0.477                              | 1.674                   | 20                     | 2.97E-02                                      | 1.42E-05                 | 4.13E-08  |
| 1244.13  | 1.667                 | 0.486                              | 1.662                   |                        |   |                          |           |
| 313.87   | 1.694                 | 0.510                              | 1.681                   |                        |   |                          |           |
| 77.69  | 1.713                 | 0.527                              | 1.704                   |                        |   |                          |           |
| 19.32  | 1.729                 | 0.541                              | 1.721                   |                        |   |                          |           |
| 4.84   | 1.737                 | 0.549                              | 1.733                   |                        |   |                          |           |
| Note:<br>k calculated using cv based on t <sub>90</sub> values.  |                       |                                    |                         |                        |   |                          |           |
| <b>SAMPLE DIMENSIONS AND PROPERTIES - FINAL</b>  |                       |                                    |                         |                        |   |                          |           |
| Sample Height, cm  | 1.74                  | Unit Weight, kN/m <sup>3</sup>     | 21.13                   |                        |   |                          |           |
| Sample Diameter, cm  | 6.34                  | Dry Unit Weight, kN/m <sup>3</sup> | 17.23                   |                        |   |                          |           |
| Area, cm <sup>2</sup>  | 31.55                 | Specific Gravity, measured         | 2.72                    |                        |   |                          |           |
| Volume, cm <sup>3</sup>  | 54.81                 | Solids Height, cm                  | 1.122                   |                        |   |                          |           |
| Water Content, %   | 22.69                 | Volume of Solids, cm <sup>3</sup>  | 35.40                   |                        |   |                          |           |
| Wet Mass, g  | 118.13                | Volume of Voids, cm <sup>3</sup>   | 19.42                   |                        |   |                          |           |
| Dry Mass, g  | 96.28                 |                                    |                         |                        |   |                          |           |
| <div style="display: flex; justify-content: space-between;"> <span>Prepared By: LH</span> <span><b>Golder Associates</b></span> <span>Checked By: MM</span> </div> |                       |                                    |                         |                        |   |                          |           |

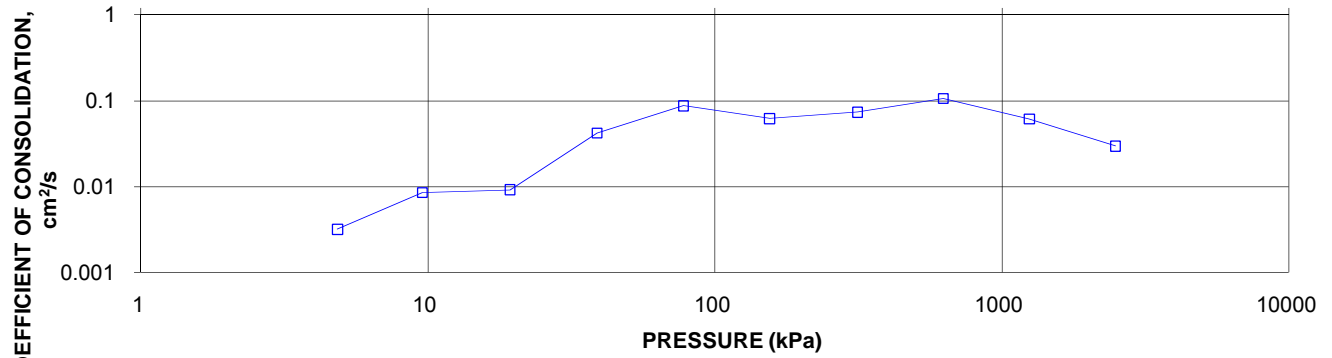
# CONSOLIDATION TEST SUMMARY

Highway 69 (SBL and NBL) STA 17+700 to 18+150

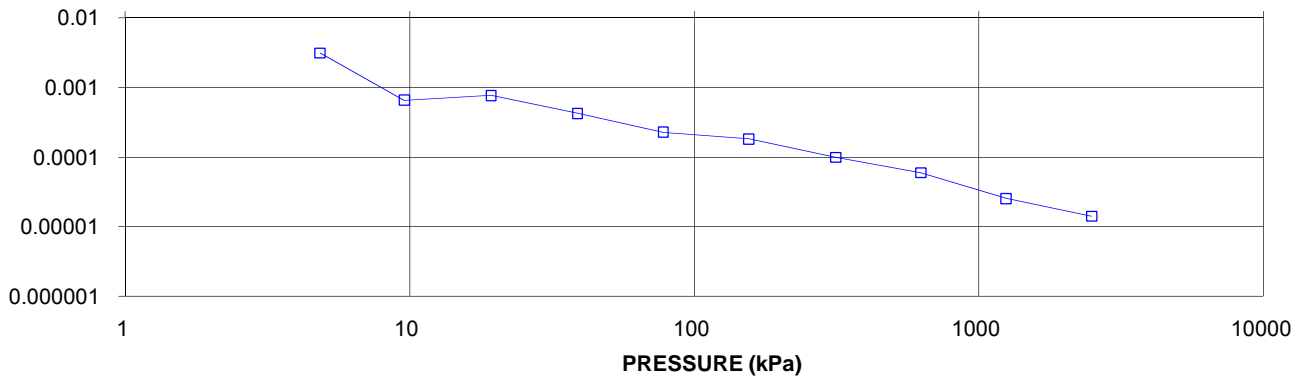
FIGURE A.S302-5

Sheet 2 of 4

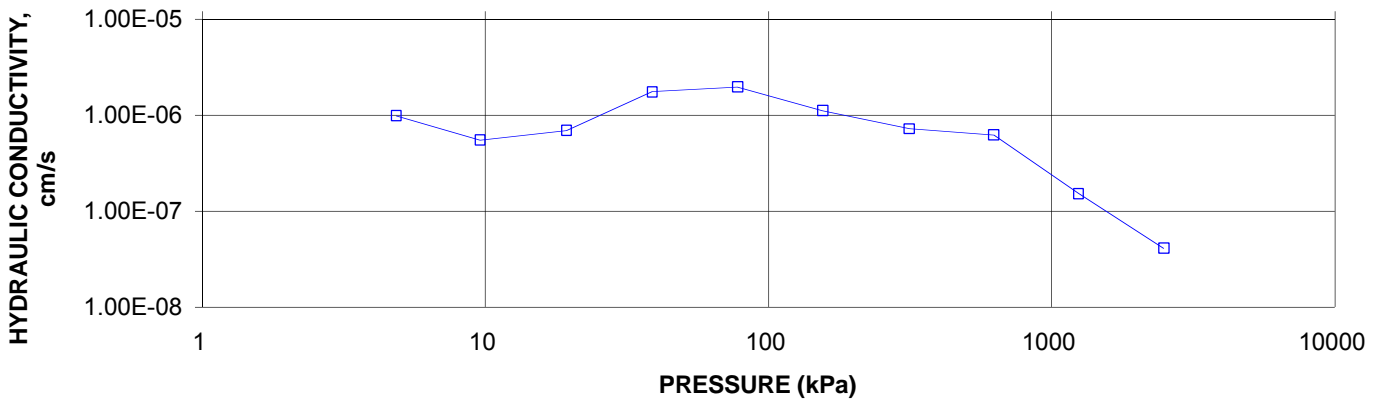
CONSOLIDATION TEST  
CV cm<sup>2</sup>/s VS PRESSURE (kPa)  
BH 302-2 SA 4

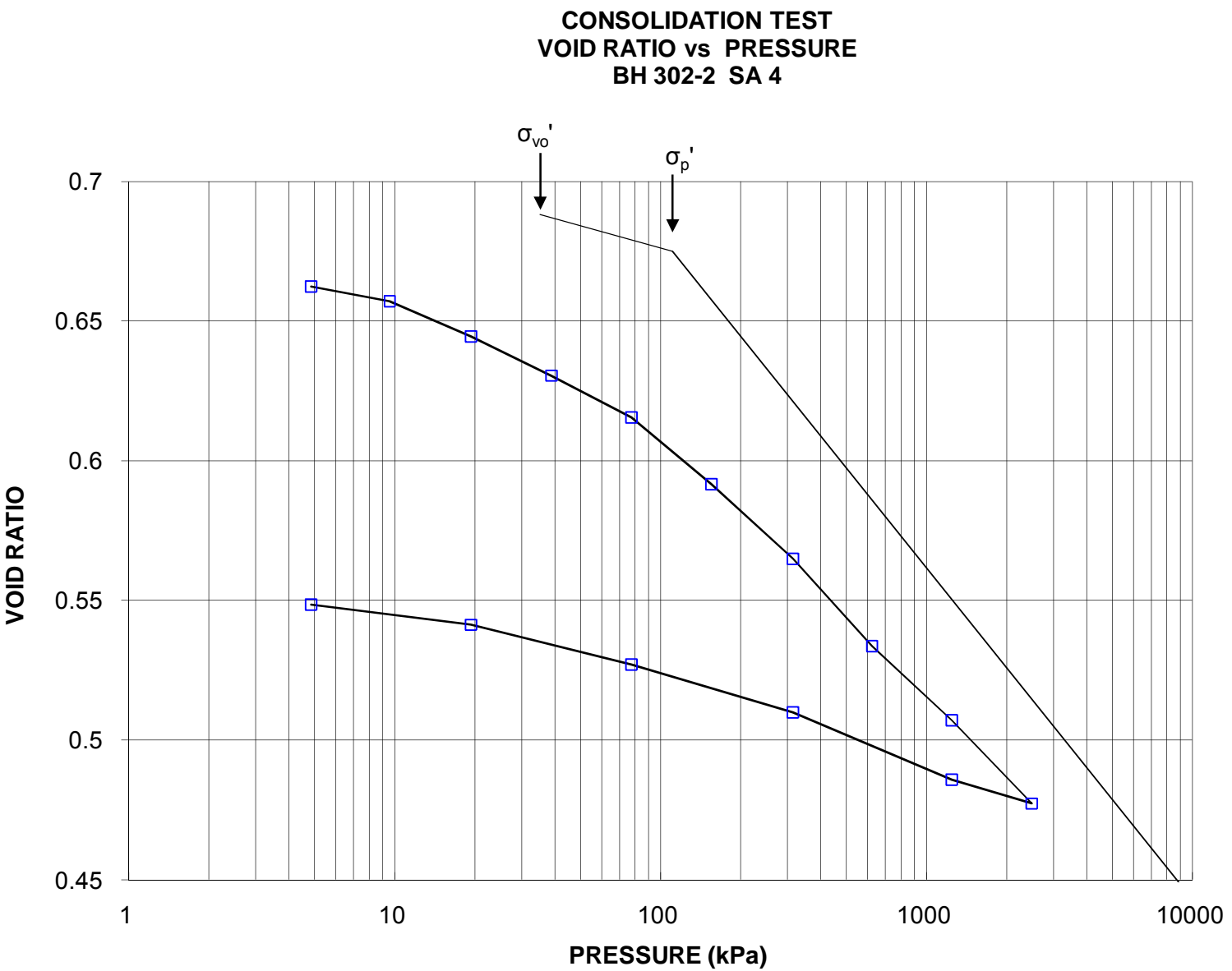


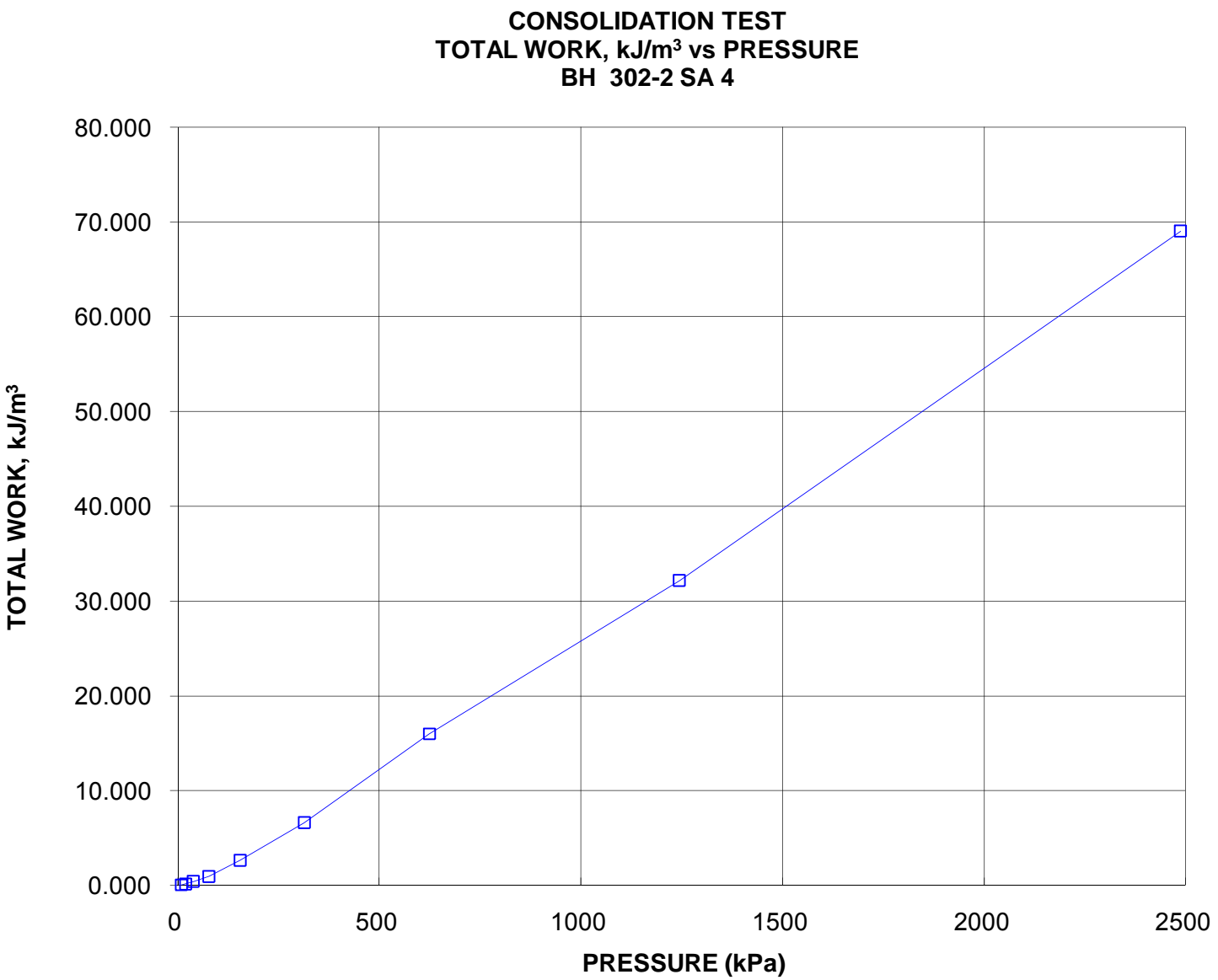
CONSOLIDATION TEST  
MV m<sup>2</sup>/kN vs PRESSURE (kPa)  
BH 302-2 SA 4



CONSOLIDATION TEST  
HYDRAULIC CONDUCTIVITY vs PRESSURE  
BH 302-2 SA 4







**CONSOLIDATION TEST SUMMARY****Highway 69 (SBL and NBL) STA 17+700 to 18+150****FIGURE A.S302-6****Sheet 1 of 4****SAMPLE IDENTIFICATION**

|                 |             |                 |         |
|-----------------|-------------|-----------------|---------|
| Project Number  | 06-1111-025 | Sample Number   | 5       |
| Borehole Number | 302-2       | Sample Depth, m | 9.1-9.8 |

**TEST CONDITIONS**

|                  |            |                   |    |
|------------------|------------|-------------------|----|
| Test Type        | Standard   | Load Duration, hr | 24 |
| Oedometer Number | 2          |                   |    |
| Date Started     | 03/25/2009 |                   |    |
| Date Completed   | 04/08/2009 |                   |    |

**SAMPLE DIMENSIONS AND PROPERTIES - INITIAL**

|                         |        |                                    |       |
|-------------------------|--------|------------------------------------|-------|
| Sample Height, cm       | 2.54   | Unit Weight, kN/m <sup>3</sup>     | 16.55 |
| Sample Diameter, cm     | 6.64   | Dry Unit Weight, kN/m <sup>3</sup> | 12.16 |
| Area, cm <sup>2</sup>   | 34.63  | Specific Gravity, measured         | 2.77  |
| Volume, cm <sup>3</sup> | 88.06  | Solids Height, cm                  | 1.138 |
| Water Content, %        | 36.12  | Volume of Solids, cm <sup>3</sup>  | 39.41 |
| Wet Mass, g             | 148.60 | Volume of Voids, cm <sup>3</sup>   | 48.65 |
| Dry Mass, g             | 109.17 | Degree of Saturation, %            | 81.1  |

**TEST COMPUTATIONS**

| Pressure<br>kPa | Corr.<br>Height<br>cm | Void<br>Ratio | Average<br>Height<br>cm | t <sub>90</sub><br>sec | cv.<br>cm <sup>2</sup> /s | mv<br>m <sup>2</sup> /kN | k<br>cm/s |
|-----------------|-----------------------|---------------|-------------------------|------------------------|---------------------------|--------------------------|-----------|
| 0.00            | 2.543                 | 1.234         | 2.543                   |                        |                           |                          |           |
| 4.77            | 2.530                 | 1.223         | 2.537                   | 14                     | 9.74E-02                  | 1.07E-03                 | 1.02E-05  |
| 9.58            | 2.523                 | 1.216         | 2.526                   | 32                     | 4.23E-02                  | 6.05E-04                 | 2.51E-06  |
| 19.55           | 2.511                 | 1.206         | 2.517                   | 38                     | 3.53E-02                  | 4.77E-04                 | 1.65E-06  |
| 39.01           | 2.496                 | 1.193         | 2.503                   | 15                     | 8.86E-02                  | 2.99E-04                 | 2.60E-06  |
| 77.62           | 2.474                 | 1.173         | 2.485                   | 18                     | 7.27E-02                  | 2.26E-04                 | 1.61E-06  |
| 155.17          | 2.410                 | 1.117         | 2.442                   | 12                     | 1.05E-01                  | 3.22E-04                 | 3.32E-06  |
| 309.54          | 2.315                 | 1.034         | 2.362                   | 20                     | 5.92E-02                  | 2.43E-04                 | 1.41E-06  |
| 619.20          | 2.237                 | 0.966         | 2.276                   | 11                     | 9.98E-02                  | 9.79E-05                 | 9.58E-07  |
| 1239.49         | 2.170                 | 0.906         | 2.203                   | 12                     | 8.58E-02                  | 4.30E-05                 | 3.62E-07  |
| 2481.87         | 2.106                 | 0.851         | 2.138                   | 14                     | 6.92E-02                  | 2.00E-05                 | 1.36E-07  |
| 1239.49         | 2.108                 | 0.852         | 2.107                   |                        |                           |                          |           |
| 309.54          | 2.130                 | 0.871         | 2.119                   |                        |                           |                          |           |
| 77.62           | 2.152                 | 0.891         | 2.141                   |                        |                           |                          |           |
| 19.55           | 2.171                 | 0.907         | 2.162                   |                        |                           |                          |           |
| 4.77            | 2.184                 | 0.919         | 2.178                   |                        |                           |                          |           |

Note:

k calculated using cv based on t<sub>90</sub> values.**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

|                         |        |                                    |       |
|-------------------------|--------|------------------------------------|-------|
| Sample Height, cm       | 2.18   | Unit Weight, kN/m <sup>3</sup>     | 18.00 |
| Sample Diameter, cm     | 6.64   | Dry Unit Weight, kN/m <sup>3</sup> | 14.16 |
| Area, cm <sup>2</sup>   | 34.63  | Specific Gravity, measured         | 2.77  |
| Volume, cm <sup>3</sup> | 75.63  | Solids Height, cm                  | 1.138 |
| Water Content, %        | 27.14  | Volume of Solids, cm <sup>3</sup>  | 39.41 |
| Wet Mass, g             | 138.80 | Volume of Voids, cm <sup>3</sup>   | 36.22 |
| Dry Mass, g             | 109.17 |                                    |       |

Prepared By: LH

**Golder Associates**

Checked By: MM

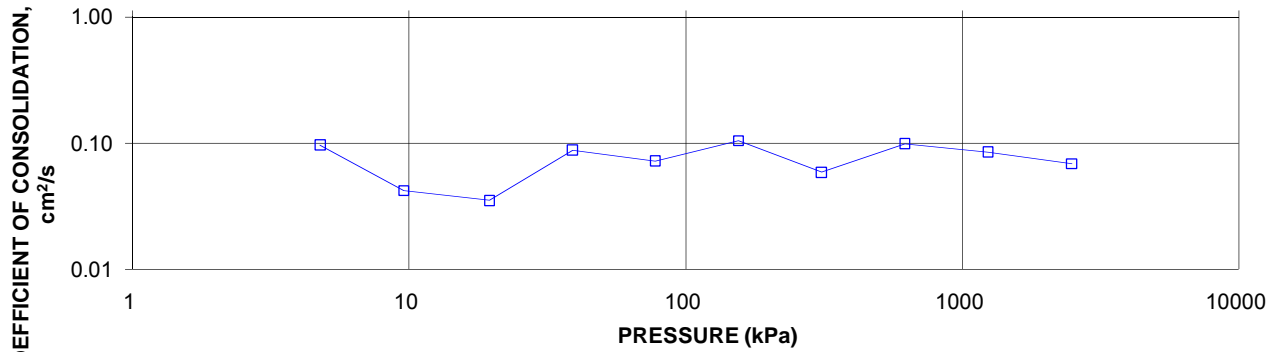
# CONSOLIDATION TEST SUMMARY

Highway 69 (SBL and NBL) STA 17+700 to 18+150

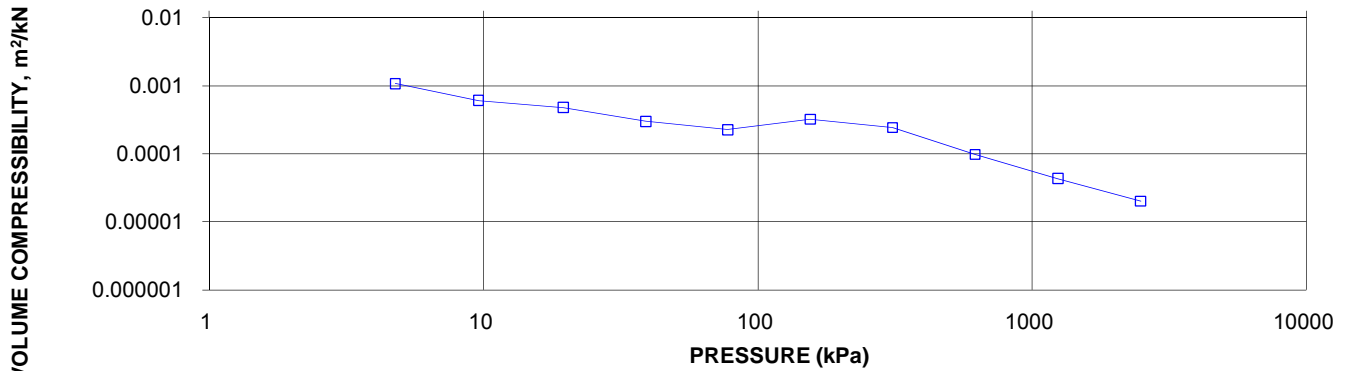
FIGURE A.S302-6

Sheet 2 of 4

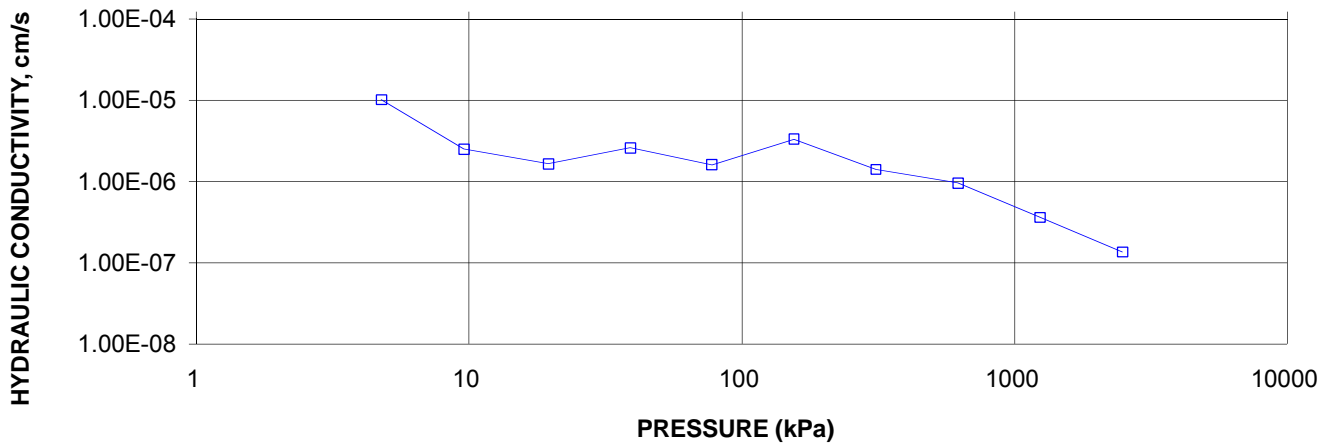
CONSOLIDATION TEST  
CV cm<sup>2</sup>/s VS PRESSURE (kPa)  
BH 302-2 SA 5

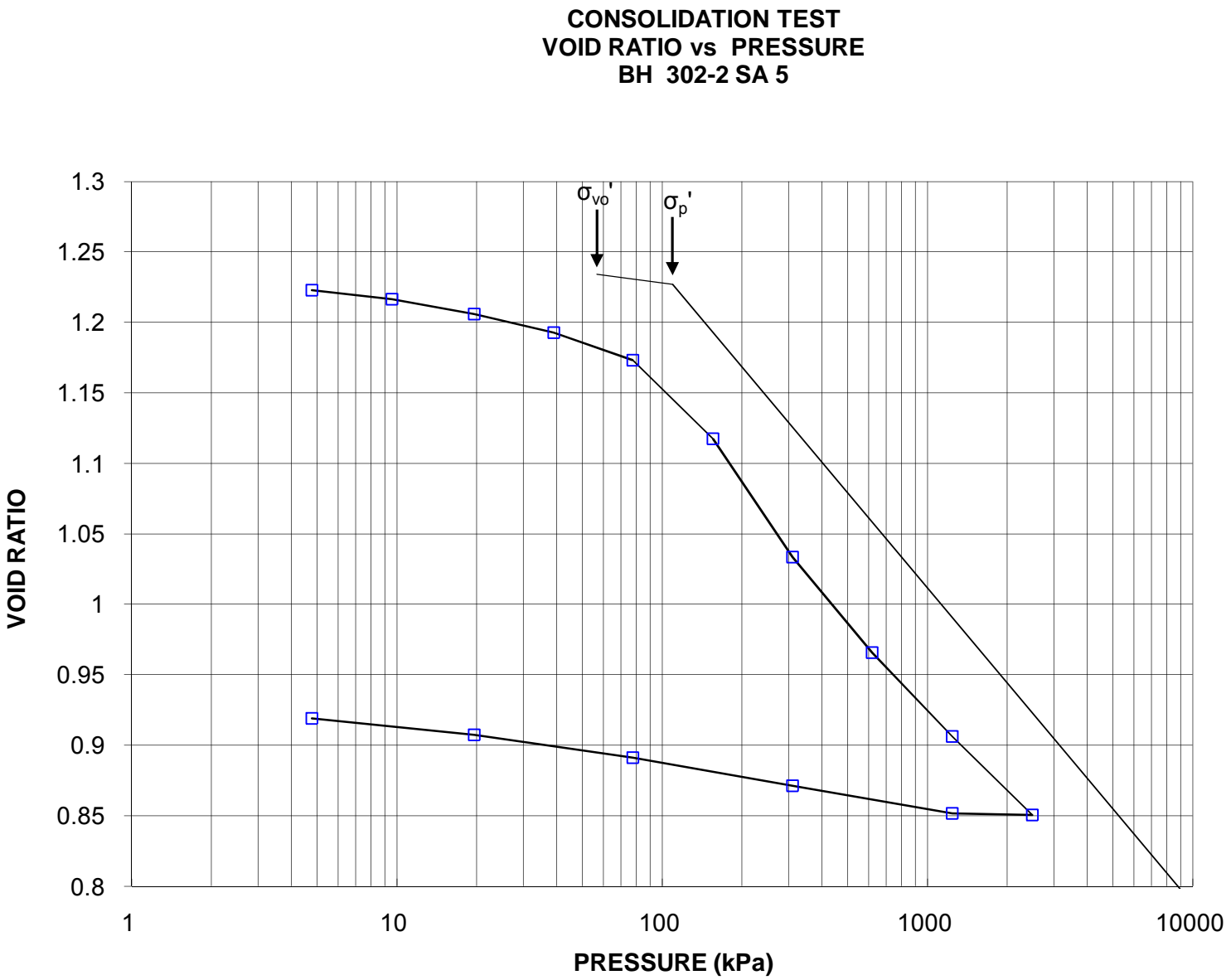


CONSOLIDATION TEST  
MV m<sup>2</sup>/kN vs PRESSURE (kPa)  
BH 302-2 SA 5

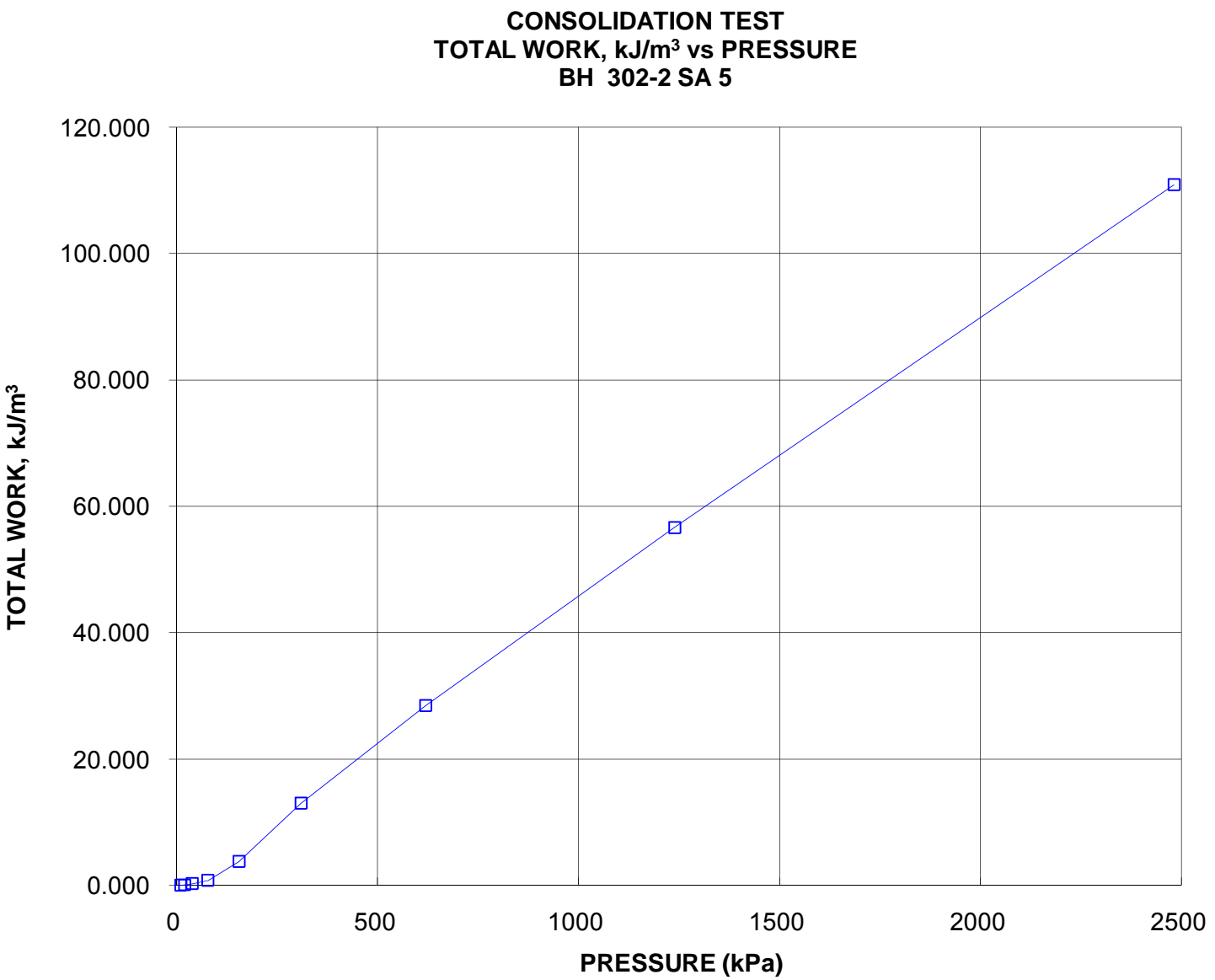


CONSOLIDATION TEST  
HYDRAULIC CONDUCTIVITY vs PRESSURE  
BH 302-2 SA 5









**CONSOLIDATION TEST SUMMARY (VTO)**  
**Highway 69 (SBL and NBL) STA 17+700 to 18+150**

**FIGURE A.S302-7**  
**Sheet 1 of 4**

**SAMPLE IDENTIFICATION**

|                 |             |                 |         |
|-----------------|-------------|-----------------|---------|
| Project Number  | 06-1111-025 | Sample Number   | 5       |
| Borehole Number | 302-2       | Sample Depth, m | 9.1-9.8 |

**TEST CONDITIONS**

|                  |            |                   |    |
|------------------|------------|-------------------|----|
| Test Type        | Standard   | Load Duration, hr | 24 |
| Oedometer Number | 1          |                   |    |
| Date Started     | 03/25/2009 |                   |    |
| Date Completed   | 04/08/2009 |                   |    |

**SAMPLE DIMENSIONS AND PROPERTIES - INITIAL**

|                         |        |                                    |       |
|-------------------------|--------|------------------------------------|-------|
| Sample Height, cm       | 2.54   | Unit Weight, kN/m <sup>3</sup>     | 18.06 |
| Sample Diameter, cm     | 6.34   | Dry Unit Weight, kN/m <sup>3</sup> | 13.07 |
| Area, cm <sup>2</sup>   | 31.61  | Specific Gravity, measured         | 2.76  |
| Volume, cm <sup>3</sup> | 80.38  | Solids Height, cm                  | 1.228 |
| Water Content, %        | 38.20  | Volume of Solids, cm <sup>3</sup>  | 38.81 |
| Wet Mass, g             | 148.04 | Volume of Voids, cm <sup>3</sup>   | 41.57 |
| Dry Mass, g             | 107.12 | Degree of Saturation, %            | 98.4  |

**TEST COMPUTATIONS**

| Pressure<br>kPa | Corr.<br>Height<br>cm | Void<br>Ratio | Average<br>Height<br>cm | t <sub>90</sub><br>sec | cv.<br>cm <sup>2</sup> /s | mv<br>m <sup>2</sup> /kN | k<br>cm/s |
|-----------------|-----------------------|---------------|-------------------------|------------------------|---------------------------|--------------------------|-----------|
| 0.00            | 2.543                 | 1.071         | 2.543                   |                        |                           |                          |           |
| 4.70            | 2.539                 | 1.068         | 2.541                   | 12                     | 1.14E-01                  | 3.23E-04                 | 3.61E-06  |
| 9.55            | 2.534                 | 1.064         | 2.537                   | 17                     | 8.02E-02                  | 4.04E-04                 | 3.18E-06  |
| 19.32           | 2.528                 | 1.059         | 2.531                   | 8                      | 1.70E-01                  | 2.60E-04                 | 4.33E-06  |
| 38.76           | 2.512                 | 1.046         | 2.520                   | 12                     | 1.12E-01                  | 3.26E-04                 | 3.58E-06  |
| 77.54           | 2.478                 | 1.018         | 2.495                   | 15                     | 8.80E-02                  | 3.43E-04                 | 2.95E-06  |
| 154.86          | 2.421                 | 0.972         | 2.449                   | 23                     | 5.53E-02                  | 2.89E-04                 | 1.57E-06  |
| 309.86          | 2.347                 | 0.911         | 2.384                   | 27                     | 4.46E-02                  | 1.88E-04                 | 8.23E-07  |
| 620.17          | 2.263                 | 0.843         | 2.305                   | 17                     | 6.62E-02                  | 1.07E-04                 | 6.93E-07  |
| 1240.42         | 2.177                 | 0.773         | 2.220                   | 28                     | 3.73E-02                  | 5.42E-05                 | 1.98E-07  |
| 2478.93         | 2.101                 | 0.711         | 2.139                   | 20                     | 4.85E-02                  | 2.43E-05                 | 1.15E-07  |
| 1240.42         | 2.103                 | 0.713         | 2.102                   |                        |                           |                          |           |
| 309.86          | 2.125                 | 0.731         | 2.114                   |                        |                           |                          |           |
| 77.54           | 2.146                 | 0.748         | 2.135                   |                        |                           |                          |           |
| 19.32           | 2.164                 | 0.762         | 2.155                   |                        |                           |                          |           |
| 4.70            | 2.181                 | 0.777         | 2.173                   |                        |                           |                          |           |

Note:  
k calculated using cv based on t<sub>90</sub> values.  
Specimen trimmed in a vertical plane

**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

|                         |        |                                    |       |
|-------------------------|--------|------------------------------------|-------|
| Sample Height, cm       | 2.18   | Unit Weight, kN/m <sup>3</sup>     | 19.58 |
| Sample Diameter, cm     | 6.34   | Dry Unit Weight, kN/m <sup>3</sup> | 15.24 |
| Area, cm <sup>2</sup>   | 31.61  | Specific Gravity, measured         | 2.76  |
| Volume, cm <sup>3</sup> | 68.95  | Solids Height, cm                  | 1.228 |
| Water Content, %        | 28.53  | Volume of Solids, cm <sup>3</sup>  | 38.81 |
| Wet Mass, g             | 137.68 | Volume of Voids, cm <sup>3</sup>   | 30.14 |
| Dry Mass, g             | 107.12 |                                    |       |

Prepared By: LH

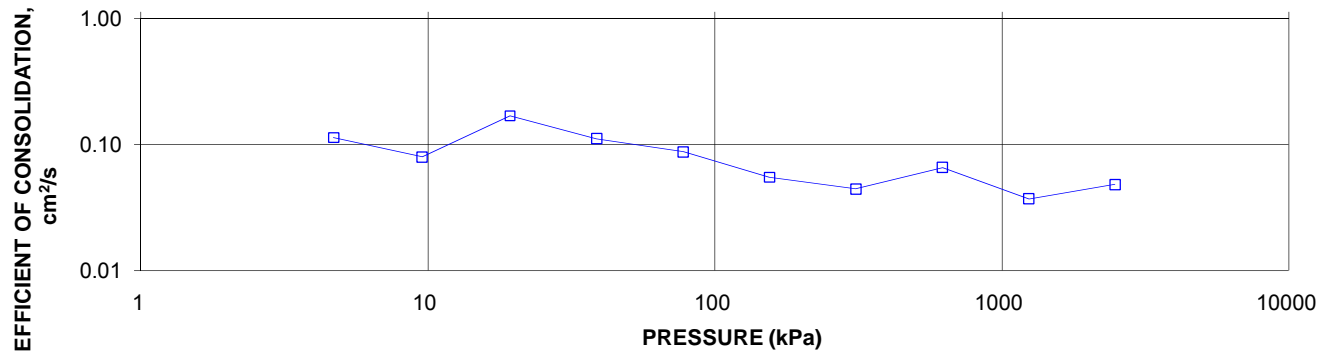
**Golder Associates**

Checked By: MM

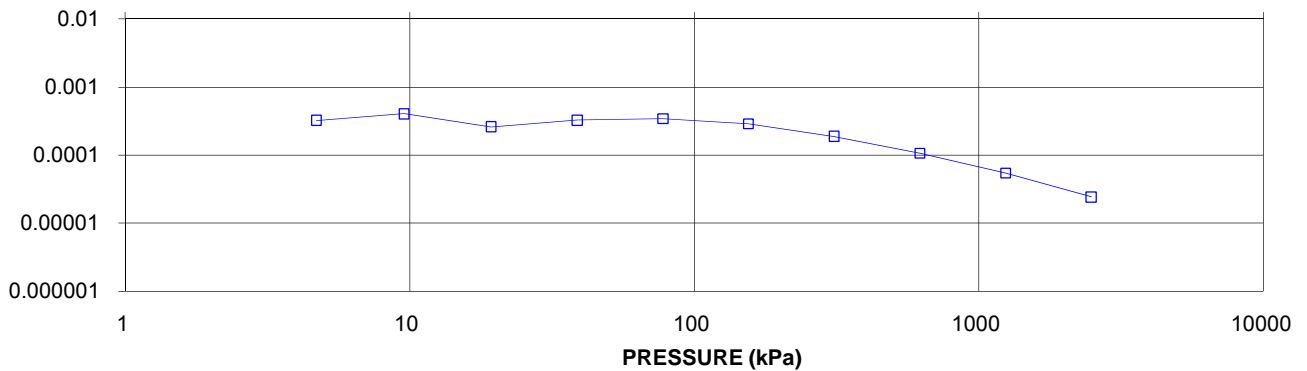
**CONSOLIDATION TEST SUMMARY (VTO)**  
**Highway 69 (SBL and NBL) STA 17+700 to 18+150**

**FIGURE A.S302-7**  
**Sheet 2 of 4**

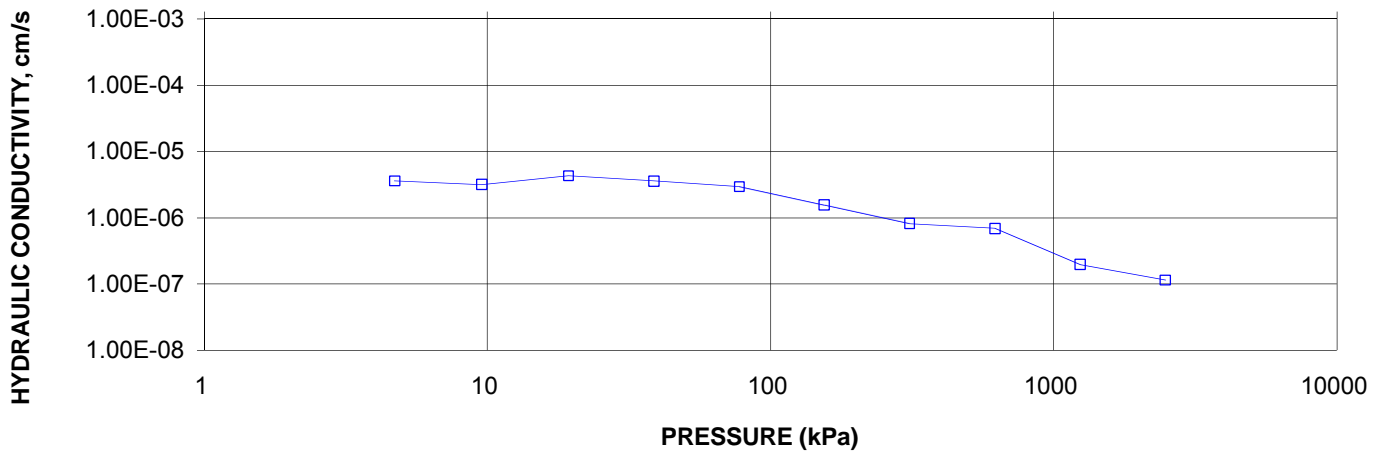
**CONSOLIDATION TEST**  
**CV cm<sup>2</sup>/s VS PRESSURE (kPa)**  
**BH 302-2 SA 5**

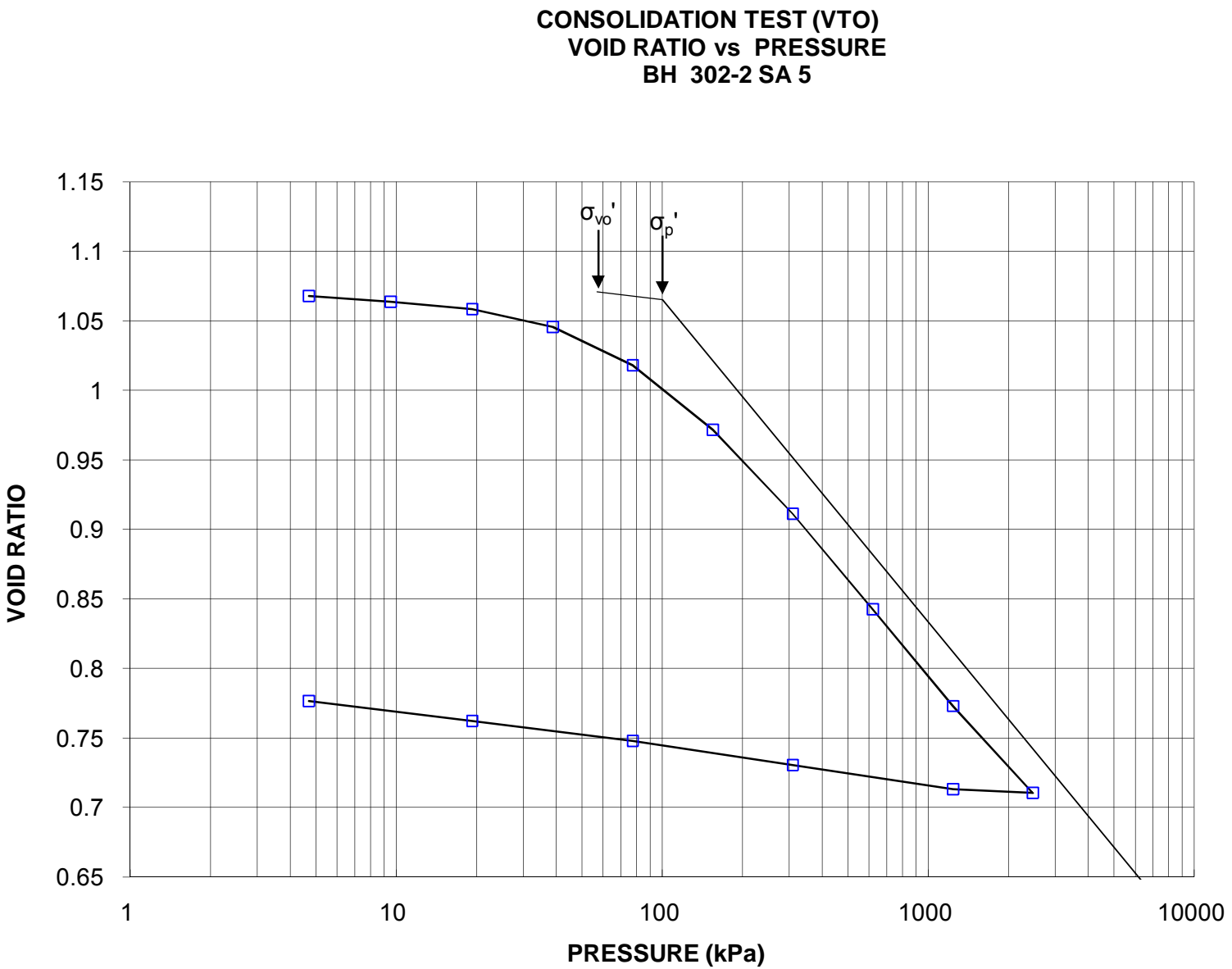


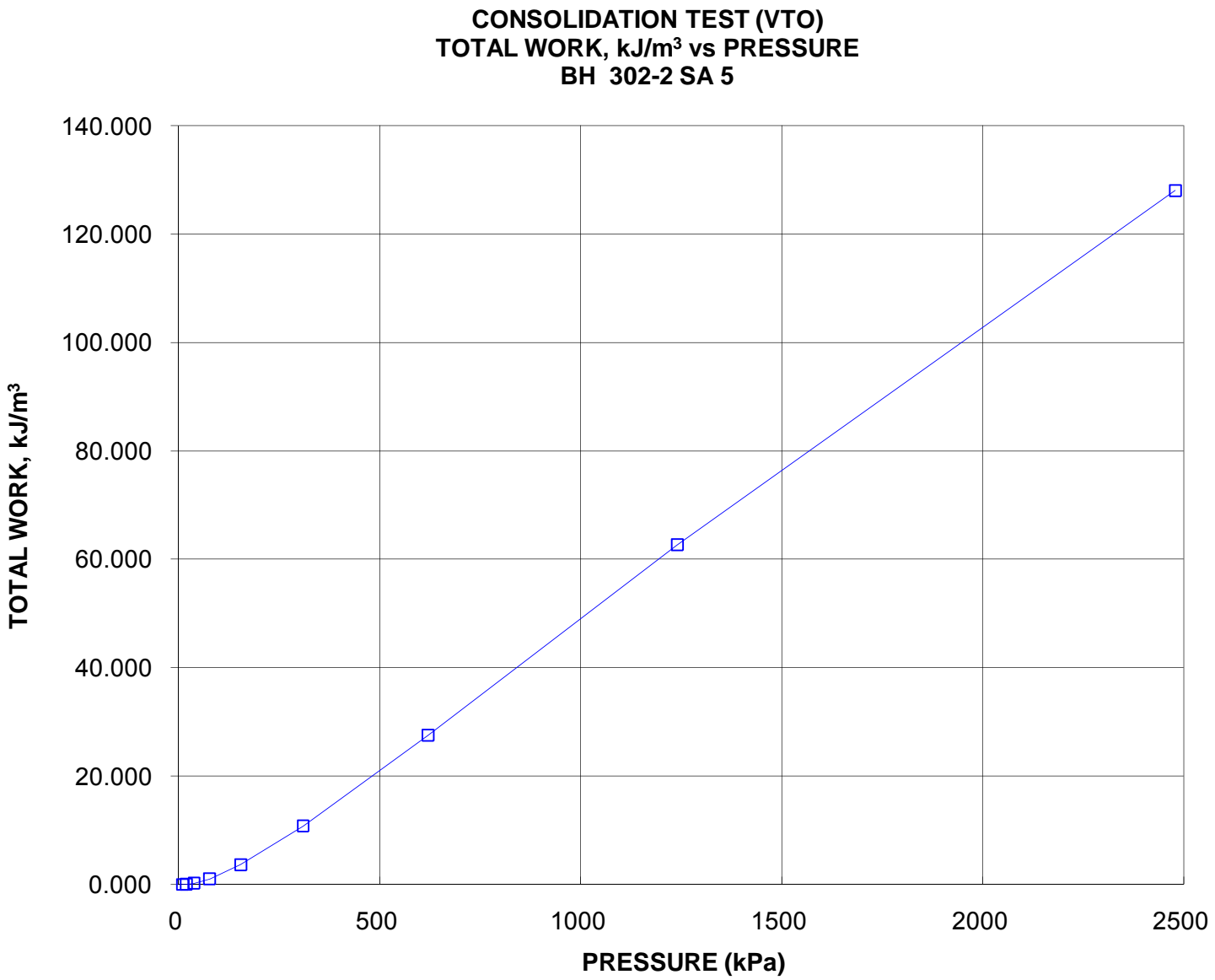
**CONSOLIDATION TEST**  
**MV m<sup>2</sup>/kN vs PRESSURE (kPa)**  
**BH 302-2 SA 5**



**CONSOLIDATION TEST**  
**HYDRAULIC CONDUCTIVITY vs PRESSURE**  
**BH 302-2 SA 5**





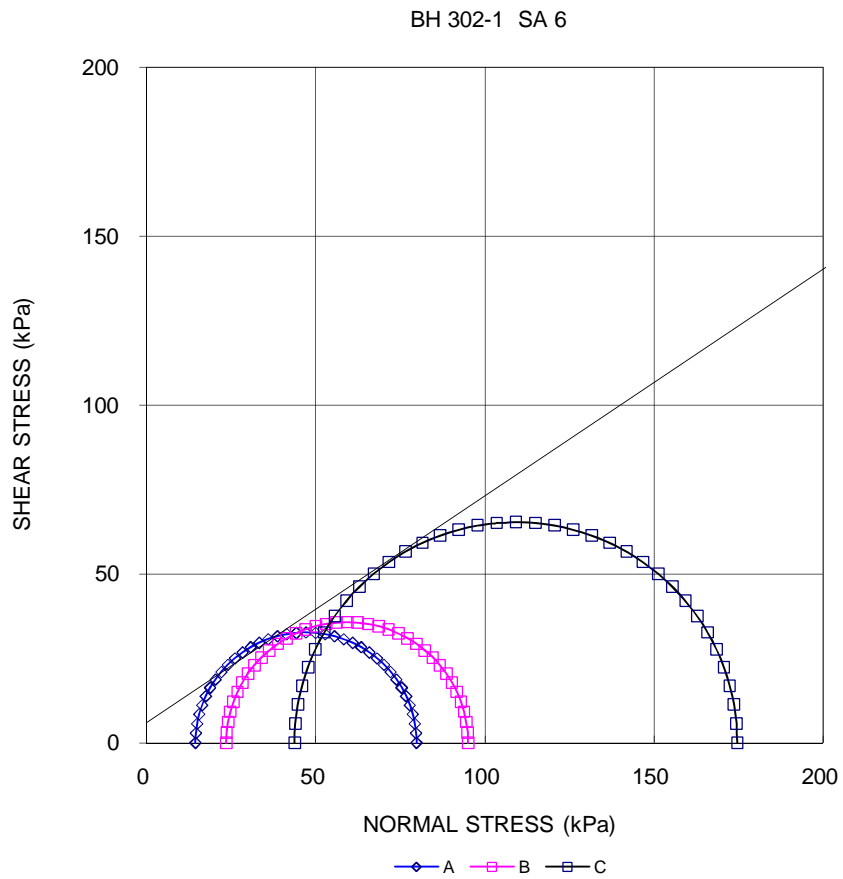


| CONSOLIDATED UNDRAINED TRIAXIAL<br>WITH PORE PRESSURE MEASUREMENTS  |        |       | FIGURE A.S302-8<br>Sheet 1 of 4 |
|---|--------|-------|---------------------------------|
| TEST STAGE  | A      | B     | C                               |
| BOREHOLE NUMBER   | 302-1  | 302-1 | 302-1                           |
| SAMPLE  | 6      | 6     | 6                               |
| SPECIMEN DIAMETER, cm   | 4.99   | 4.99  | 5.02                            |
| SPECIMEN HEIGHT, cm   | 10.10  | 10.18 | 10.58                           |
| WATER CONTENT BEFORE CONSOLIDATION, %   | 49.2   | 53.4  | 51.9                            |
| CELL PRESSURE, $\sigma_3$ , kPa   | 575.0  | 480.0 | 615.0                           |
| BACK PRESSURE, kPa  | 555.0  | 415.0 | 485.0                           |
| PORE PRESSURE PARAMETER "B"   | 0.98   | 0.90  | 0.90                            |
| CONSOLIDATION PRESSURE, $\sigma_c$ , kPa  | 20.0   | 65.0  | 130.0                           |
| VOLUMETRIC STRAIN DURING CONSOLIDATION, %   | 0.5    | 2.7   | 10.5                            |
| WATER CONTENT AFTER CONSOLIDATION, %  | 48.7   | 50.9  | 42.2                            |
| AVERAGE RATE OF STRAIN, %/hr  | 0.5    | 0.5   | 0.5                             |
| TIME TO FAILURE, DAYS   | 2      | 2     | 2                               |
| WATER CONTENT AFTER TEST, %   | 48.9   | 51.2  | 44.2                            |
| MAX. DEVIATOR STRESS, $(\sigma_1 - \sigma_3)$ , kPa   | 65.5   | 71.5  | 130.8                           |
| AXIAL STRAIN AT $(\sigma_1 - \sigma_3)$ MAXIMUM, %  | 5.4    | 4.7   | 7.8                             |
| MAX EFFECTIVE PRINCIPAL STRESS<br>RATIO, $(\sigma_1 / \sigma_3)$ MAXIMUM  | 6.6    | 4.4   | 4.4                             |
| DEVIATOR STRESS AT $(\sigma_1 / \sigma_3)$ MAXIMUM, kPa   | 56.7   | 71.5  | 121.0                           |
| AXIAL STRAIN AT $(\sigma_1 / \sigma_3)$ MAXIMUM, %  | 2.5    | 5.3   | 15.2                            |
| PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 - \sigma_3)$ MAXIMUM   | 0.09   | 0.58  | 0.66                            |
| PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 / \sigma_3)$ MAXIMUM   | 0.17   | 0.59  | 0.77                            |
| NATURAL WATER CONTENT, %  | 46.6   | 52.3  | 50.4                            |
| DRY DENSITY, Mg/m <sup>3</sup>  | 1.19   | 1.10  | 1.08                            |
| FILTER DRAINS USED, y/n   | y      | y     | y                               |
| TEST NOTES:   |        |       |                                 |
| CHANGED RATE OF STRAIN, %/hr  | -      | -     | -                               |
| AXIAL STRAIN WHERE RATE OF STRAIN WAS CHANGED, %  | -      | -     | -                               |
| FAILURE PLANE NUMBER  | -      | 1.0   | -                               |
| ANGLE OF FAILURE, DEGREES   | bulged | 70.0  | -                               |
| <div> <div>Date: 04/27/2009</div> <div>Project No. 06-1111-025</div> <div>Golder Associates</div> <div>Prepared By: LH</div> <div>Checked By: MM</div> </div> |        |       |                                 |

**CONSOLIDATED UNDRAINED TRIAXIAL  
WITH PORE PRESSURE MEASUREMENTS**

**FIGURE A.S302-8**

**Sheet 2 of 4**



Date: 04/27/2009  
Project No. 06-1111-025

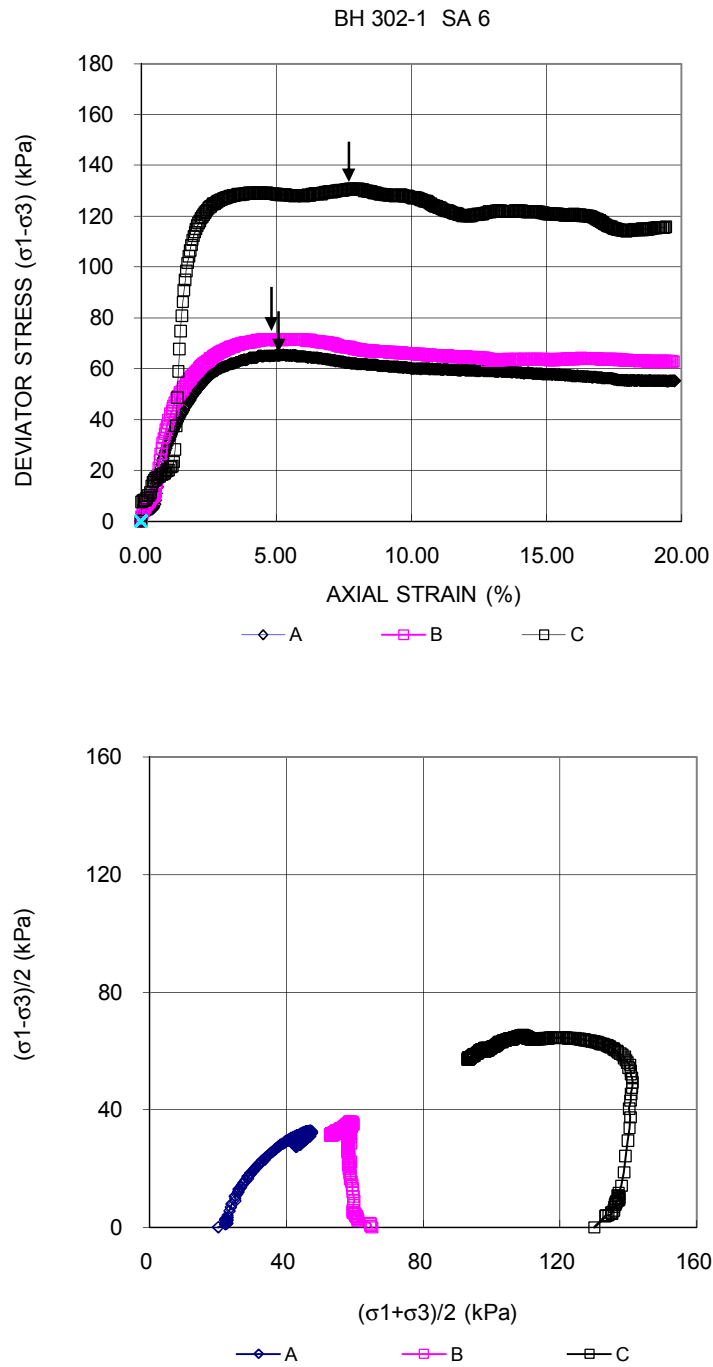
**Golder Associates**

Prepared By: LH  
Checked By: MM

CONSOLIDATED UNDRAINED TRIAXIAL  
WITH PORE PRESSURE MEASUREMENTS

FIGURE A.S302-8

Sheet 3 of 4



Date: 04/27/2009  
Project No. 06-1111-025

**Golder Associates**

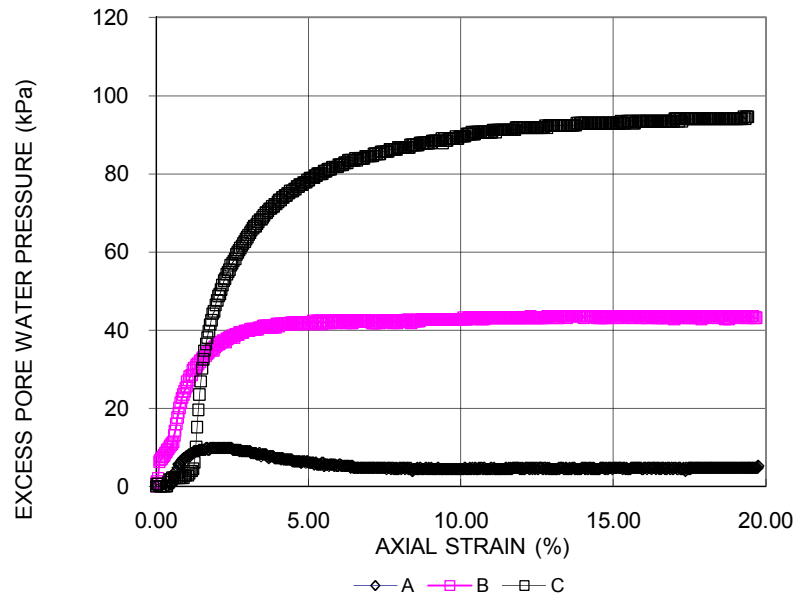
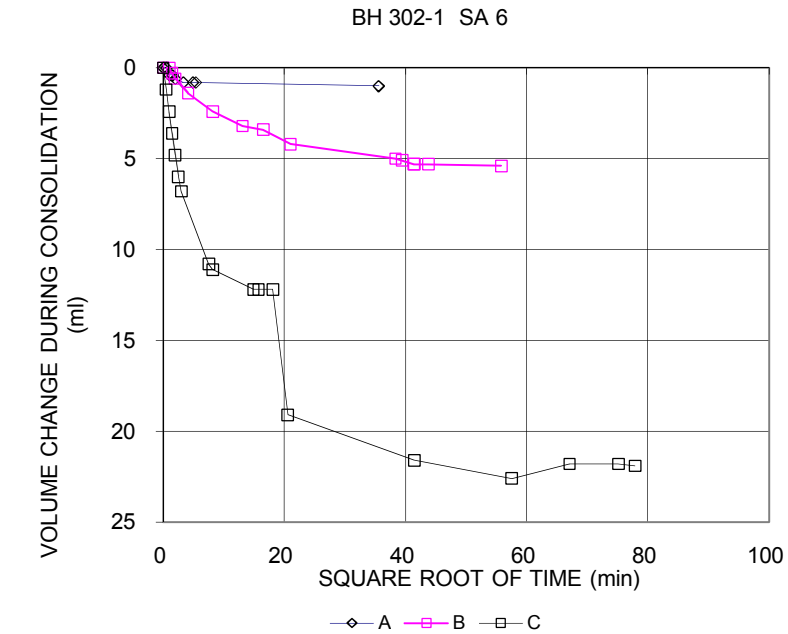
Prepared By: LH  
Checked By: MM



**CONSOLIDATED UNDRAINED TRIAXIAL  
WITH PORE PRESSURE MEASUREMENTS**

**FIGURE A.S302-8**

**Sheet 4 of 4**

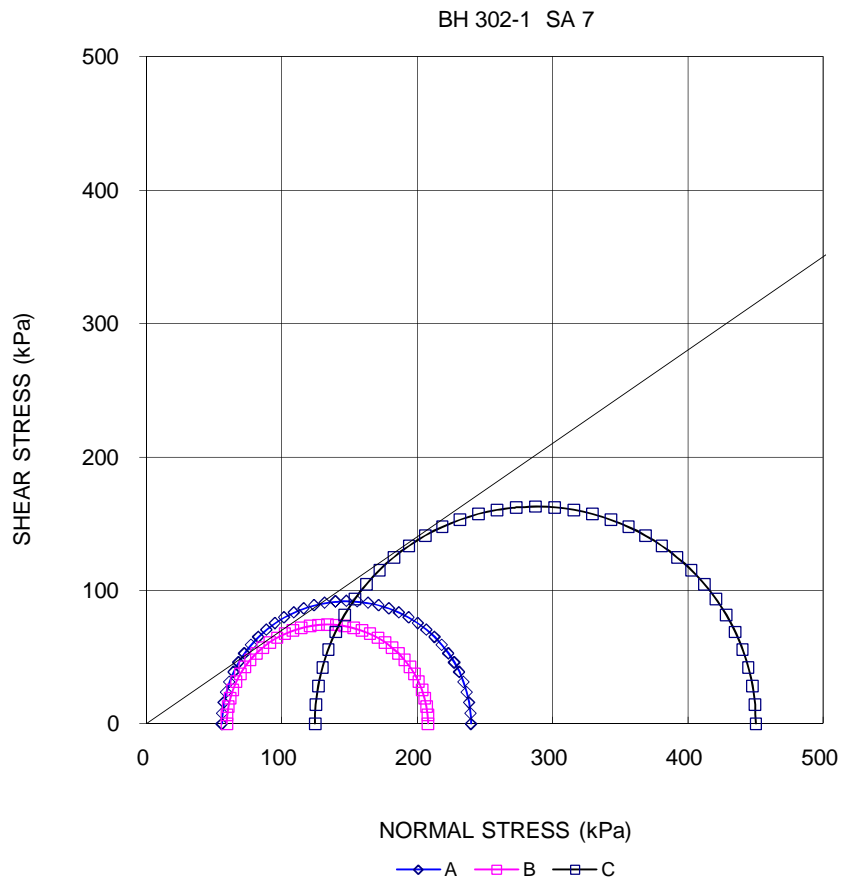


Date: 04/27/2009  
Project No. 06-1111-025

**Golder Associates**

Prepared By: LH  
Checked By: MM

| CONSOLIDATED UNDRAINED TRIAXIAL<br>WITH PORE PRESSURE MEASUREMENTS  |        |        | FIGURE A.S302-9<br>Sheet 1 of 4 |
|---|--------|--------|---------------------------------|
| TEST STAGE  | A      | B      | C                               |
| BOREHOLE NUMBER   | 302-1  | 302-1  | 302-1                           |
| SAMPLE  | 7      | 7      | 7                               |
| SPECIMEN DIAMETER, cm   | 4.98   | 5.02   | 5.04                            |
| SPECIMEN HEIGHT, cm   | 10.14  | 10.15  | 10.09                           |
| WATER CONTENT BEFORE CONSOLIDATION, %   | 28.9   | 31.7   | 30.8                            |
| CELL PRESSURE, $\sigma_3$ , kPa   | 245.0  | 515.0  | 285.0                           |
| BACK PRESSURE, kPa  | 205.0  | 415.0  | 135.0                           |
| PORE PRESSURE PARAMETER "B"   | 0.98   | 0.92   | 1.00                            |
| CONSOLIDATION PRESSURE, $\sigma_c$ , kPa  | 40.0   | 100.0  | 150.0                           |
| VOLUMETRIC STRAIN DURING CONSOLIDATION, %   | 2.3    | 3.7    | 5.5                             |
| WATER CONTENT AFTER CONSOLIDATION, %  | 27.5   | 29.2   | 27.2                            |
| AVERAGE RATE OF STRAIN, %/hr  | 0.5    | 0.5    | 0.5                             |
| TIME TO FAILURE, DAYS   | 2      | 2      | 2                               |
| WATER CONTENT AFTER TEST, %   | 26.0   | 28.0   | 25.7                            |
| MAX. DEVIATOR STRESS, $(\sigma_1 - \sigma_3)$ , kPa   | 184.1  | 148.8  | 325.7                           |
| AXIAL STRAIN AT $(\sigma_1 - \sigma_3)$ MAXIMUM, %  | 15.4   | 17.2   | 19.5                            |
| MAX EFFECTIVE PRINCIPAL STRESS<br>RATIO, $(\sigma_1 / \sigma_3)$ MAXIMUM  | 5.0    | 3.6    | 3.9                             |
| DEVIATOR STRESS AT $(\sigma_1 / \sigma_3)$ MAXIMUM, kPa   | 68.5   | 107.4  | 217.4                           |
| AXIAL STRAIN AT $(\sigma_1 / \sigma_3)$ MAXIMUM, %  | 4.3    | 7.4    | 8.6                             |
| PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 - \sigma_3)$ MAXIMUM   | -0.09  | 0.27   | 0.08                            |
| PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 / \sigma_3)$ MAXIMUM   | 0.34   | 0.55   | 0.35                            |
| NATURAL WATER CONTENT, %  | 27.4   | 29.2   | 29.4                            |
| DRY DENSITY, Mg/m <sup>3</sup>  | 1.58   | 1.49   | 1.52                            |
| FILTER DRAINS USED, y/n   | y      | y      | y                               |
| TEST NOTES:   |        |        |                                 |
| CHANGED RATE OF STRAIN, %/hr  | -      | -      | -                               |
| AXIAL STRAIN WHERE RATE OF STRAIN WAS CHANGED, %  | -      | -      | -                               |
| FAILURE PLANE NUMBER  | -      | -      | 1.0                             |
| ANGLE OF FAILURE, DEGREES   | bulged | bulged | 70.0                            |
| <div> <div>Date: 04/28/2009</div> <div>Project No. 06-1111-025</div> <div>Golder Associates</div> <div>Prepared By: LH</div> <div>Checked By: MM</div> </div> |        |        |                                 |



Date: 04/28/2009  
Project No. 06-1111-025

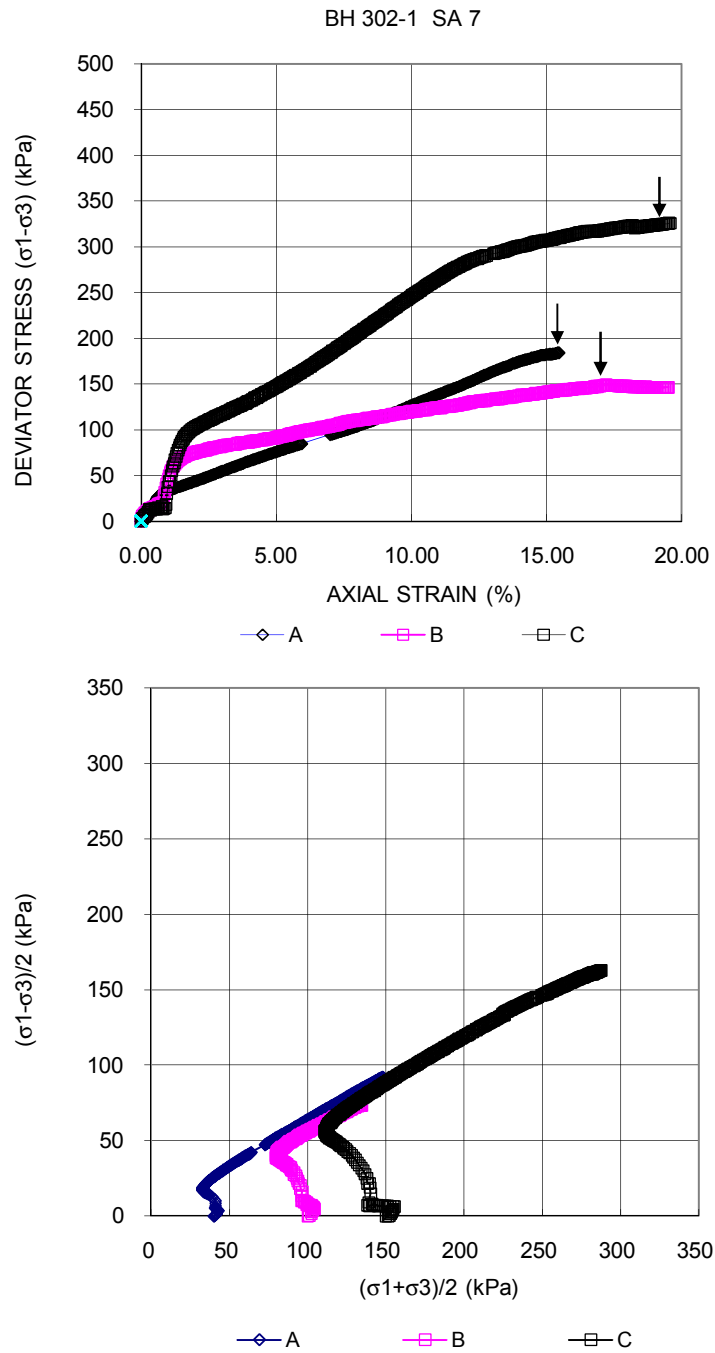
**Golder Associates**

Prepared By: LH  
Checked By: MM

**CONSOLIDATED UNDRAINED TRIAXIAL  
WITH PORE PRESSURE MEASUREMENTS**

**FIGURE A.S302-9**

**Sheet 3 of 4**



Date: 04/28/2009  
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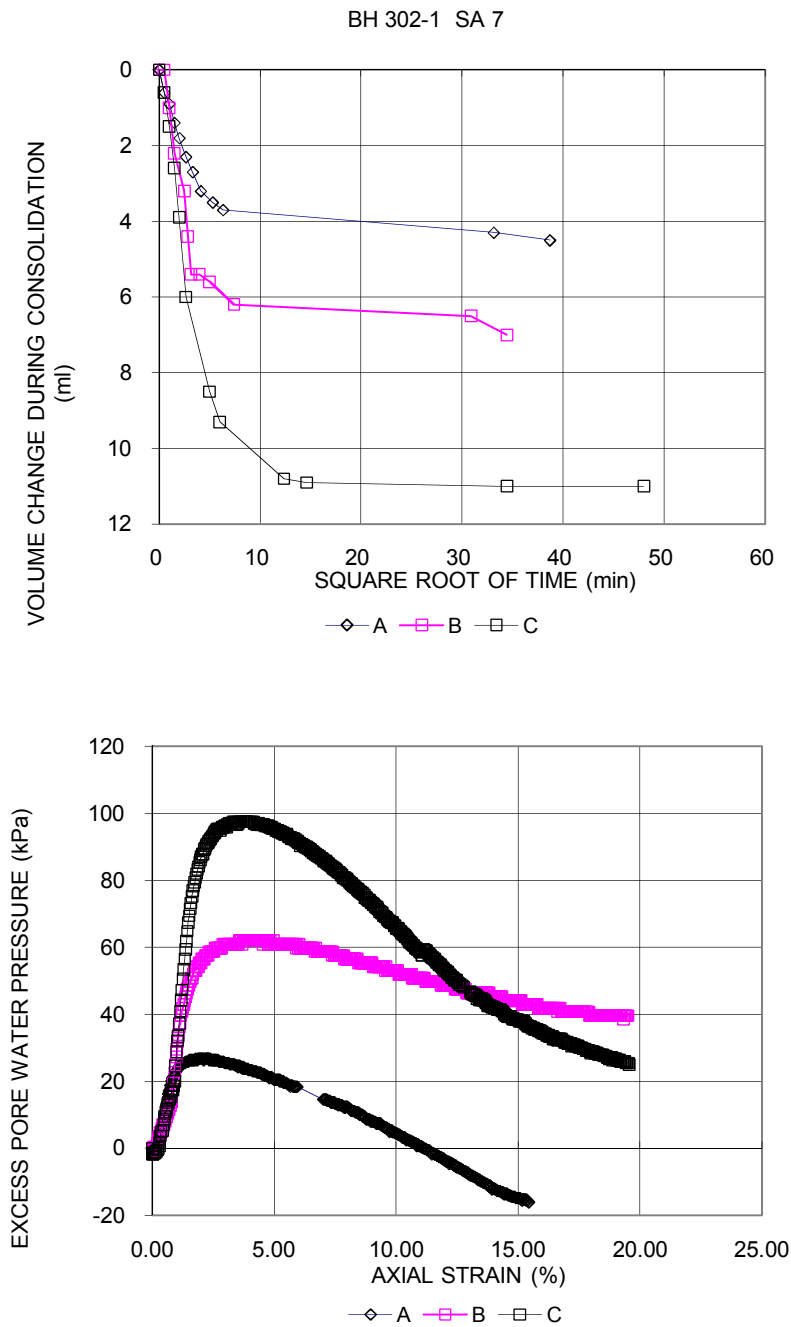
**Golder Associates**

Prepared By: LH  
Checked By: MM

**CONSOLIDATED UNDRAINED TRIAXIAL  
WITH PORE PRESSURE MEASUREMENTS**

**FIGURE A.S302-9**

**Sheet 4 of 4**

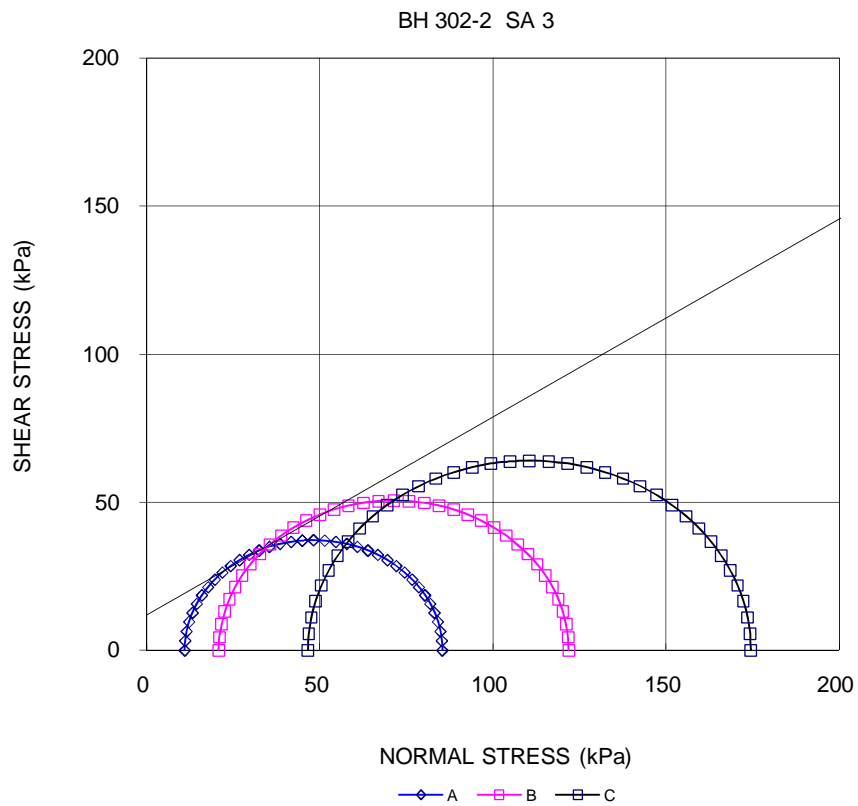


Date: 04/28/2009  
Project No. 06-1111-025

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Prepared By: LH  
Checked By: MM

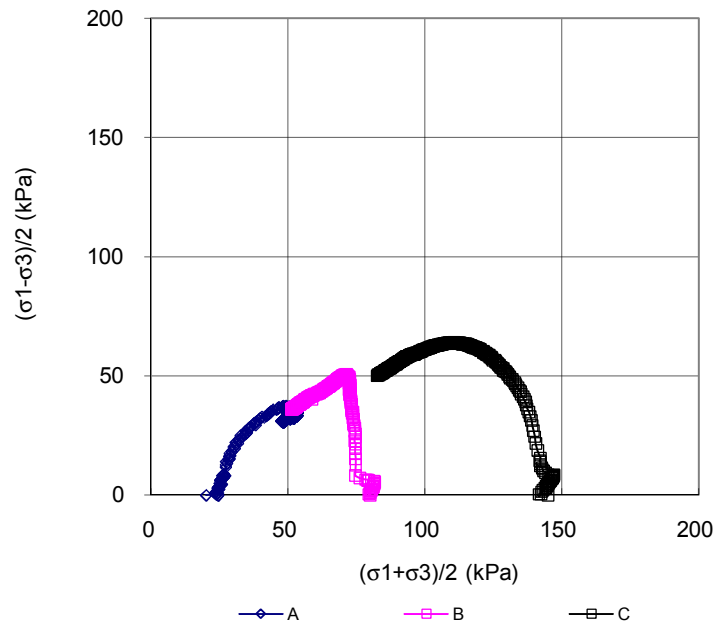
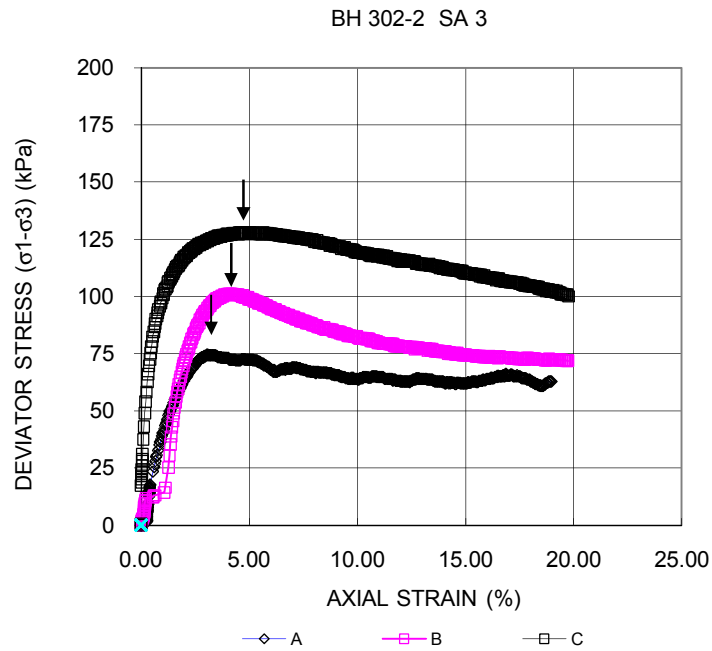
| CONSOLIDATED UNDRAINED TRIAXIAL<br>WITH PORE PRESSURE MEASUREMENTS  |       |        | FIGURE A.S302-10<br>Sheet 1 of 4 |
|---|-------|--------|----------------------------------|
| TEST STAGE  | A     | B      | C                                |
| BOREHOLE NUMBER   | 302-2 | 302-2  | 302-2                            |
| SAMPLE  | 3     | 3      | 3                                |
| SPECIMEN DIAMETER, cm   | 5.03  | 5.05   | 5.03                             |
| SPECIMEN HEIGHT, cm   | 10.20 | 10.26  | 10.13                            |
| WATER CONTENT BEFORE CONSOLIDATION, %   | 66.0  | 71.4   | 69.8                             |
| CELL PRESSURE, $\sigma_3$ , kPa   | 295.0 | 495.0  | 420.0                            |
| BACK PRESSURE, kPa  | 275.0 | 415.0  | 275.0                            |
| PORE PRESSURE PARAMETER "B"   | 0.99  | 0.98   | 0.98                             |
| CONSOLIDATION PRESSURE, $\sigma_c$ , kPa  | 20.0  | 80.0   | 145.0                            |
| VOLUMETRIC STRAIN DURING CONSOLIDATION, %   | 1.1   | 3.4    | 8.7                              |
| WATER CONTENT AFTER CONSOLIDATION, %  | 64.9  | 67.7   | 60.9                             |
| AVERAGE RATE OF STRAIN, %/hr  | 0.5   | 0.5    | 0.5                              |
| TIME TO FAILURE, DAYS   | 2     | 2      | 2                                |
| WATER CONTENT AFTER TEST, %   | 64.6  | 66.1   | 58.6                             |
| MAX. DEVIATOR STRESS, $(\sigma_1 - \sigma_3)$ , kPa   | 74.4  | 101.1  | 128.0                            |
| AXIAL STRAIN AT $(\sigma_1 - \sigma_3)$ MAXIMUM, %  | 3.0   | 4.0    | 5.0                              |
| MAX EFFECTIVE PRINCIPAL STRESS<br>RATIO, $(\sigma_1 / \sigma_3)$ MAXIMUM  | 9.6   | 6.1    | 4.3                              |
| DEVIATOR STRESS AT $(\sigma_1 / \sigma_3)$ MAXIMUM, kPa   | 65.5  | 100.5  | 116.0                            |
| AXIAL STRAIN AT $(\sigma_1 / \sigma_3)$ MAXIMUM, %  | 2.1   | 4.6    | 12.0                             |
| PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 - \sigma_3)$ MAXIMUM   | 0.12  | 0.59   | 0.77                             |
| PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 / \sigma_3)$ MAXIMUM   | 0.19  | 0.60   | 0.95                             |
| NATURAL WATER CONTENT, %  | 64.7  | 67.8   | 66.8                             |
| DRY DENSITY, Mg/m <sup>3</sup>  | 0.98  | 0.93   | 0.98                             |
| FILTER DRAINS USED, y/n   | y     | y      | y                                |
| TEST NOTES:   |       |        |                                  |
| CHANGED RATE OF STRAIN, %/hr  | -     | -      | -                                |
| AXIAL STRAIN WHERE RATE OF STRAIN WAS CHANGED, %  | -     | -      | -                                |
| FAILURE PLANE NUMBER  | 1.0   | -      | -                                |
| ANGLE OF FAILURE, DEGREES   | 65.0  | bulged | bulged                           |
| <div> <div>Date: 04/26/2009</div> <div>Project No. 06-1111-025</div> </div> <div> <b>Golder Associates</b> </div> <div> <div>Prepared By: MM</div> <div>Checked By: RO</div> </div> |       |        |                                  |



Date: 04/26/2009  
Project No. 06-1111-025

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Checked By: RO



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Project No. 06-1111-025

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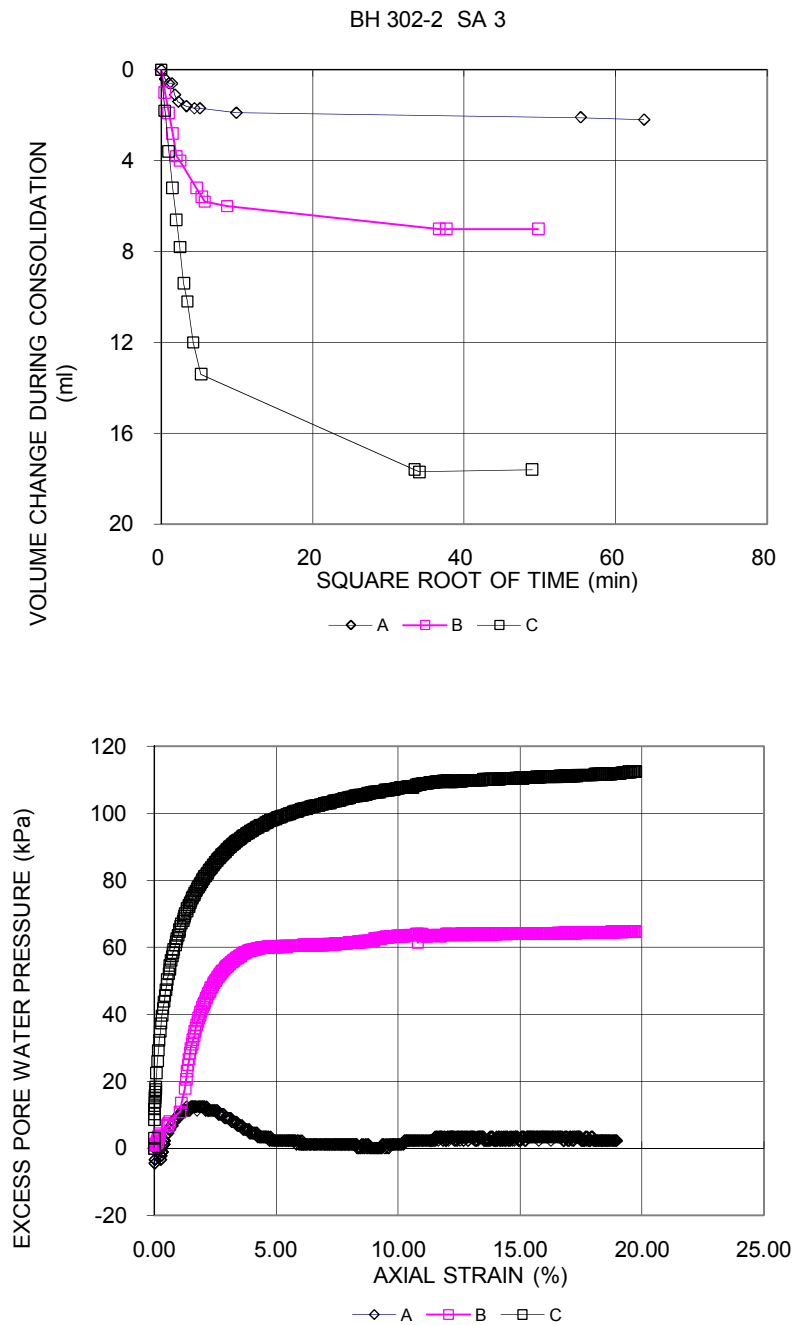
Prepared By: MM  
Checked By: RO



**CONSOLIDATED UNDRAINED TRIAXIAL  
WITH PORE PRESSURE MEASUREMENTS**

**FIGURE A.S302-10**

**Sheet 4 of 4**

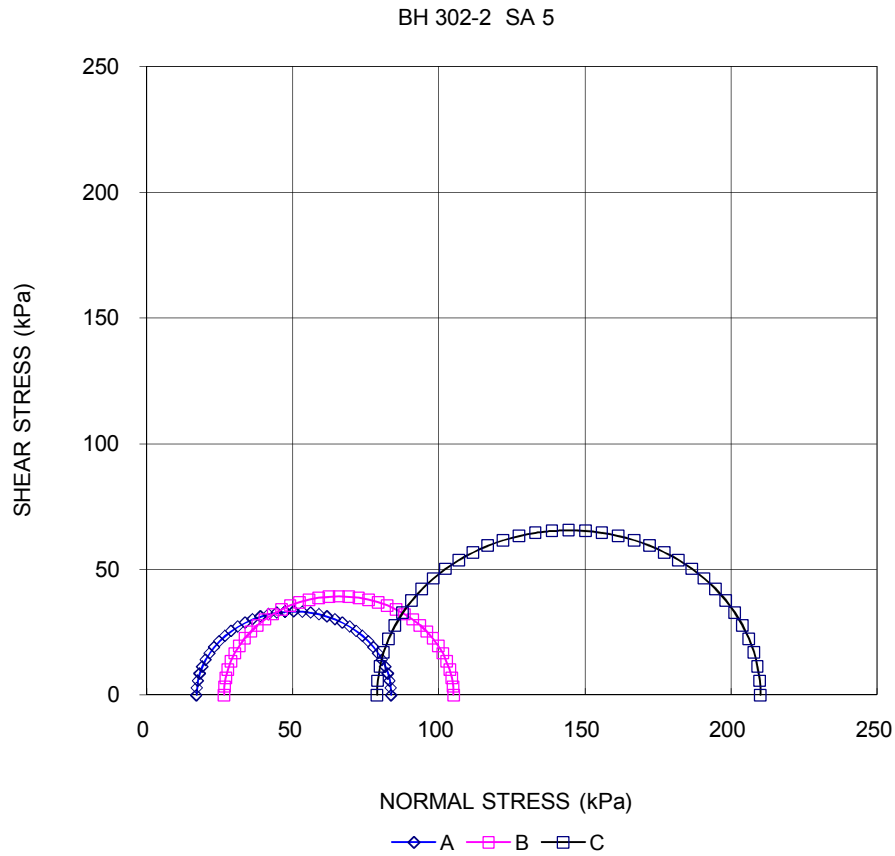


Date: 04/26/2009  
Project No. 06-1111-025

**Golder Associates**

Prepared By: MM  
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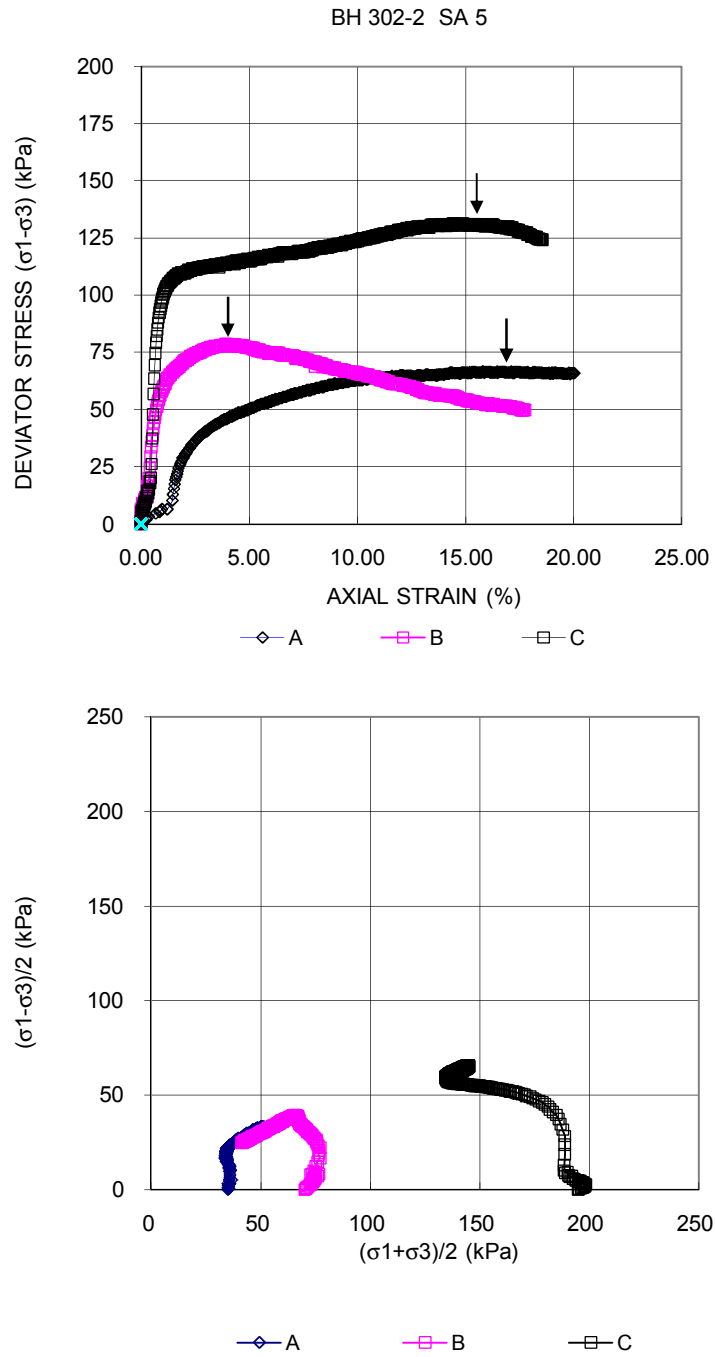
| CONSOLIDATED UNDRAINED TRIAXIAL<br>WITH PORE PRESSURE MEASUREMENTS  |        | FIGURE A.S302-11<br>Sheet 1 of 4 |        |
|---|--------|----------------------------------|--------|
| TEST STAGE  | A      | B                                | C      |
| BOREHOLE NUMBER   | 302-2  | 302-2                            | 302-2  |
| SAMPLE  | 5      | 5                                | 5      |
| SPECIMEN DIAMETER, cm   | 4.98   | 5.02                             | 4.93   |
| SPECIMEN HEIGHT, cm   | 10.08  | 10.11                            | 10.00  |
| WATER CONTENT BEFORE CONSOLIDATION, %   | 38.9   | 44.4                             | 41.7   |
| CELL PRESSURE, $\sigma_3$ , kPa   | 100.0  | 135.0                            | 610.0  |
| BACK PRESSURE, kPa  | 65.0   | 65.0                             | 415.0  |
| PORE PRESSURE PARAMETER "B"   | 0.98   | 0.98                             | 0.96   |
| CONSOLIDATION PRESSURE, $\sigma_c$ , kPa  | 35.0   | 70.0                             | 195.0  |
| VOLUMETRIC STRAIN DURING CONSOLIDATION, %   | 3.0    | 7.3                              | 8.5    |
| WATER CONTENT AFTER CONSOLIDATION, %  | 36.7   | 38.6                             | 35.3   |
| AVERAGE RATE OF STRAIN, %/hr  | 0.5    | 0.5                              | 0.5    |
| TIME TO FAILURE, DAYS   | 2      | 2                                | 2      |
| WATER CONTENT AFTER TEST, %   | 36.9   | 40.2                             | 33.0   |
| MAX. DEVIATOR STRESS, $(\sigma_1 - \sigma_3)$ , kPa   | 66.6   | 78.6                             | 131.2  |
| AXIAL STRAIN AT $(\sigma_1 - \sigma_3)$ MAXIMUM, %  | 17.1   | 3.9                              | 14.4   |
| MAX EFFECTIVE PRINCIPAL STRESS  |        |                                  |        |
| RATIO, $(\sigma_1 / \sigma_3)$ MAXIMUM  | 5.4    | 4.1                              | 2.3    |
| DEVIATOR STRESS AT $(\sigma_1 / \sigma_3)$ MAXIMUM, kPa   | 59.9   | 73.7                             | 130.8  |
| AXIAL STRAIN AT $(\sigma_1 / \sigma_3)$ MAXIMUM, %  | 8.3    | 6.8                              | 13.4   |
| PORE PRESSURE PARAMETER, $A_f$ , AT $(\sigma_1 - \sigma_3)$ MAXIMUM   | 0.27   | 0.55                             | 0.89   |
| PORE PRESSURE PARAMETER, $A_f$ , AT $(\sigma_1 / \sigma_3)$ MAXIMUM   | 0.36   | 0.63                             | 0.89   |
| NATURAL WATER CONTENT, %  | 38.6   | 41.2                             | 39.9   |
| DRY DENSITY, Mg/m <sup>3</sup>  | 1.33   | 1.28                             | 1.33   |
| FILTER DRAINS USED, y/n   | y      | y                                | y      |
| TEST NOTES:   |        |                                  |        |
| CHANGED RATE OF STRAIN, %/hr  | -      | -                                | -      |
| AXIAL STRAIN WHERE RATE OF STRAIN WAS CHANGED, %  | -      | -                                | -      |
| FAILURE PLANE NUMBER  | -      | 1.0                              | -      |
| ANGLE OF FAILURE, DEGREES   | bulged | 70.0                             | bulged |
| <div> <div>Date: 04/16/2009</div> <div>Project No. 06-1111-025</div> <div>Golder Associates</div> <div>Prepared By: LH</div> <div>Checked By: MM</div> </div> |        |                                  |        |



Date: 04/16/2009  
Project No. 06-1111-025

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Checked By: MM



Date: 04/16/2009  
Project No. 06-1111-025

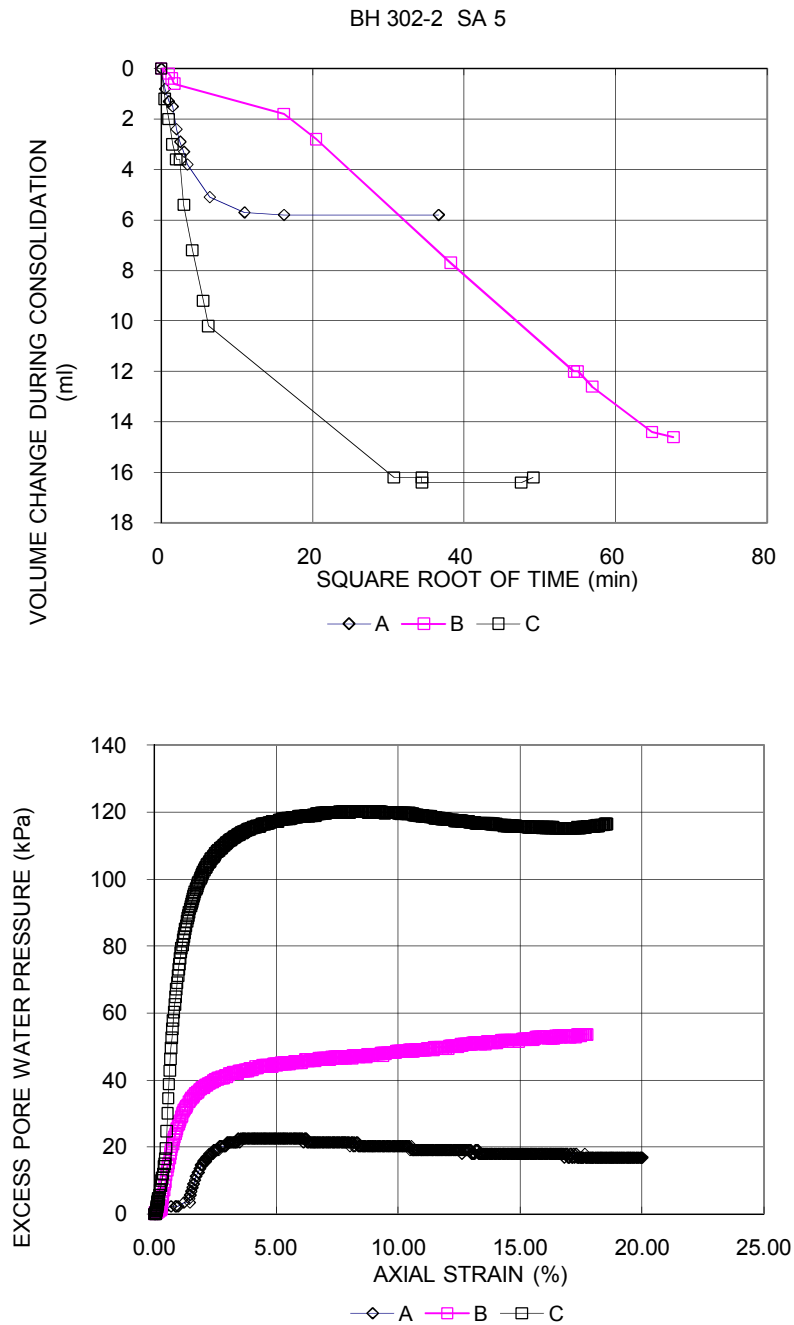
**Golder Associates**

Prepared By: LH  
Checked By: MM

**CONSOLIDATED UNDRAINED TRIAXIAL  
WITH PORE PRESSURE MEASUREMENTS**

**FIGURE A.S302-11**

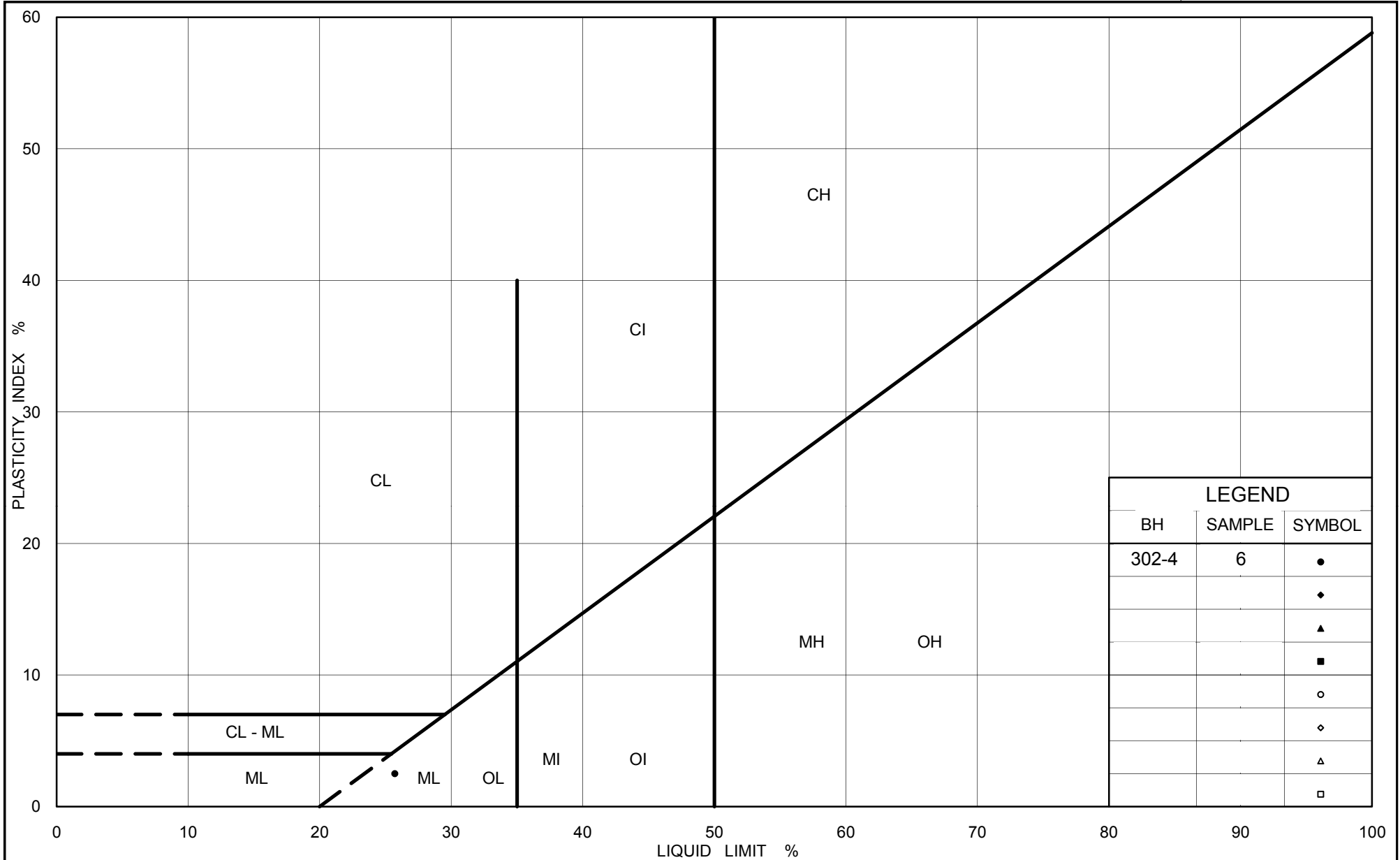
**Sheet 4 of 4**



Date: 04/16/2009  
Project No. 06-1111-025

**Golder Associates**

Prepared By: LH  
Checked By: MM



Ministry of Transportation

Ontario

## PLASTICITY CHART

Silt

Highway 69 (SBL and NBL) STA 17+700 to 18+150

Figure No. A.S302-12

Project No. 06-1111-025

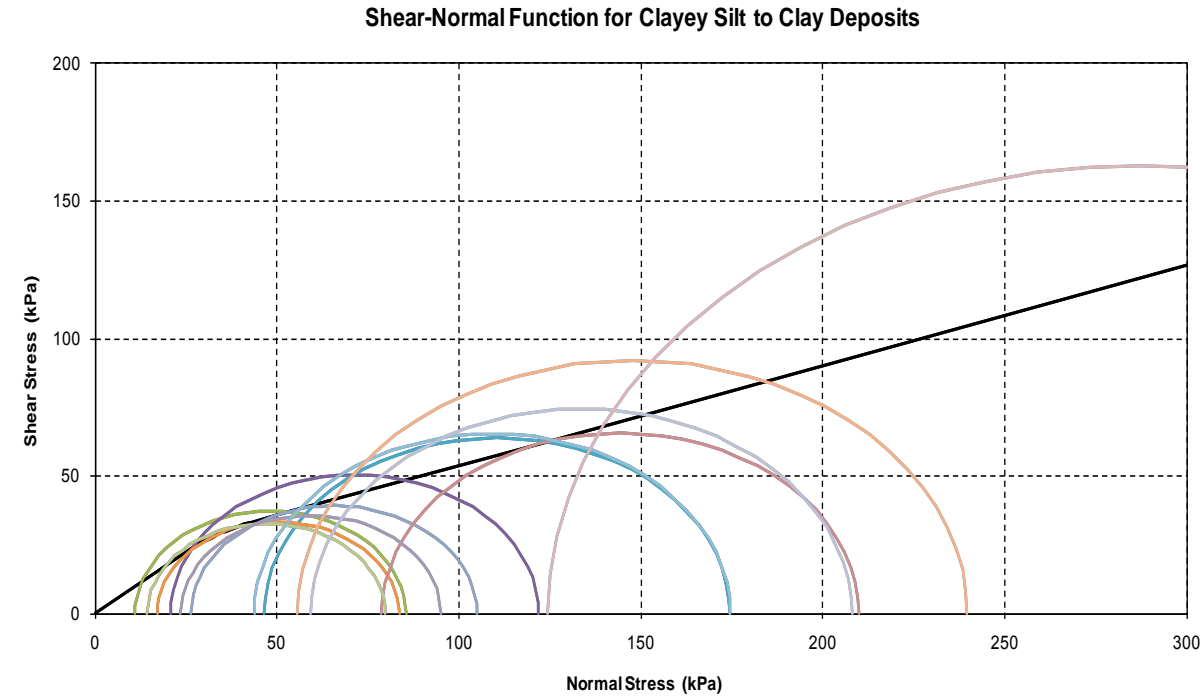
Checked By: TVA



TABLE A1 – SUMMARY OF FOUNDATION ENGINEERING PARAMETERS  
HIGHWAY 69 FOUR-LANING – PHASE 3

| Swamp Crossing  | Stratigraphic Unit                | Top Elevation<br>(m) | Thickness<br>(m) | $\gamma'$<br>(kN/m <sup>3</sup> ) | $\phi'$<br>(°)  | $c'$<br>(kPa)  | $s_u$<br>(kPa) | $\sigma_p'$<br>(kPa) | $e_o$       | $C_c$      | $C_r$         | $E'$<br>(MPa) | $C_{\alpha(\epsilon)}$ |     | $c_h$<br>(cm <sup>2</sup> /s) |
|---|-----------------------------------|----------------------|------------------|-----------------------------------|-----------------|----------------|----------------|----------------------|-------------|------------|---------------|---------------|------------------------|-----|-------------------------------|
|   |                                   |                      |                  |                                   |                 |                |                |                      |             |            |               |               | N/C                    | O/C |                               |
| Swamp 302 SBL<br><br>Highway 69 SBL and NBL –<br>STA 17+700 to 18+150 | Sand Blanket                      | 189.5 – 186.5        | 1.0 – 2.6        | 18.5                              | 32              | 0              | --             | --                   | --          | --         | --            | 30            | --                     | --  | --                            |
|   | Peat / Topsoil                    | 189.5 – 185.3        | 0.1 – 2.1        | 12                                | 27              | 1              | --             | --                   | --          | --         | --            | --            | --                     | --  | --                            |
|   | Organic Clayey Silt to Silty Clay | 186.2 – 185.8        | 0.3 – 2.6        | 16                                | 20              | 0              | --             | --                   | --          | --         | --            | --            | --                     | --  | --                            |
|   | Sand to Silt                      | 189.4 – 185.4        | 0.6 – 5.7        | 18.5 – 18                         | 28              | 0              | --             | --                   | --          | --         | --            | 3             | --                     | --  | --                            |
|   | Clayey Silt to Clay               | 187.5 – 183.3        | 3.0 – 10.5       | 17                                | 27 <sup>1</sup> | 4 <sup>1</sup> | 15 – 47        | 68 – 214             | 1.05 – 1.65 | 0.2 – 0.65 | 0.028 – 0.065 | --            | 1.5                    | 0.3 | 9.1 x 10 <sup>-3</sup>        |
|   | Silt to Sand and Silt             | 182.6 – 174.5        | 0.6 – 5.7        | 18                                | 27              | 0              | --             | --                   | --          | --         | --            | 3 – 5         | --                     | --  | --                            |

Note: <sup>1</sup> Clayey silt to clay deposits use a fully defined shear-normal function based on results of triaxial tests (approximately equivalent to  $c' = 4$  kPa and  $\phi' = 27^\circ$  over the stress range of  $0 \text{ kPa} \leq \sigma_n' \leq 200 \text{ kPa}$ ). See Inset below.



\\mis1-s-filesrv1\data\active\2006\1111\06-1111-025 mrc hwy 69-522 to 64 french river\reporting\wick drain embankments\final\tables\06-1111-025-1 tbla1 summary of foundation engineering parameters.docx

Prepared By: TZ

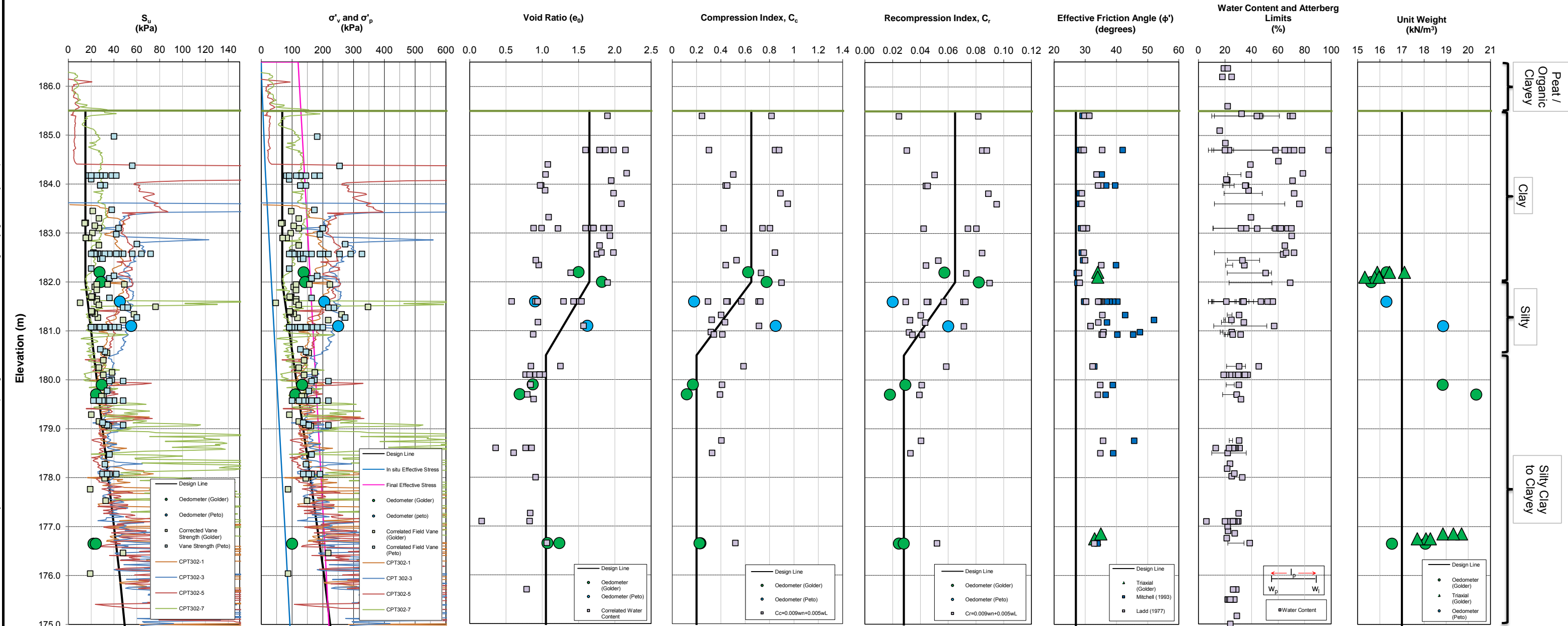
Reviewed By: JPD/JMAC

\\ms1-s-files\1\data\active\2006\11106-1111-025 MRC Hwy 69-522 to 64 French River\Reporting\Wick Drain Embankments\Final\Figures\Figure A1 xls\Swamp 302 Plots - Final

SUMMARY PLOT OF ENGINEERING PARAMETERS FOR COHESIVE DEPOSITS

Highway 69 (SBL) - Swamp 302 - STA 17+750 to 18+125  
Highway 69 (NBL) - Swamp 302 - STA 17+750 to 18+100

FIGURE A1



NOTES:

Average original ground surface at the critical section is at about Elevation 186.5 m.  
Minimum sand blanket thickness below the original ground surface is about 1 m, with base extending to no lower than Elevation 183.9 m.

Golder Associates

Date: April 2012  
Project No: 06-1111-025-1

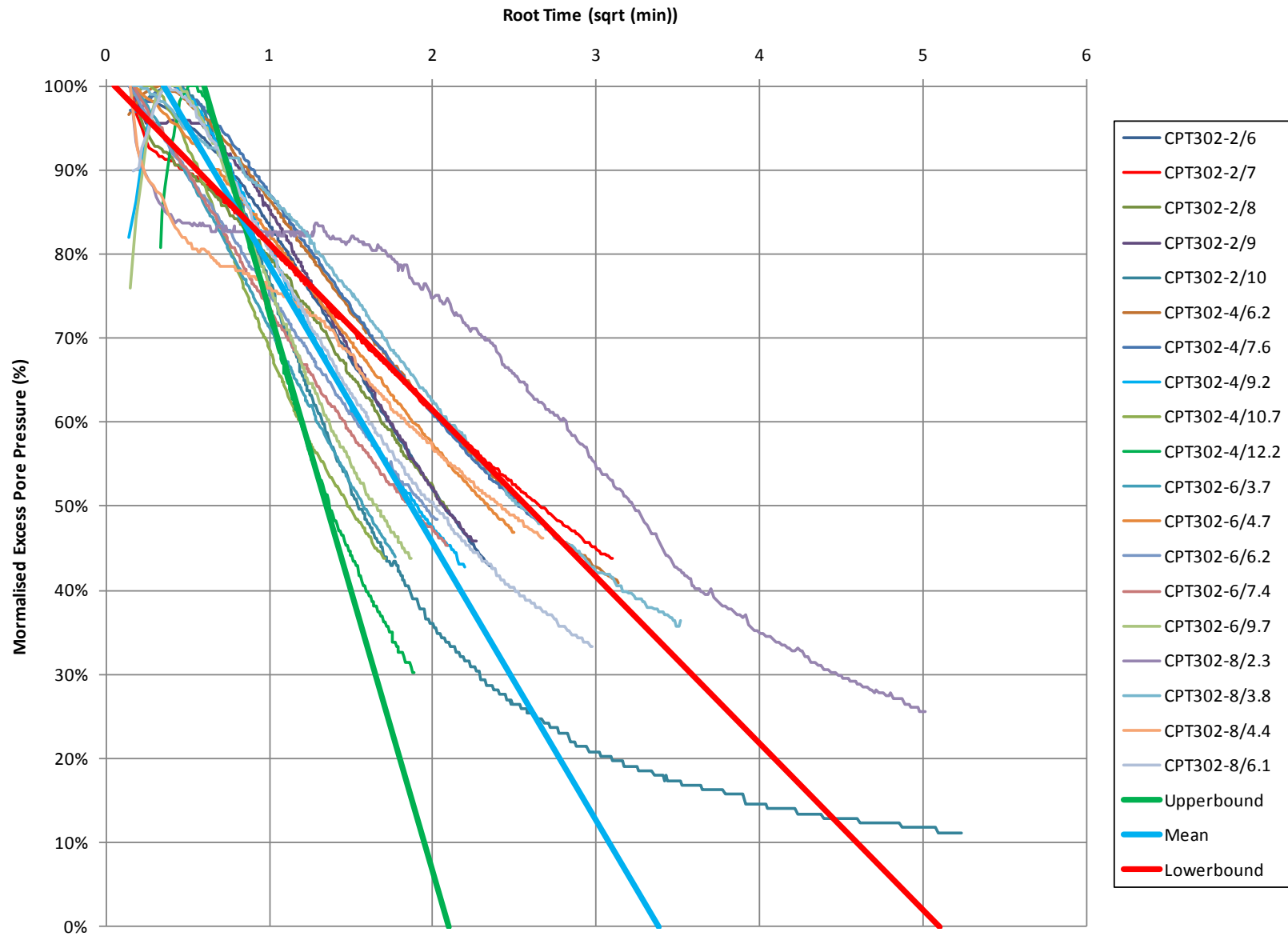
DB: TZ / MWK  
CHK: JPD





# CPT Pore Pressure Dissipation Tests Swamp 302 SBL/NBL

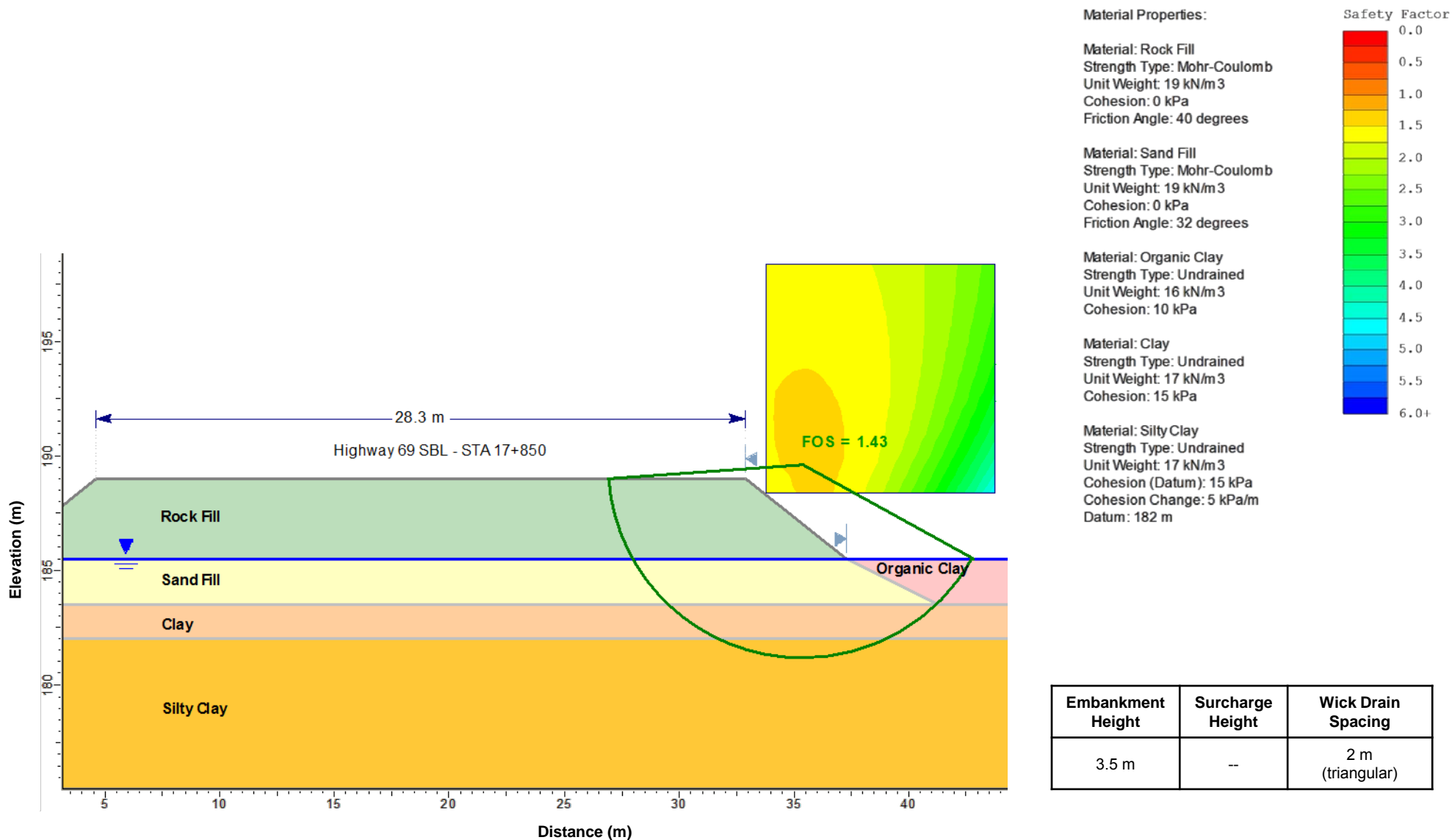
Figure A2





# Slope Stability – Total Stress Analysis – STA 17+850 (Swamp 302 SBL/NBL)

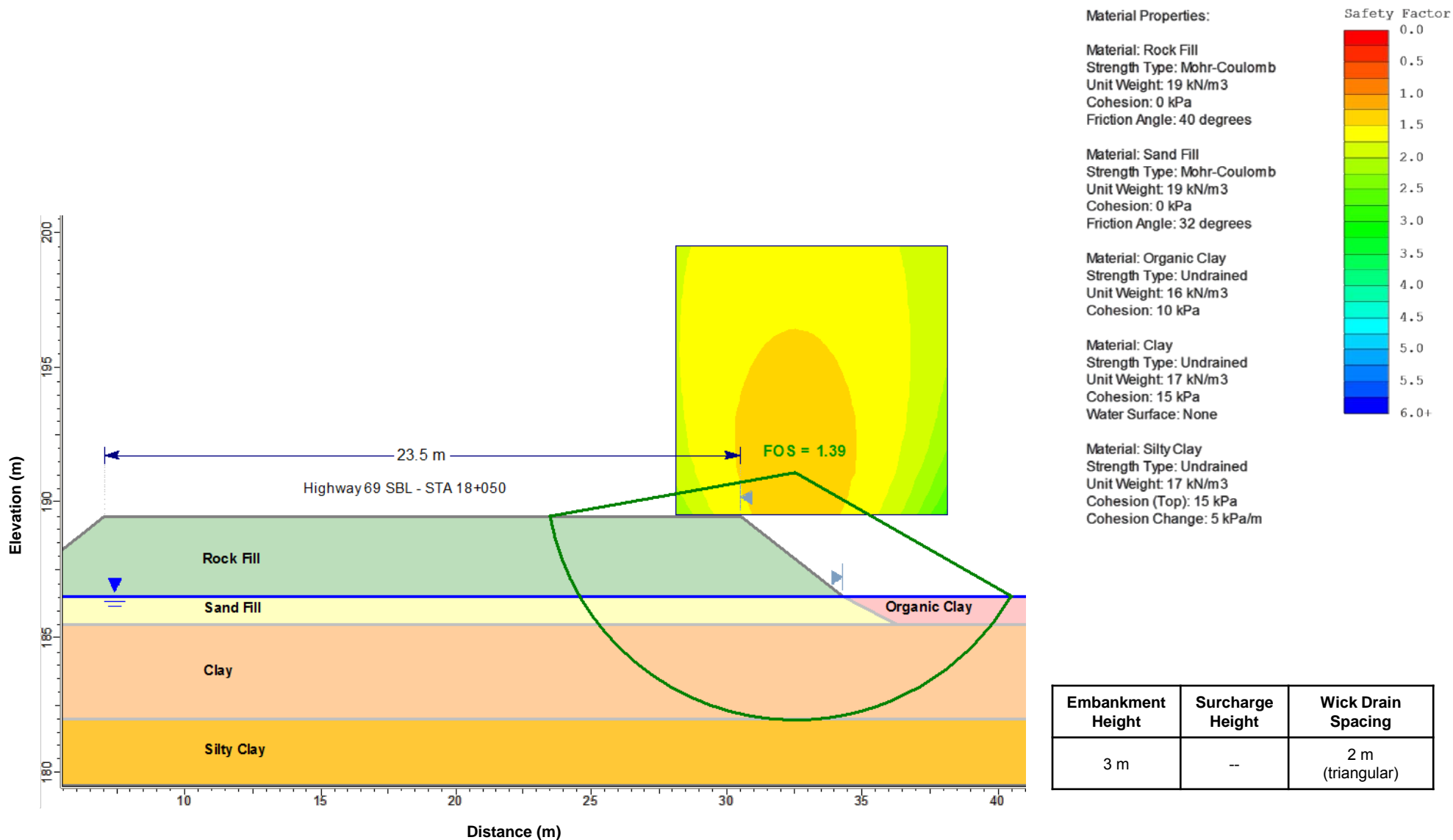
Figure A3-1





# Slope Stability – Total Stress Analysis – STA 18+050 (Swamp 302 SBL/NBL)

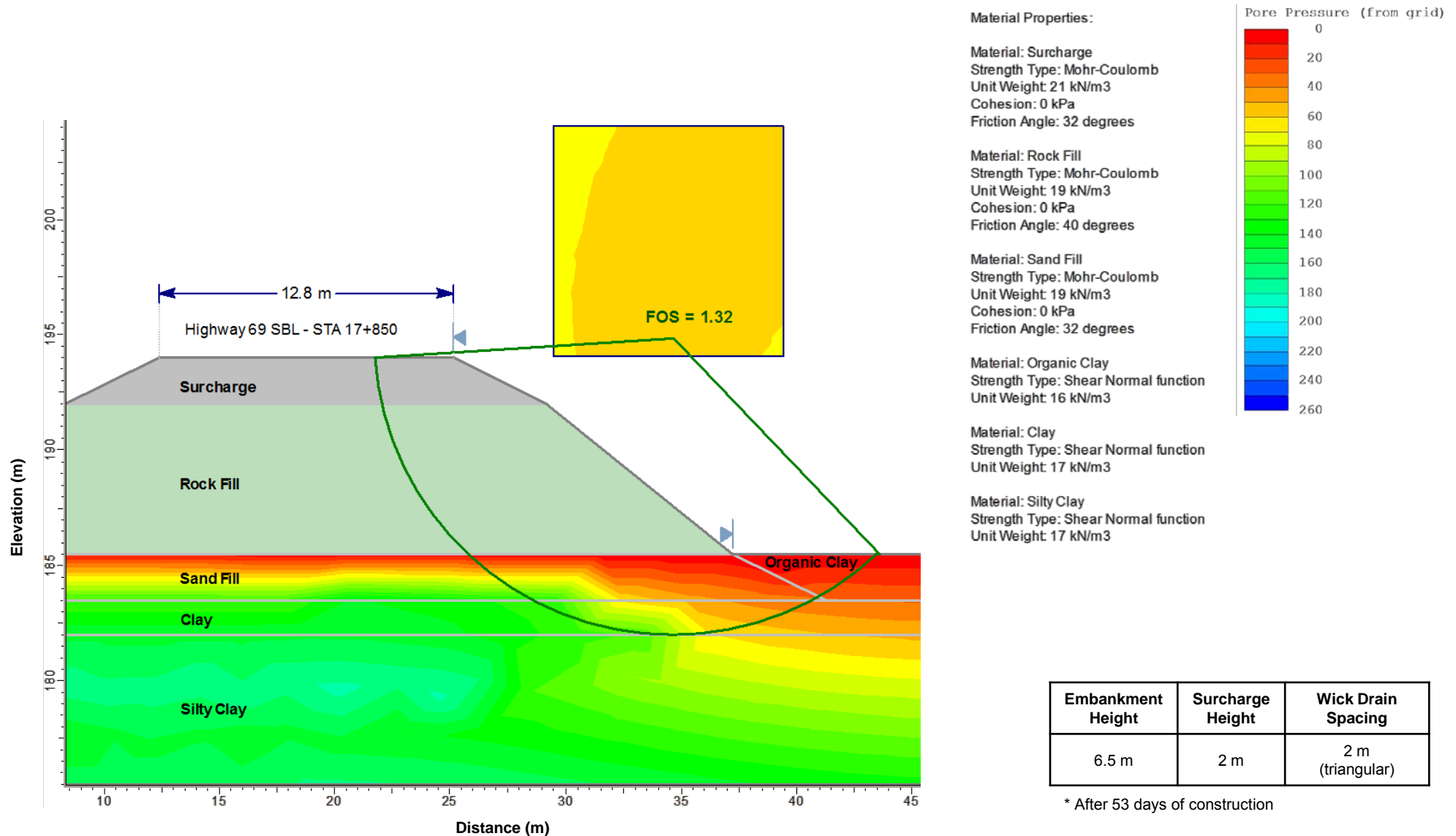
Figure A3-2





# Slope Stability – Effective Stress Analysis – STA 17+850 (Swamp 302 SBL/NBL)

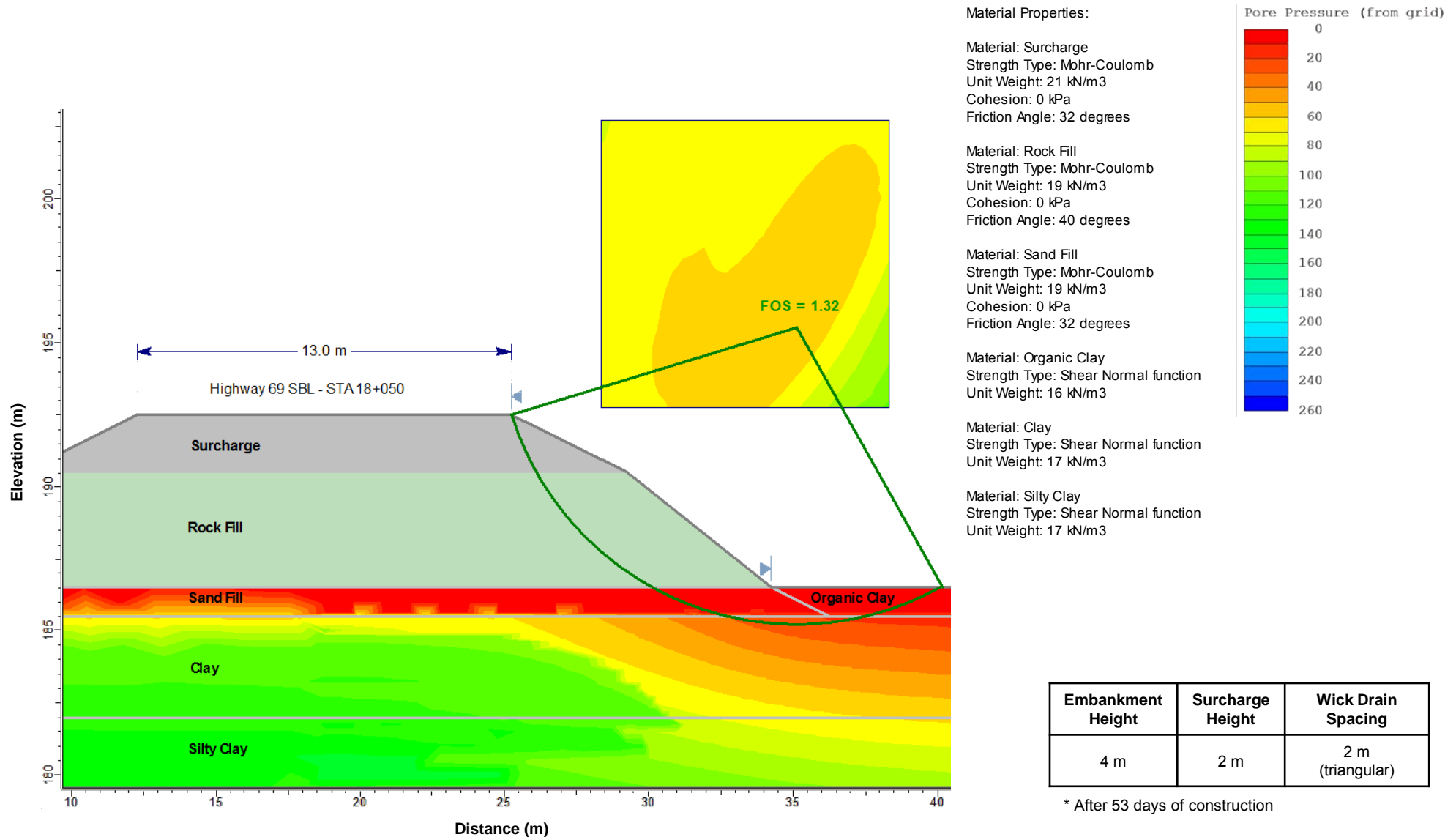
Figure A4-1





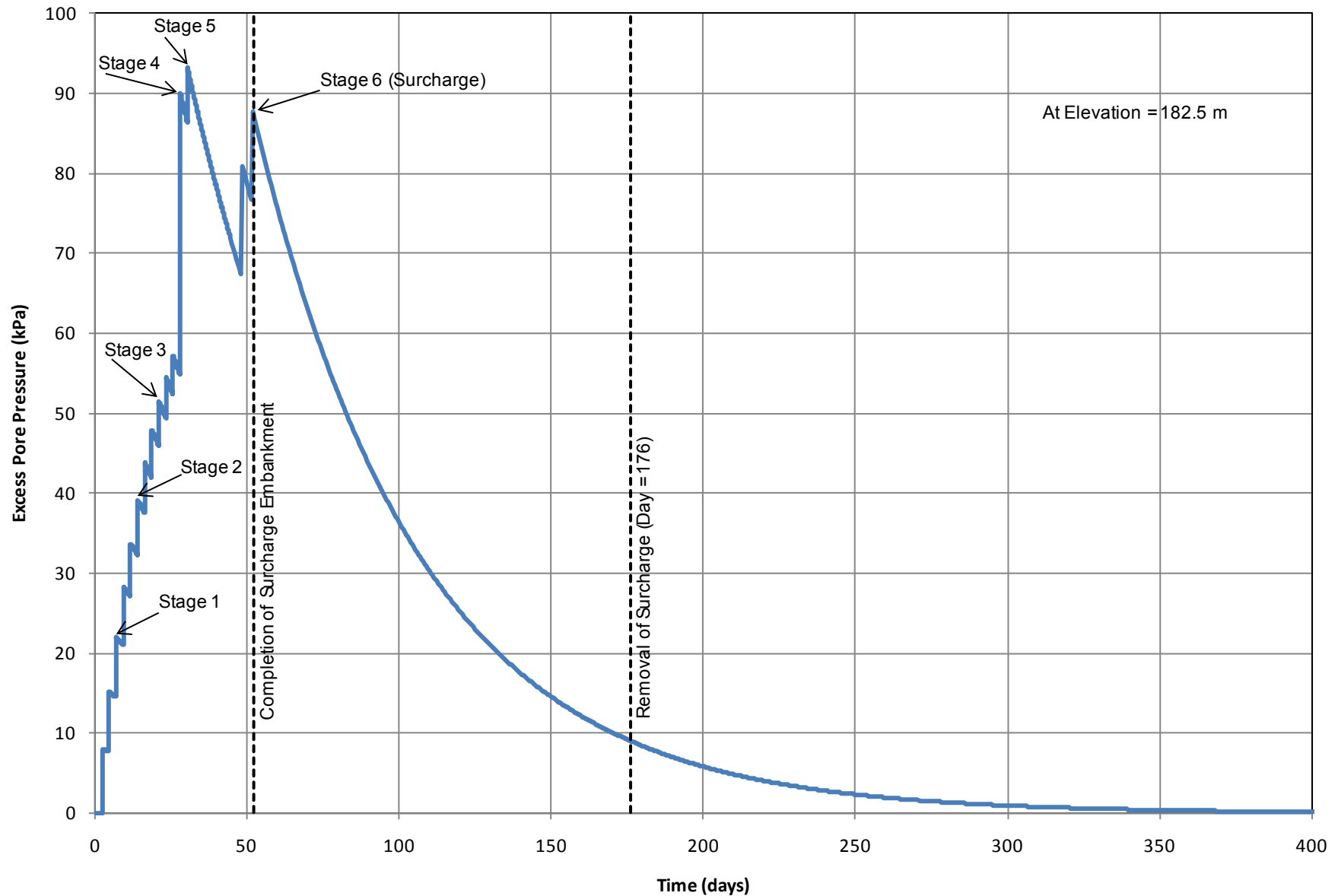
# Slope Stability – Effective Stress Analysis – STA 18+050 (Swamp 302 SBL/NBL)

Figure A4-2



## Excess Pore Pressure Response below Embankment Centreline – STA 17+850 (Swamp 302 SBL/NBL)

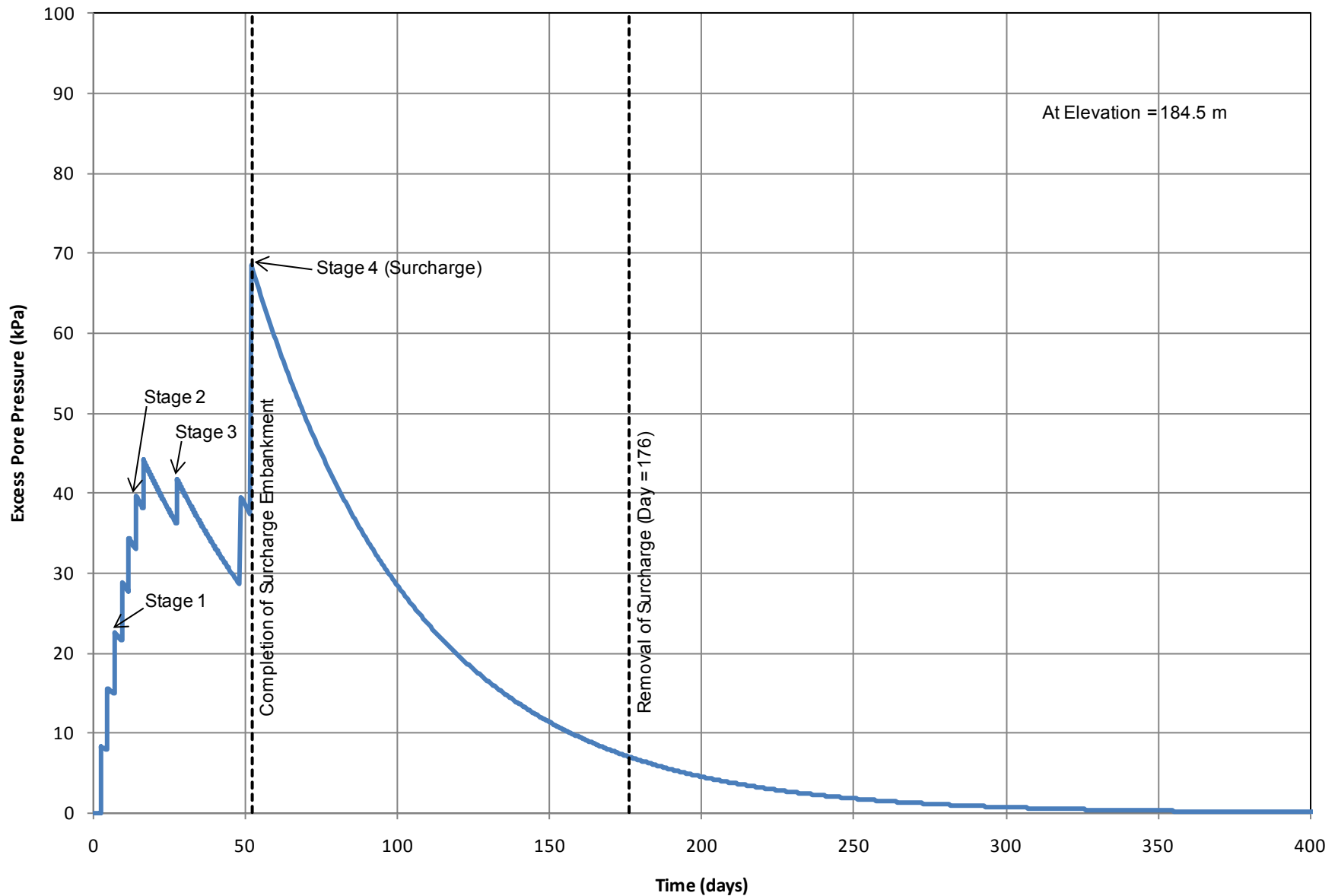
Figure A5-1





## Excess Pore Pressure Response below Embankment Centreline – STA 18+050 (Swamp 302 SBL/NBL)

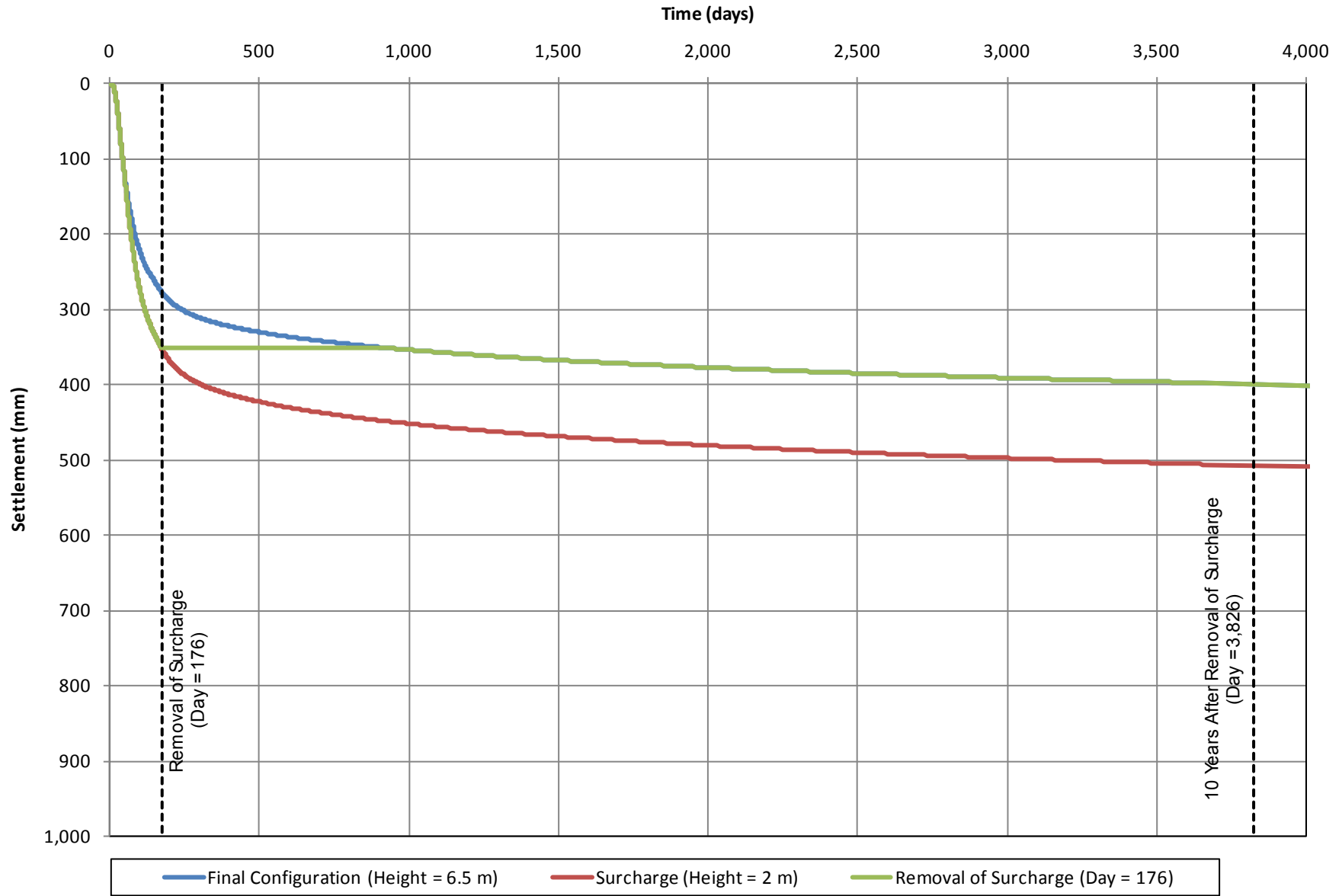
Figure A5-2





## Time – Rate Consolidation Settlement at Embankment Centreline – STA 17+850 (Swamp 302)

Figure A6-1

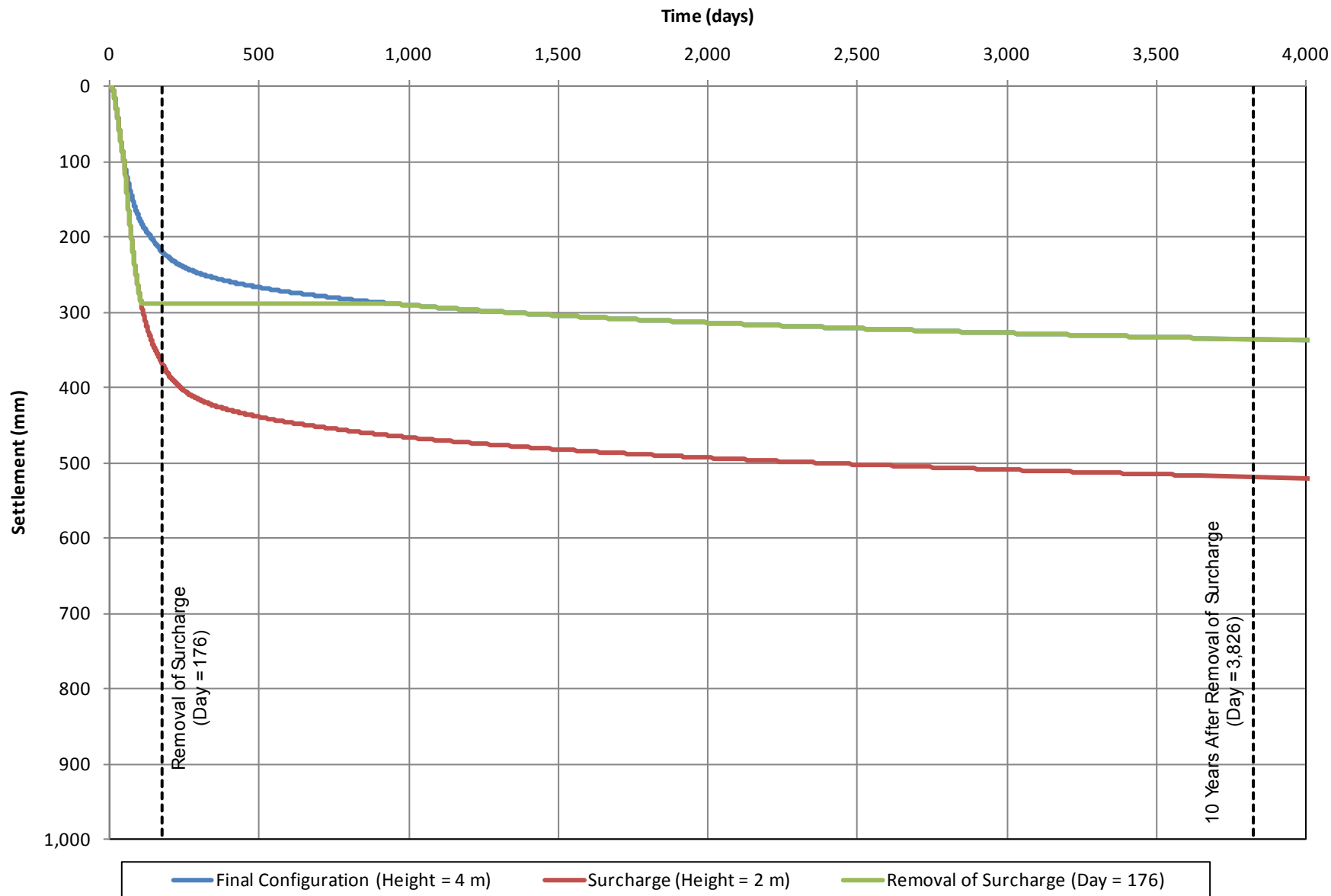






## Time – Rate Consolidation Settlement at Embankment Centreline – STA 18+050 (Swamp 302)

Figure A6-2





# **APPENDIX B**

**Highway 69 SBL – STA 16+050 to 16+350 (Swamp 305 SBL)**

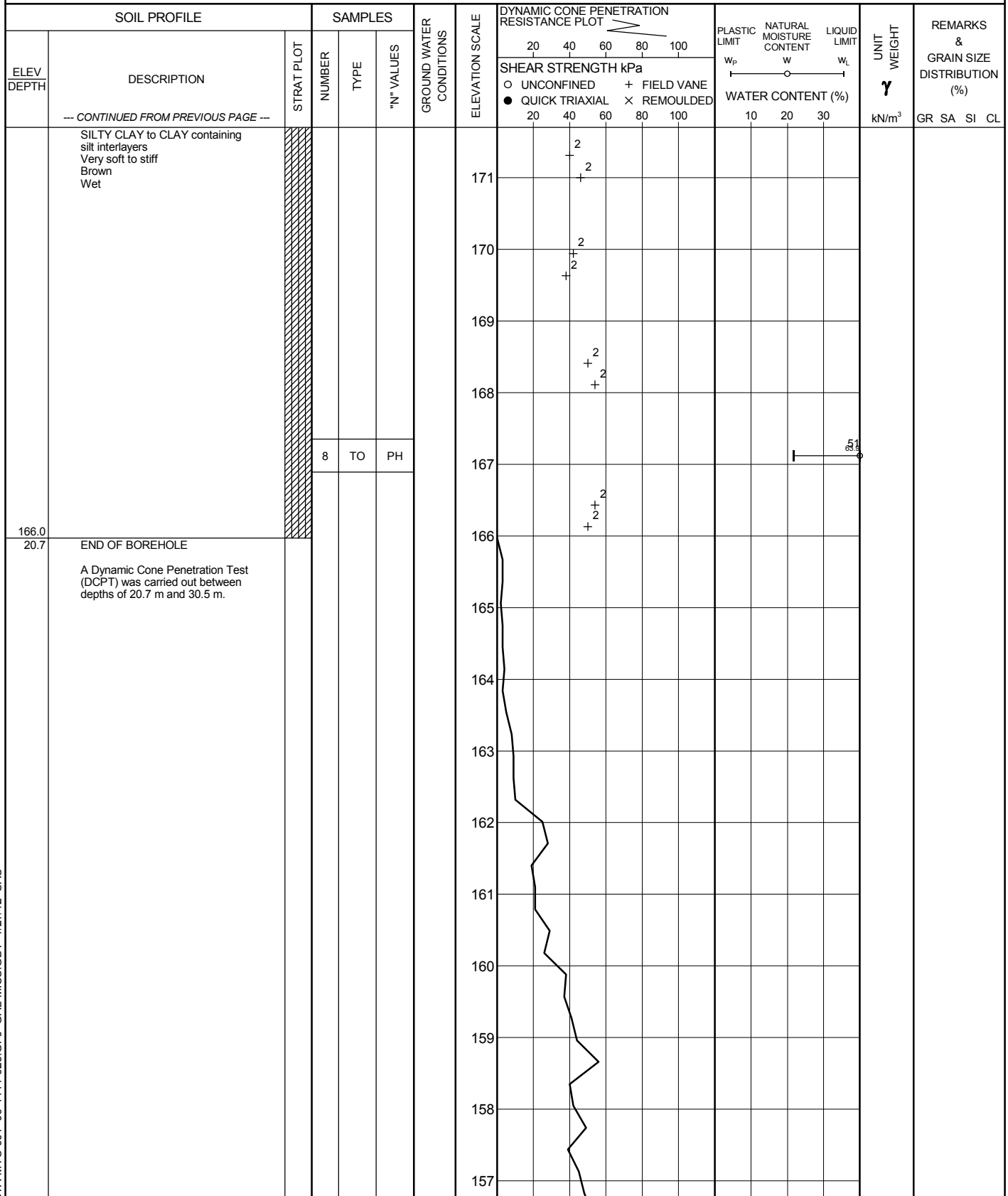
| PROJECT 06-1111-025 |  |            | RECORD OF BOREHOLE No 305-1          |      |            | 1 OF 3 METRIC                            |                 |                    |   |    |   |             |                   |                   |                                       |   |                         |
|---------------------|--|------------|--------------------------------------|------|------------|--|-----------------|--------------------|---|----|---|-------------|-------------------|-------------------|---------------------------------------|---|-------------------------|
| G.W.P. 5203-06-00   |  |            | LOCATION N 5092255.3 ; E 221116.7    |      |            | ORIGINATED BY MR                         |                 |                    |   |    |   |             |                   |                   |                                       |   |                         |
| DIST _____ HWY 69   |  |            | BOREHOLE TYPE NW Casing, Wash Boring |      |            | COMPILED BY MWK                          |                 |                    |   |    |   |             |                   |                   |                                       |   |                         |
| DATUM Geodetic      |  |            | DATE March 5, 2009                   |      |            | CHECKED BY VA                            |                 |                    |   |    |   |             |                   |                   |                                       |   |                         |
| SOIL PROFILE        |  |            | SAMPLES                              |      |            | DYNAMIC CONE PENETRATION RESISTANCE PLOT |                 |                    | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT |    |   | UNIT WEIGHT |                   |                   | REMARKS & GRAIN SIZE DISTRIBUTION (%) |   |                         |
| ELEV<br>DEPTH       | DESCRIPTION  | STRAT PLOT | NUMBER                               | TYPE | "N" VALUES | GROUND WATER CONDITIONS                  | ELEVATION SCALE | SHEAR STRENGTH kPa |   |    |   |             | WATER CONTENT (%) |                   |                                       | γ | GR SA SI CL             |
|                     |  |            |                                      |      |            |  |                 | 20 40 60 80 100    | 20 40 60 80 100                                     | Wp | W | WL          | 10 20 30          | kN/m <sup>3</sup> |                                       |   |                         |
| 186.7<br>0.0        | ICE SURFACE<br>Ice   |            |                                      |      |            |  |                 |                    |   |    |   |             |                   |                   |                                       |   |                         |
| 186.1<br>0.6        | Water  |            |                                      |      |            |  | 186             |                    |   |    |   |             |                   |                   |                                       |   |                         |
| 185.0<br>1.7        | PEAT, containing roots (Amorphous)<br>Very soft<br>Dark Brown<br>Wet                 |            |                                      |      |            |  | 185             |                    |   |    |   |             |                   |                   |                                       |   |                         |
| 184.1<br>2.6        | Organic SILT<br>Very loose<br>Dark Grey<br>Wet                                       |            | 1A<br>1B                             | SS   | WR         |  | 184             |                    |   |    |   |             |                   | 597.3<br>141.4    |                                       |   | OC = 40.8%<br>OC = 6.8% |
| 182.7<br>4.0        | SAND<br>Loose<br>Grey  |            |                                      |      |            |  | 183             |                    |   |    |   |             |                   |                   |                                       |   |                         |
|                     |  |            | 2                                    | SS   | 5          |  | 182             |                    |   |    |   |             |                   |                   |                                       |   |                         |
|                     |  |            |                                      |      |            |  | 181             |                    |   |    |   |             |                   |                   |                                       |   |                         |
|                     |  |            | 3                                    | SS   | 4          |  | 180             |                    |   |    |   |             |                   |                   |                                       |   |                         |
| 179.7<br>7.0        | SAND, some silt<br>Loose<br>Grey<br>Wet  |            |                                      |      |            |  | 179             |                    |   |    |   |             |                   |                   |                                       |   |                         |
|                     |  |            | 4                                    | SS   | 4          |  |                 |                    |   |    |   |             |                   |                   |                                       |   |                         |
| 178.2<br>8.5        | SILTY CLAY to CLAY containing silt interlayers<br>Very soft to stiff<br>Brown<br>Wet |            |                                      |      |            |  | 178             |                    |   |    |   |             |                   |                   |                                       |   |                         |
|                     |  |            | 5                                    | SS   | 1          |  | 177             |                    |   |    |   |             |                   | 71.5              |                                       |   |                         |
|                     |  |            | 6                                    | TO   | PH         |  |                 |                    |   |    |   |             |                   |                   |                                       |   |                         |
|                     |  |            |                                      |      |            |  | 176             |                    |   |    |   |             |                   |                   |                                       |   |                         |
|                     |  |            |                                      |      |            |  | 175             |                    |   |    |   |             |                   |                   |                                       |   |                         |
|                     |  |            |                                      |      |            |  | 174             |                    |   |    |   |             |                   |                   |                                       |   |                         |
|                     |  |            |                                      |      |            |  | 173             |                    |   |    |   |             |                   |                   |                                       |   |                         |
|                     |  |            | 7                                    | TO   | PH         |  |                 |                    |   |    |   |             |                   | 47.0              | 16.8                                  |   | C/CIU                   |
|                     |  |            |                                      |      |            |  | 172             |                    |   |    |   |             |                   |                   |                                       |   |                         |

Continued Next Page

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE


GTA-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 1/27/12 SAC

|                                      |  |   |  |                         |  |
|--------------------------------------|--|---|--|-------------------------|--|
| PROJECT <u>06-1111-025</u>           |  | <b>RECORD OF BOREHOLE No 305-1</b>          |  | 2 OF 3 <b>METRIC</b>    |  |
| G.W.P. <u>5203-06-00</u>             |  | LOCATION <u>N 5092255.3 ; E 221116.7</u>    |  | ORIGINATED BY <u>MR</u> |  |
| DIST <u>          </u> HWY <u>69</u> |  | BOREHOLE TYPE <u>NW Casing, Wash Boring</u> |  | COMPILED BY <u>MWK</u>  |  |
| DATUM <u>Geodetic</u>                |  | DATE <u>March 5, 2009</u>                   |  | CHECKED BY <u>VA</u>    |  |



Continued Next Page

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

| <div style="display: flex; justify-content: space-between;"> <div>PROJECT <u>06-1111-025</u></div> <div><b>RECORD OF BOREHOLE No 305-1</b></div> <div>3 OF 3 <b>METRIC</b></div> </div> |   |   |        |                         |            |                            |                 |  |  |  |  |  |                                    |                                     |                                   |  |  |
|---|---|---|--------|-------------------------|------------|----------------------------|-----------------|--|--|--|--|--|------------------------------------|-------------------------------------|-----------------------------------|--|--|
| G.W.P. <u>5203-06-00</u>  |   | LOCATION <u>N 5092255.3 ; E 221116.7</u>    |        | ORIGINATED BY <u>MR</u> |            |                            |                 |  |  |  |  |  |                                    |                                     |                                   |  |  |
| DIST <u>          </u> HWY <u>69</u>  |   | BOREHOLE TYPE <u>NW Casing, Wash Boring</u> |        | COMPILED BY <u>MWK</u>  |            |                            |                 |  |  |  |  |  |                                    |                                     |                                   |  |  |
| DATUM <u>Geodetic</u>   |   | DATE <u>March 5, 2009</u>                   |        | CHECKED BY <u>VA</u>    |            |                            |                 |  |  |  |  |  |                                    |                                     |                                   |  |  |
| SOIL PROFILE  |   | SAMPLES                                     |        |                         |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT  |  |  |  |  | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br><br>γ<br><br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br><br>GR SA SI CL |
| ELEV<br>DEPTH   | DESCRIPTION   | STRAT PLOT                                  | NUMBER | TYPE                    | "N" VALUES |                            |                 | SHEAR STRENGTH kPa   |  |  |  |  |                                    |                                     |                                   |  |  |
|   | --- CONTINUED FROM PREVIOUS PAGE ---  |   |        |                         |            |                            |                 | <div style="display: flex; justify-content: space-between;"> <div> ○ UNCONFINED<br/>● QUICK TRIAXIAL </div> <div> + FIELD VANE<br/>× REMOULDED </div> </div> |  |  |  |  |                                    |                                     |                                   |  |  |
| 156.2<br>30.5   | END OF DCPT<br><br>NOTE:<br><br>1. Water level in open borehole at ice surface (Elev. 186.7 m) upon completion of drilling. |   |        |                         |            |                            |                 |    |  |  |  |  |                                    |                                     |                                   |  |  |

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+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○<sup>3%</sup> STRAIN AT FAILURE



+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○<sup>3%</sup> STRAIN AT FAILURE

GT-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 1/27/12 SAC

| PROJECT            |   | RECORD OF BOREHOLE |         | No 305-3                 |            | 1 OF 1   |                 | METRIC                                      |  |  |  |                                    |                                     |                                   |   |  |
|--------------------|---|--------------------|---------|--------------------------|------------|--|-----------------|---|--|--|--|------------------------------------|-------------------------------------|-----------------------------------|---|--|
| G.W.P. 06-1111-025 |   | LOCATION           |         | N 5092337.2 ; E 221104.5 |            | ORIGINATED BY                                    |                 | MWK   |  |  |  |                                    |                                     |                                   |   |  |
| DIST               |   | HWY 69             |         | BOREHOLE TYPE            |            | 108 mm I.D. Continuous Flight Hollow Stem Augers |                 | COMPILED BY                                 |  |  |  |                                    |                                     |                                   |   |  |
| DATUM              |   | Geodetic           |         | DATE                     |            | March 19, 2009                                   |                 | CHECKED BY                                  |  |  |  |                                    |                                     |                                   |   |  |
|                    |   |                    |         |                          |            |  |                 | VA  |  |  |  |                                    |                                     |                                   |   |  |
| SOIL PROFILE       |   |                    | SAMPLES |                          |            | GROUND WATER<br>CONDITIONS                       | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |  |  |  | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>$\gamma$<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
| ELEV<br>DEPTH      | DESCRIPTION   | STRAT PLOT         | NUMBER  | TYPE                     | "N" VALUES |  |                 | SHEAR STRENGTH kPa                          |  |  |  |                                    |                                     |                                   |   |  |
| 187.2              | GROUND SURFACE  |                    |         |                          |            |  |                 |   |  |  |  |                                    |                                     |                                   |   |  |
| 0.0                | Borehole augered from ground surface to a depth of 3.0 m (Elev. 184.2 m)<br>Stratigraphy inferred from augered sample |                    |         |                          |            |  |                 |   |  |  |  |                                    |                                     |                                   |   |  |
| 184.7              |   |                    |         |                          |            |  |                 |   |  |  |  |                                    |                                     |                                   |   |  |
| 2.5                | SILTY CLAY to CLAY, some silt containing silt interlayers<br>Grey<br>Wet  |                    |         |                          |            |  |                 |   |  |  |  |                                    |                                     |                                   |   |  |
| 183.5              |   |                    | 1       | TO                       | PH         |  |                 |   |  |  |  |                                    |                                     |                                   |   |  |
| 3.7                | SILT, trace to some clay, trace sand<br>Grey<br>Wet   |                    |         |                          |            |  |                 |   |  |  |  |                                    |                                     |                                   |   |  |
| 180.5              |   |                    | 2       | TO                       | PH         |  |                 |   |  |  |  |                                    |                                     |                                   |   |  |
| 6.7                | END OF BOREHOLE   |                    |         |                          |            |  |                 |   |  |  |  |                                    |                                     |                                   |   |  |
|                    | NOTE:<br>1. Water level in open borehole at ground surface (Elev. 187.2 m) upon completion of drilling.               |                    |         |                          |            |  |                 |   |  |  |  |                                    |                                     |                                   |   |  |

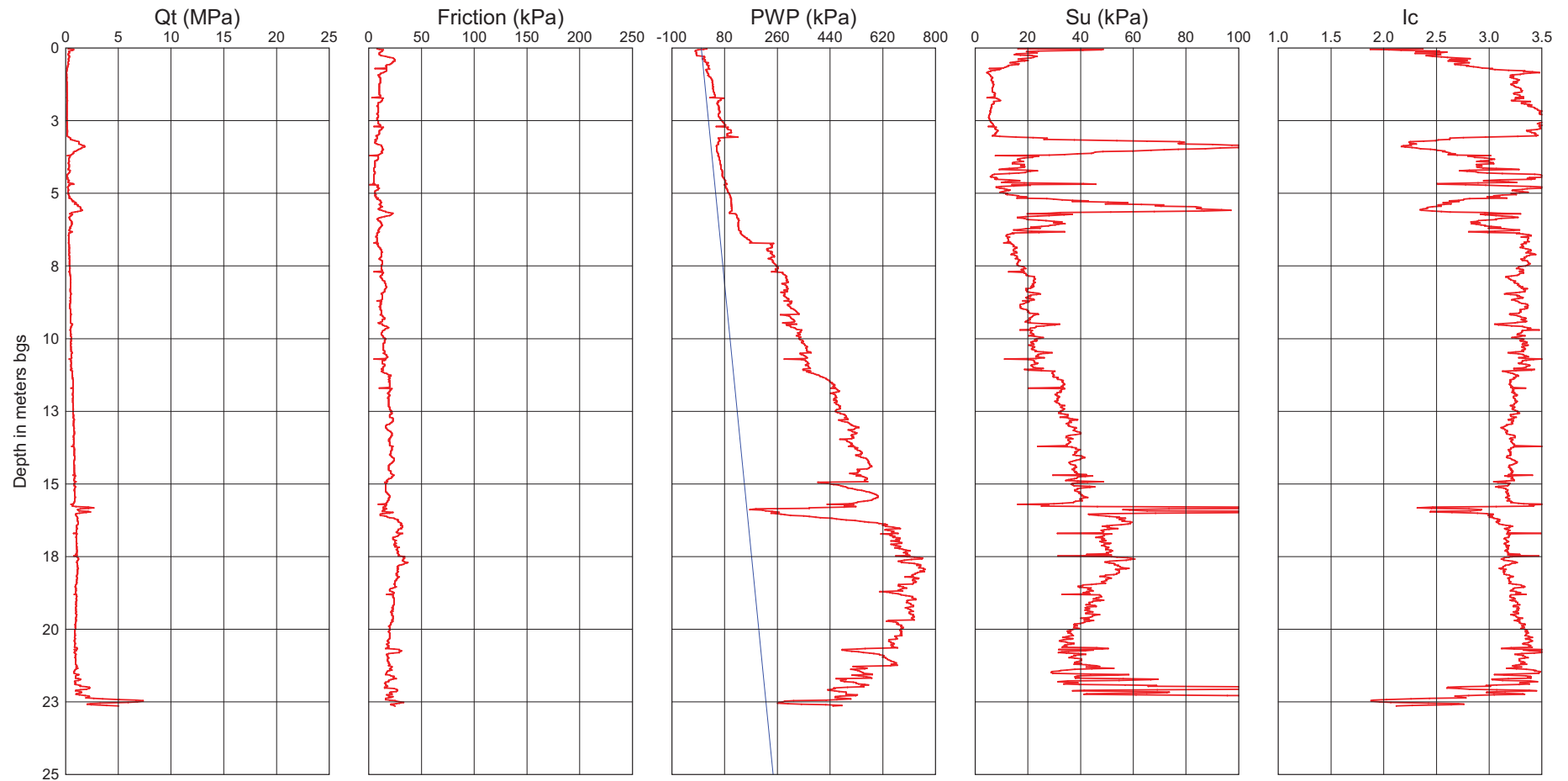


# Cone Penetration Test - CPT305-1

Test Date : March 06, 2009  
Location : Highway 69 - STA 16+217 o/s 19 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 186.70  
Water Table Depth : 0.00



Qt normalized for  
unequal end area effects

$Su = (Qt - \sigma_v) / Nk$   
 $Nk = 15.5$   
 $\gamma = 16.5 \text{ kN/m}^3$

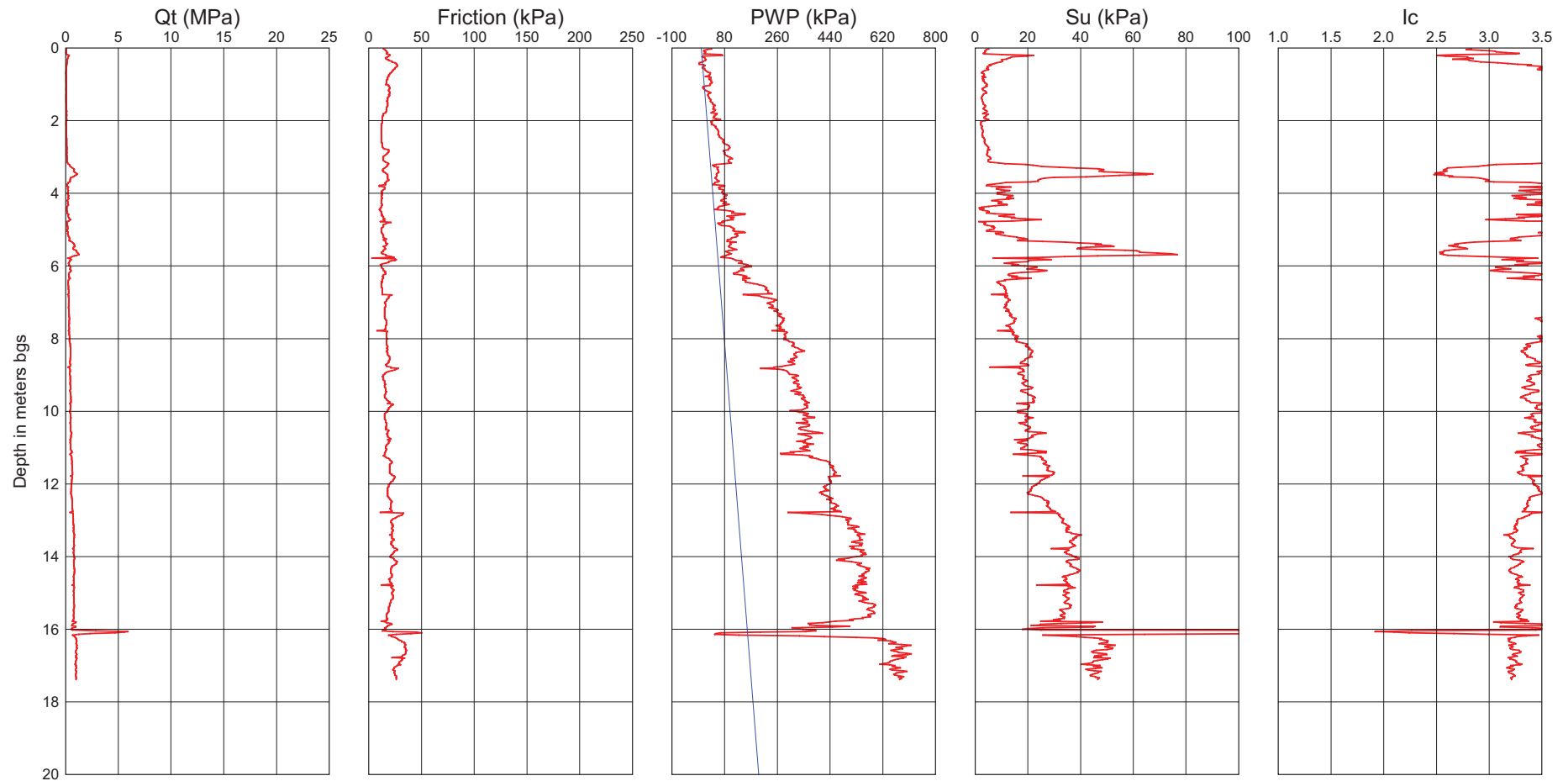
After Robertson and (Fear) Wride (1998)  
 $Ic < 1.31$  - Gravelly sands  
 $1.31 < Ic < 2.05$  - Clean to silty sand  
 $2.05 < Ic < 2.60$  - Silty sand to sandy silt  
 $2.60 < Ic < 2.95$  - Clayey silt to silty clay  
 $2.95 < Ic < 3.60$  - Clays

# Cone Penetration Test - CPT305-2

Test Date : March 05, 2009  
Location : Highway 69 - STA 16+217 o/s 20 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 186.70  
Water Table Depth : 0.00



Qt normalized for  
unequal end area effects

$Su = (Qt - \sigma_v) / Nk$   
 $Nk = 15.5$   
 $\gamma = 16.5 \text{ kN/m}^3$

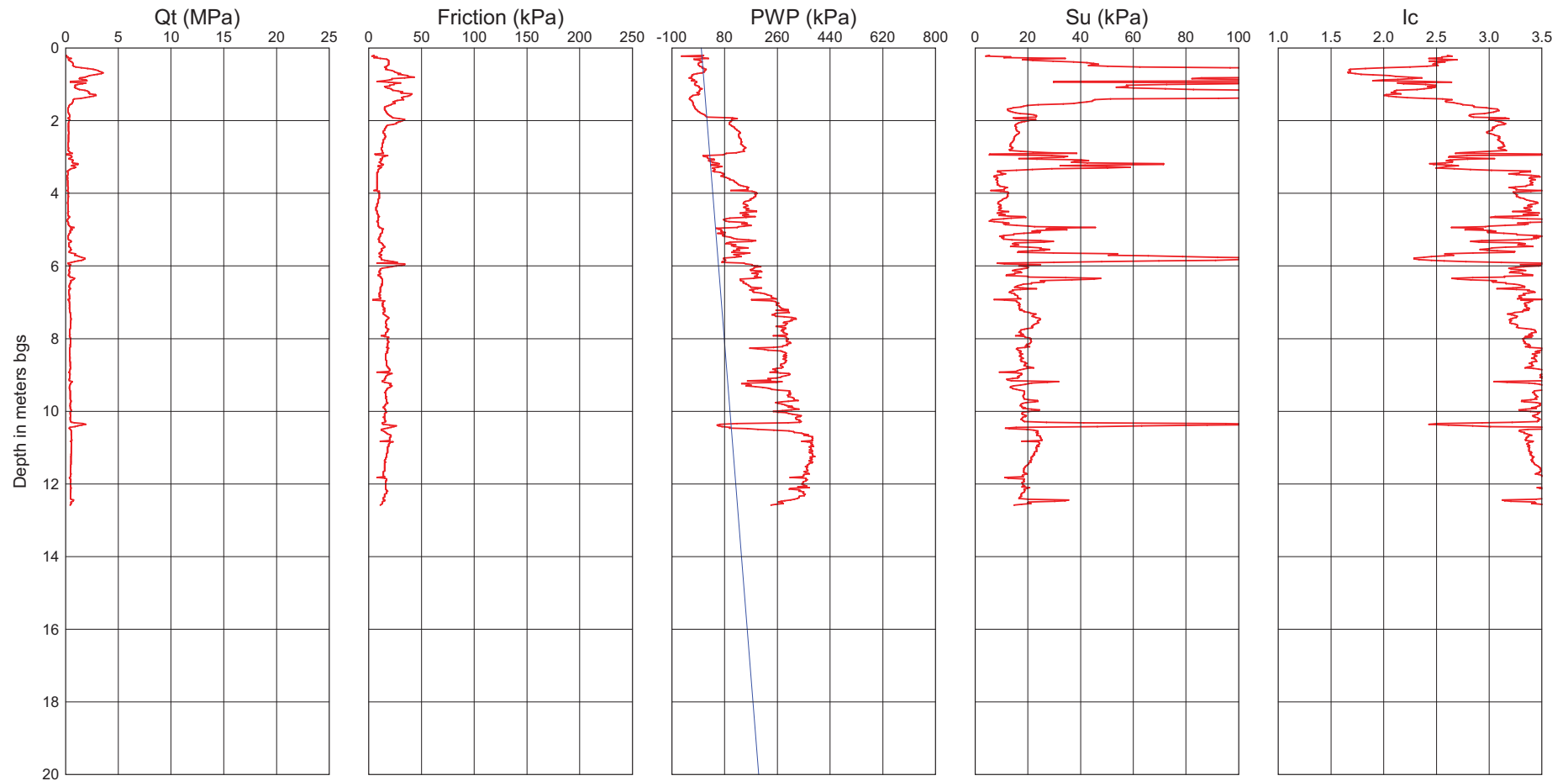
After Robertson and (Fear) Wride (1998)  
 $Ic < 1.31$  - Gravelly sands  
 $1.31 < Ic < 2.05$  - Clean to silty sand  
 $2.05 < Ic < 2.60$  - Silty sand to sandy silt  
 $2.60 < Ic < 2.95$  - Clayey silt to silty clay  
 $2.95 < Ic < 3.60$  - Clays

# Cone Penetration Test - CPT305-3

Test Date : March 06, 2009  
Location : Highway 69 - STA 16+280 o/s 20 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 186.80  
Water Table Depth : 0.00



Qt normalized for  
unequal end area effects

$Su = (Qt - \sigma_v) / Nk$   
 $Nk = 15.5$   
 $\gamma = 16.5 \text{ kN/m}^3$

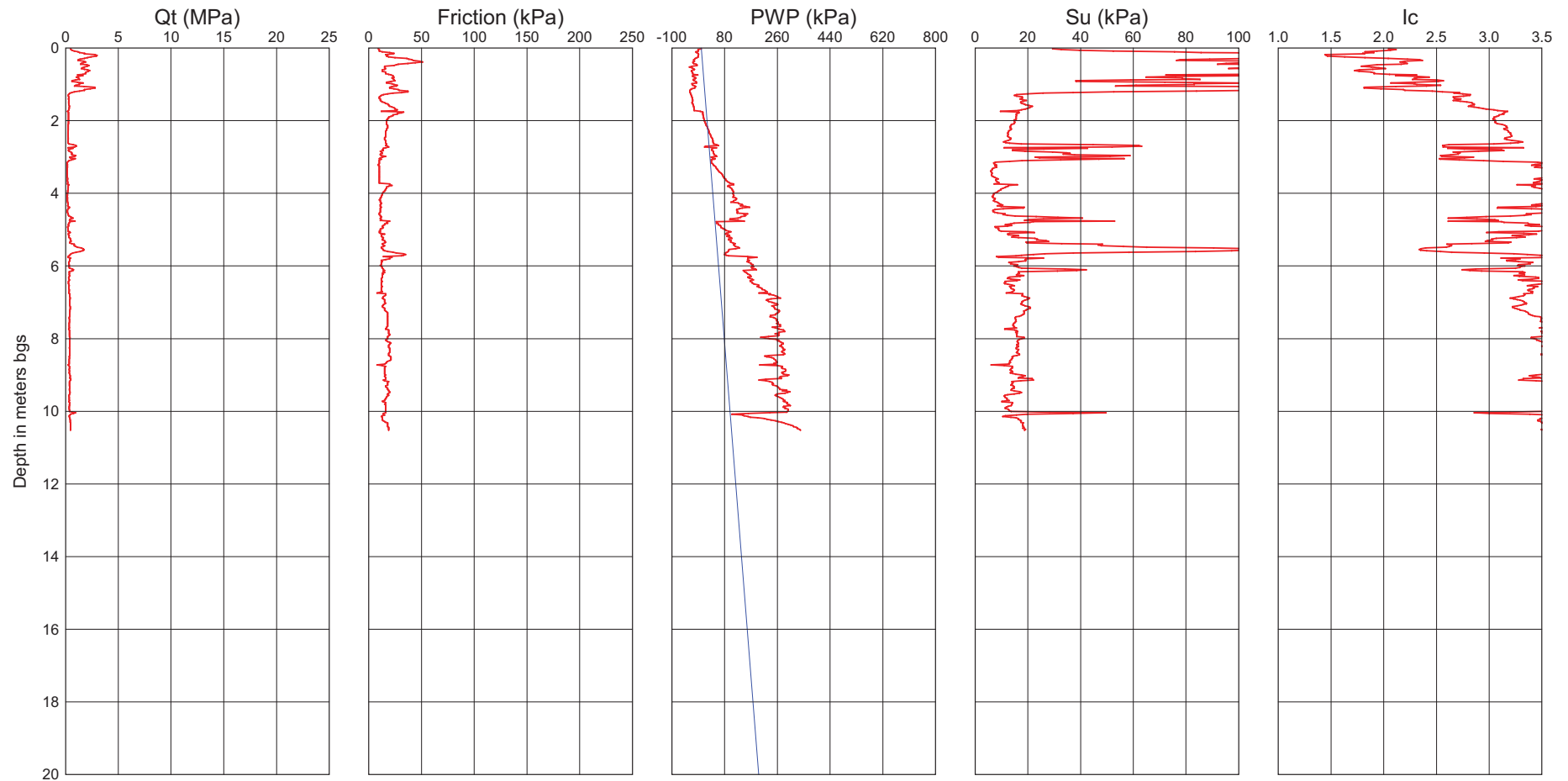
After Robertson and (Fear) Wride (1998)  
Ic < 1.31 - Gravelly sands  
1.31 < Ic < 2.05 - Clean to silty sand  
2.05 < Ic < 2.60 - Silty sand to sandy silt  
2.60 < Ic < 2.95 - Clayey silt to silty clay  
2.95 < Ic < 3.60 - Clays

# Cone Penetration Test - CPT305-4

Test Date : March 06, 2009  
Location : Highway 69 - STA 16+280 o/s 20.5 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 186.80  
Water Table Depth : 0.00



Qt normalized for  
unequal end area effects

$S_u = (Q_t - \sigma_{vV}) / N_k$   
 $N_k = 15.5$   
 $\gamma = 16.5 \text{ kN/m}^3$

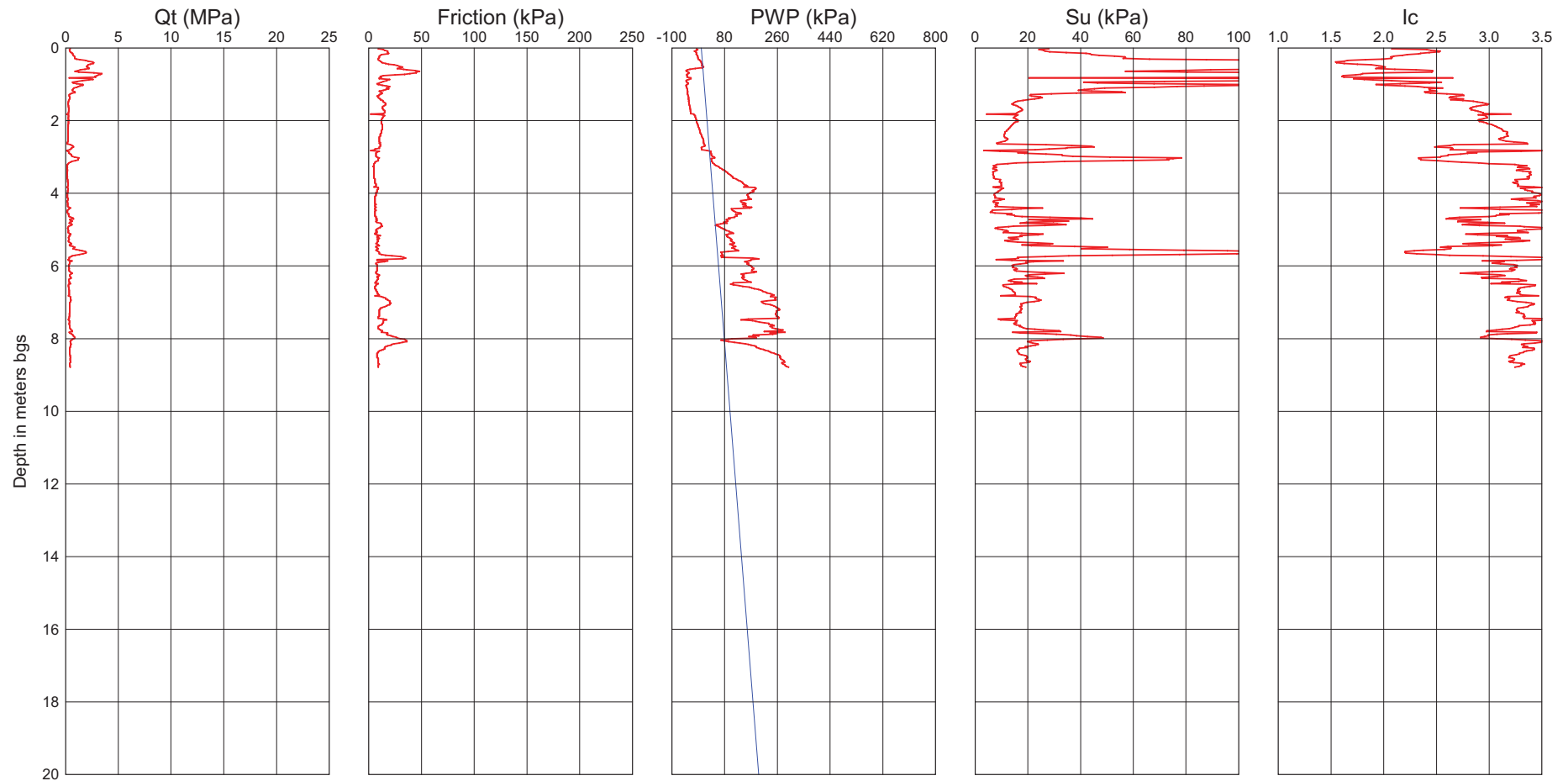
After Robertson and (Fear) Wride (1998)  
Ic < 1.31 - Gravelly sands  
1.31 < Ic < 2.05 - Clean to silty sand  
2.05 < Ic < 2.60 - Silty sand to sandy silt  
2.60 < Ic < 2.95 - Clayey silt to silty clay  
2.95 < Ic < 3.60 - Clays

# Cone Penetration Test - CPT305-5

Test Date : March 06, 2009  
Location : Highway 69 - STA 16+280 o/s 21 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 186.80  
Water Table Depth : 0.00



Qt normalized for  
unequal end area effects

$Su = (Qt - \sigma_v) / Nk$   
Nk = 15.5  
Gamma = 16.5 kN/m<sup>3</sup>

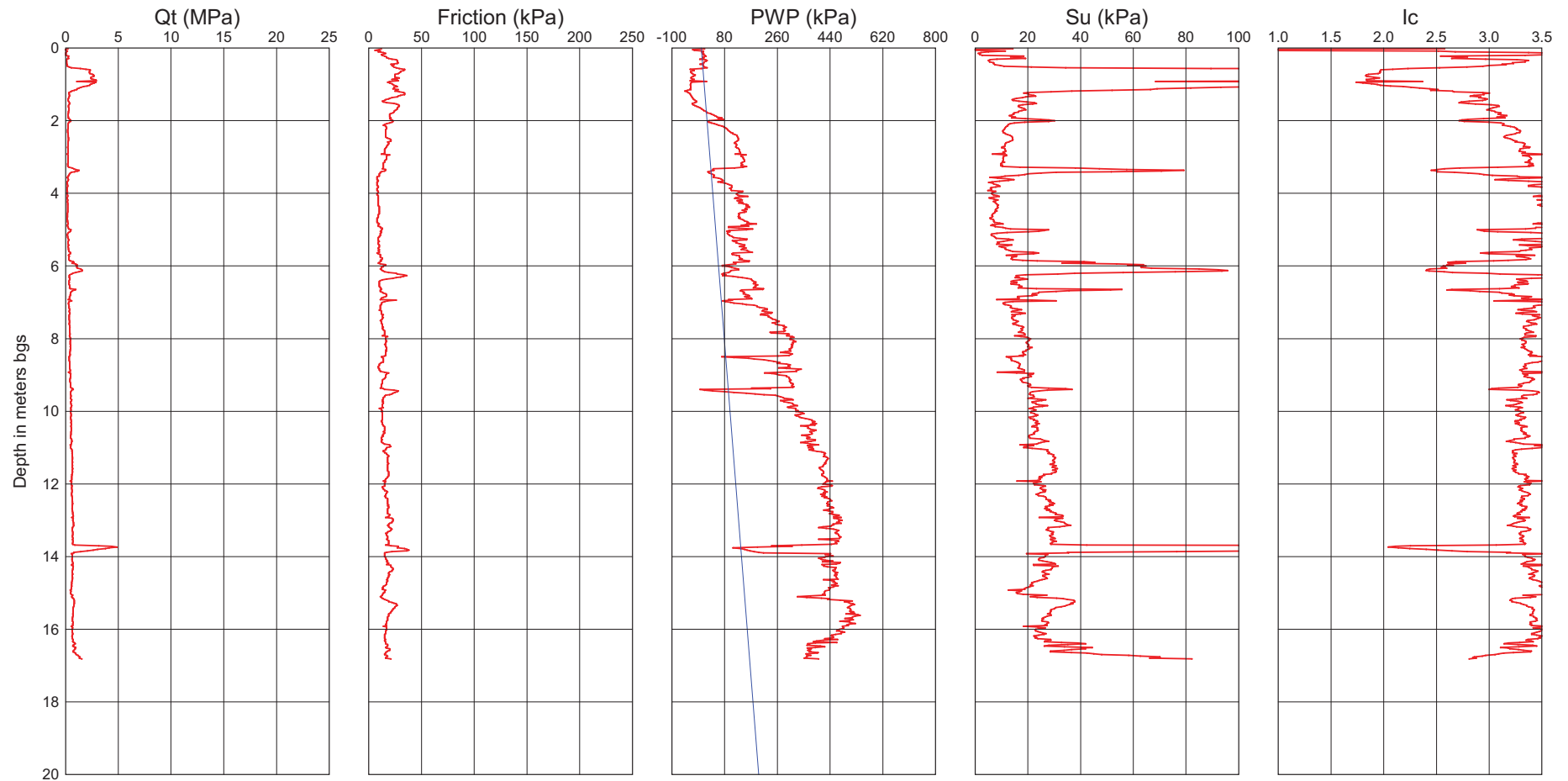
After Robertson and (Fear) Wride (1998)  
Ic < 1.31 - Gravelly sands  
1.31 < Ic < 2.05 - Clean to silty sand  
2.05 < Ic < 2.60 - Silty sand to sandy silt  
2.60 < Ic < 2.95 - Clayey silt to silty clay  
2.95 < Ic < 3.60 - Clays

# Cone Penetration Test - CPT305-6

Test Date : March 19, 2009  
Location : Highway 69 - STA 16+280 o/s 39 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 187.20  
Water Table Depth : 0.00



Qt normalized for  
unequal end area effects

$Su = (Qt - \sigma_v) / Nk$   
Nk = 15.5  
Gamma = 16.5 kN/m<sup>3</sup>

After Robertson and (Fear) Wride (1998)  
Ic < 1.31 - Gravelly sands  
1.31 < Ic < 2.05 - Clean to silty sand  
2.05 < Ic < 2.60 - Silty sand to sandy silt  
2.60 < Ic < 2.95 - Clayey silt to silty clay  
2.95 < Ic < 3.60 - Clays

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

CONT No.  
GWP No. 5203-06-00

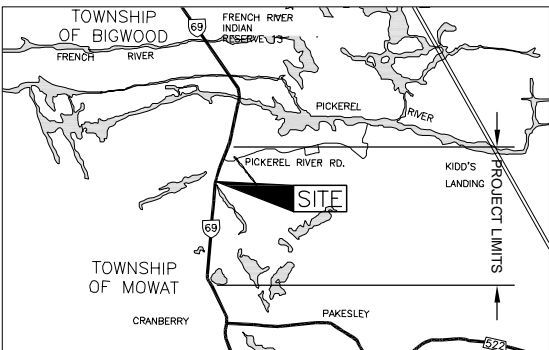


HIGHWAY 69 (SBL)  
STA 16+050 TO 16+350  
BOREHOLE LOCATION

SHEET



**Golder Associates Ltd.**  
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN



LEGEND

- Borehole - Current Investigation
- CPT - Current Investigation
- Borehole - Previous Investigation (Peto MacCallum Ltd.)
- Dynamic Cone Penetration Test - Previous Investigation (Peto MacCallum Ltd.)
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL observed during or upon completion of drilling
- R Refusal

| No.      | ELEVATION | CO-ORDINATES |          |
|----------|-----------|--------------|----------|
|          |           | NORTHING     | EASTING  |
| BH305-1  | 186.7     | 5092255.3    | 221116.7 |
| BH305-2  | 186.8     | 5092335.0    | 221124.4 |
| BH305-3  | 187.2     | 5092337.2    | 221104.5 |
| CPT305-1 | 186.7     | 5092272.2    | 221118.5 |
| CPT305-2 | 186.7     | 5092272.3    | 221117.5 |
| CPT305-3 | 186.8     | 5092335.0    | 221124.4 |
| CPT305-4 | 186.8     | 5092335.0    | 221123.9 |
| CPT305-5 | 186.8     | 5092335.1    | 221123.4 |
| CPT305-6 | 187.2     | 5092337.1    | 221105.5 |

NOTES

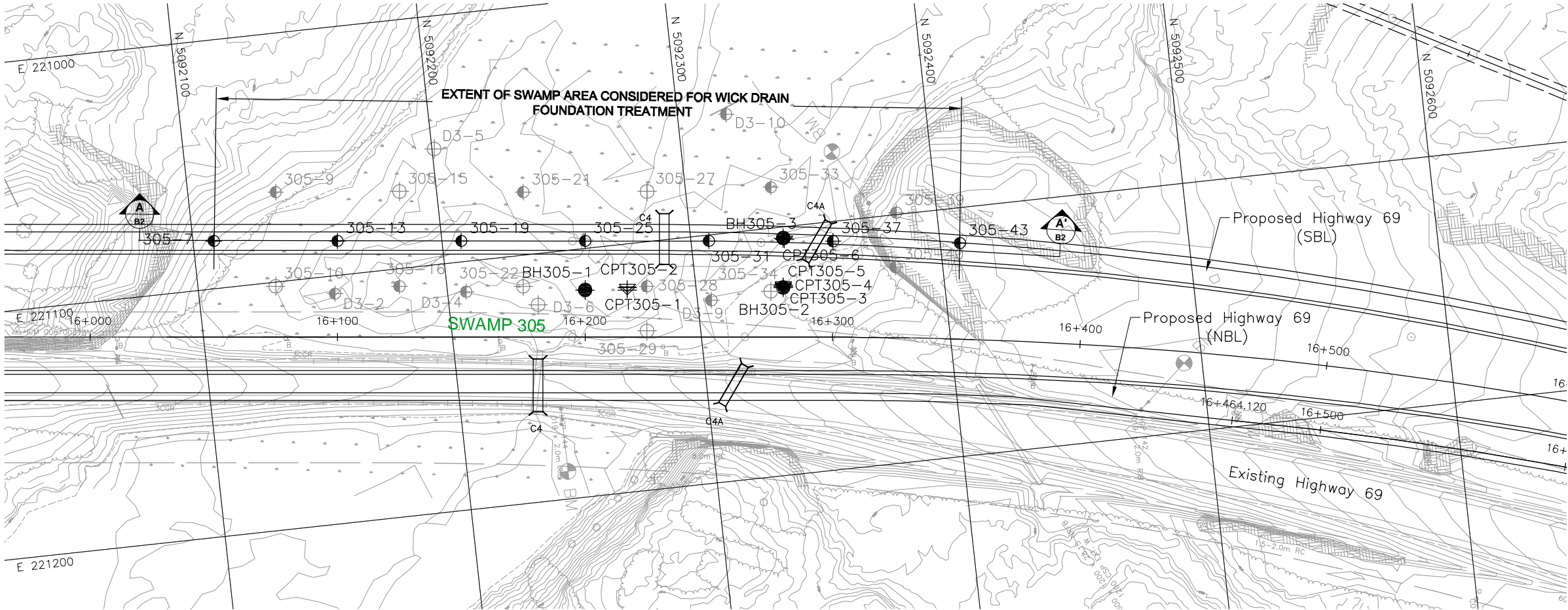
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

The boundaries between soil strata have been established only at borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

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

REFERENCE

Base plans and Profile provided in digital format by MRC, drawing file's no. PHASE 3 Plan 090211 - Golder.dwg, received February 11, 2009.  
1-6454\_ Phase3-ML PROFILE-Mar 26-09.dwg, received Sept. 30, 2009.



PLAN



| NO.                 | DATE                    | BY              | REVISION |
|---------------------|-------------------------|-----------------|----------|
| 1                   |                         |                 |          |
| Geocres No. 41H-106 |                         |                 |          |
| HWY. 69             | PROJECT NO. 06-1111-025 |                 | DIST.    |
| SUBM'D. MWK         | CHKD. MWK               | DATE: Feb. 2012 | SITE:    |
| DRAWN: DD/RJ        | CHKD. VA                | APPD. JPD/JMAC  | DWG. B1  |



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

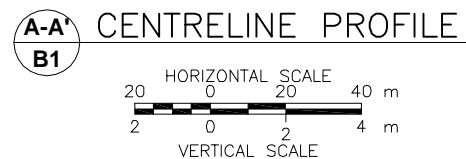
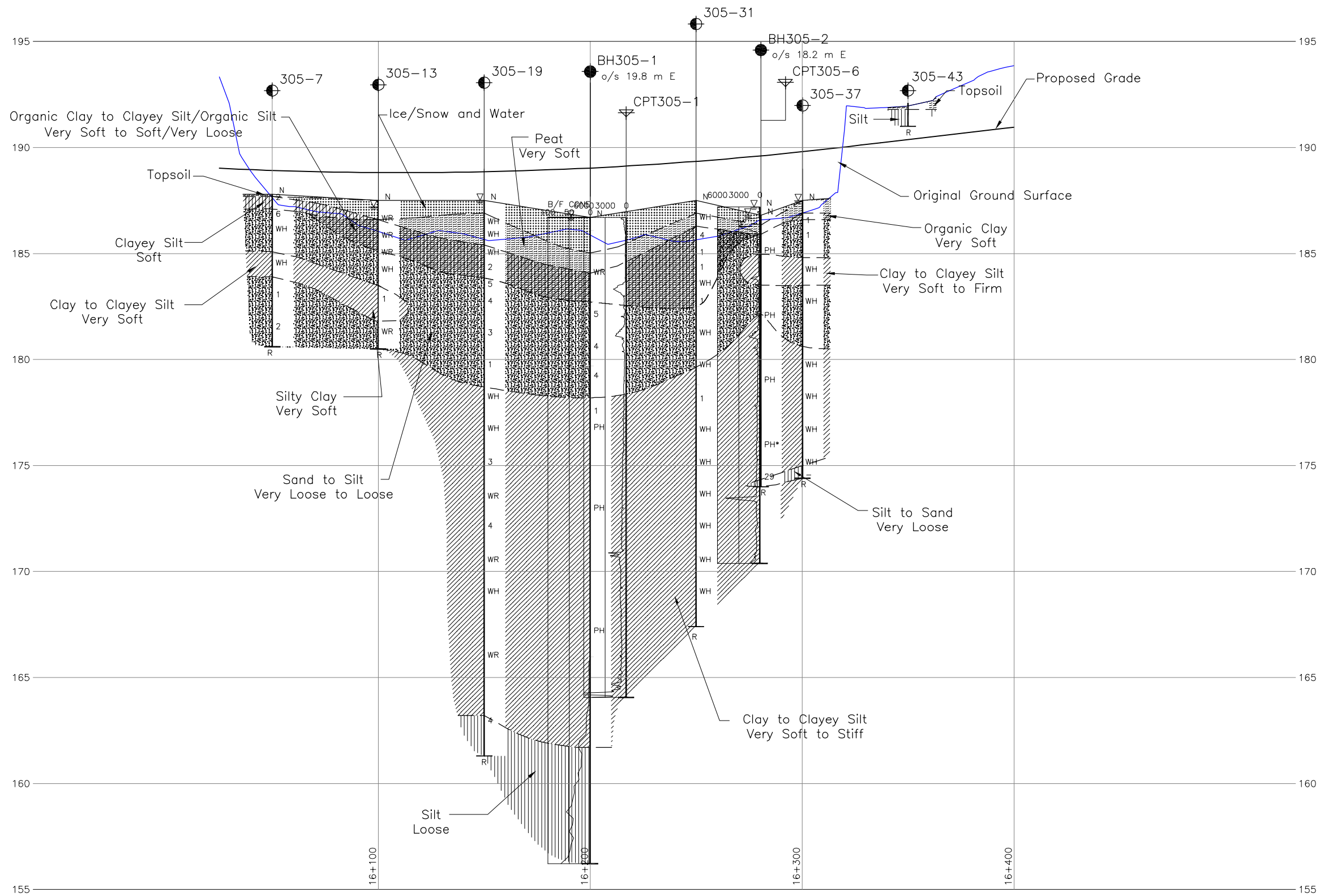
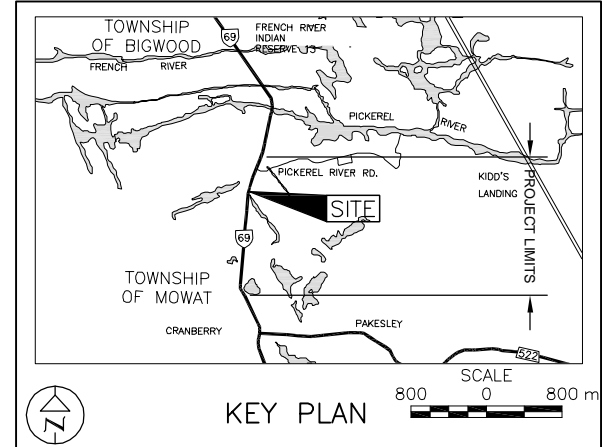
CONT No.  
GWP No. 5203-06-00

HIGHWAY 69 (SBL)  
STA 16+050 TO 16+350  
SOIL STRATA

SHEET



**Golder Associates Ltd.**  
MISSISSAUGA, ONTARIO, CANADA



#### LEGEND

- Borehole - Current Investigation
- ⊕ CPT - Current Investigation
- Borehole - Previous Investigation (Peto MacCallum Ltd.)
- ⊕ Dynamic Cone Penetration Test - Previous Investigation (Peto MacCallum Ltd.)
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL observed during or upon completion of drilling
- R Refusal

| No.      | ELEVATION | CO-ORDINATES |          |
|----------|-----------|--------------|----------|
|          |           | NORTHING     | EASTING  |
| BH305-1  | 186.7     | 5092255.3    | 221116.7 |
| BH305-2  | 186.8     | 5092335.0    | 221124.4 |
| CPT305-1 | 186.7     | 5092272.2    | 221118.5 |
| CPT305-6 | 187.2     | 5092337.1    | 221105.5 |

#### NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

The boundaries between soil strata have been established only at borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

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#### REFERENCE

Base plans and Profile provided in digital format by MRC, drawing file's no. PHASE 3 Plan 090211 - Golder.dwg, received February 11, 2009.  
1-6454\_ Phase3-ML PROFILE-Mar 26-09.dwg, received Sept. 30, 2009.



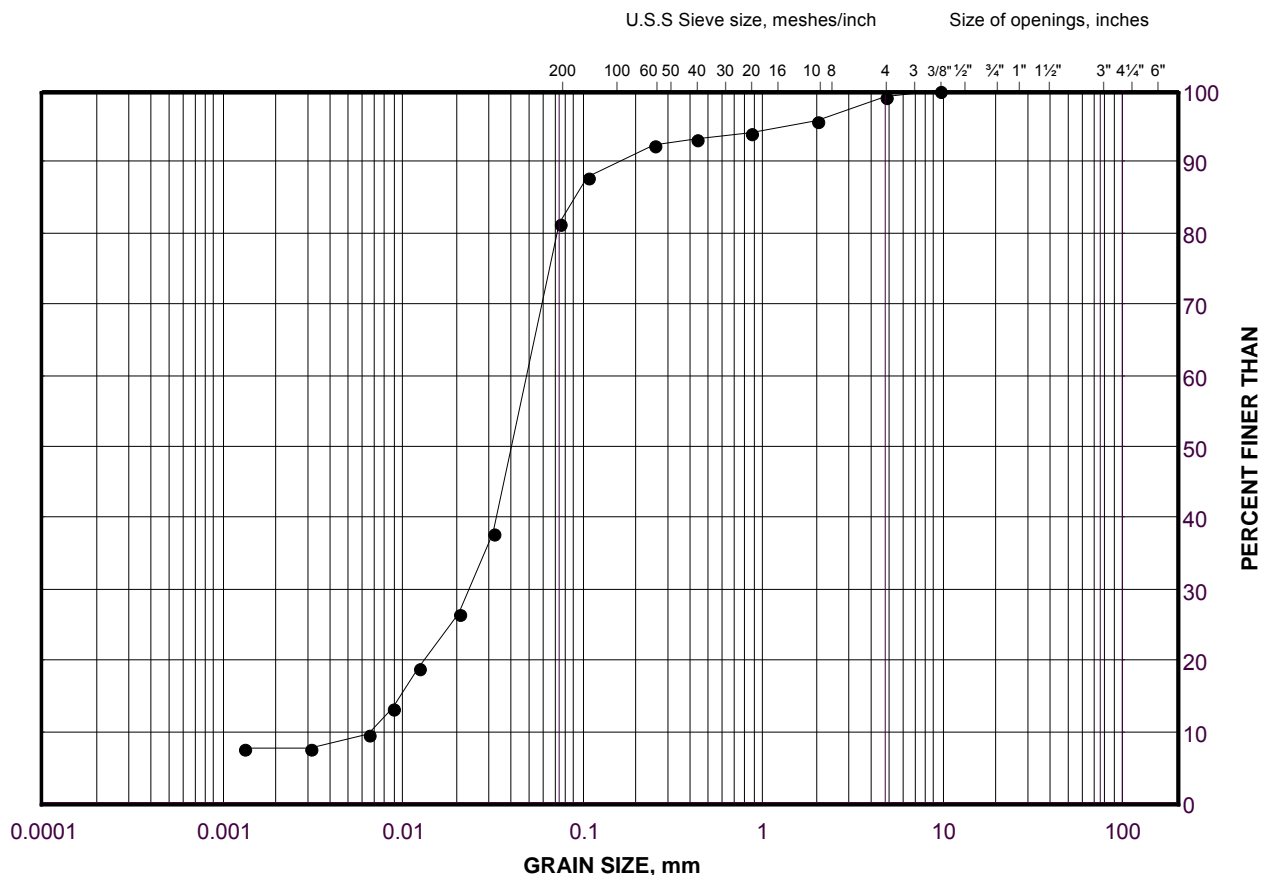
| NO.                 | DATE                    | BY              | REVISION |
|---------------------|-------------------------|-----------------|----------|
| Geocres No. 41H-106 |                         |                 |          |
| HWY. 69             | PROJECT NO. 06-1111-025 |                 | DIST.    |
| SUBM'D. MWK         | CHKD. MWK               | DATE: Feb. 2012 | SITE:    |
| DRAWN: RJ/JFC       | CHKD. VA                | APPD. JPD/JMAC  | DWG. B2  |



# GRAIN SIZE DISTRIBUTION

Silt  
Highway 69 (SBL) STA 16+050 to 16+350

FIGURE B.S305-1



|                     |  |           |        |        |             |        |        |
|---------------------|--|-----------|--------|--------|-------------|--------|--------|
| SILT AND CLAY SIZES |  | FINE      | MEDIUM | COARSE | FINE        | COARSE | COBBLE |
| FINE GRAINED        |  | SAND SIZE |        |        | GRAVEL SIZE |        | SIZE   |

## LEGEND

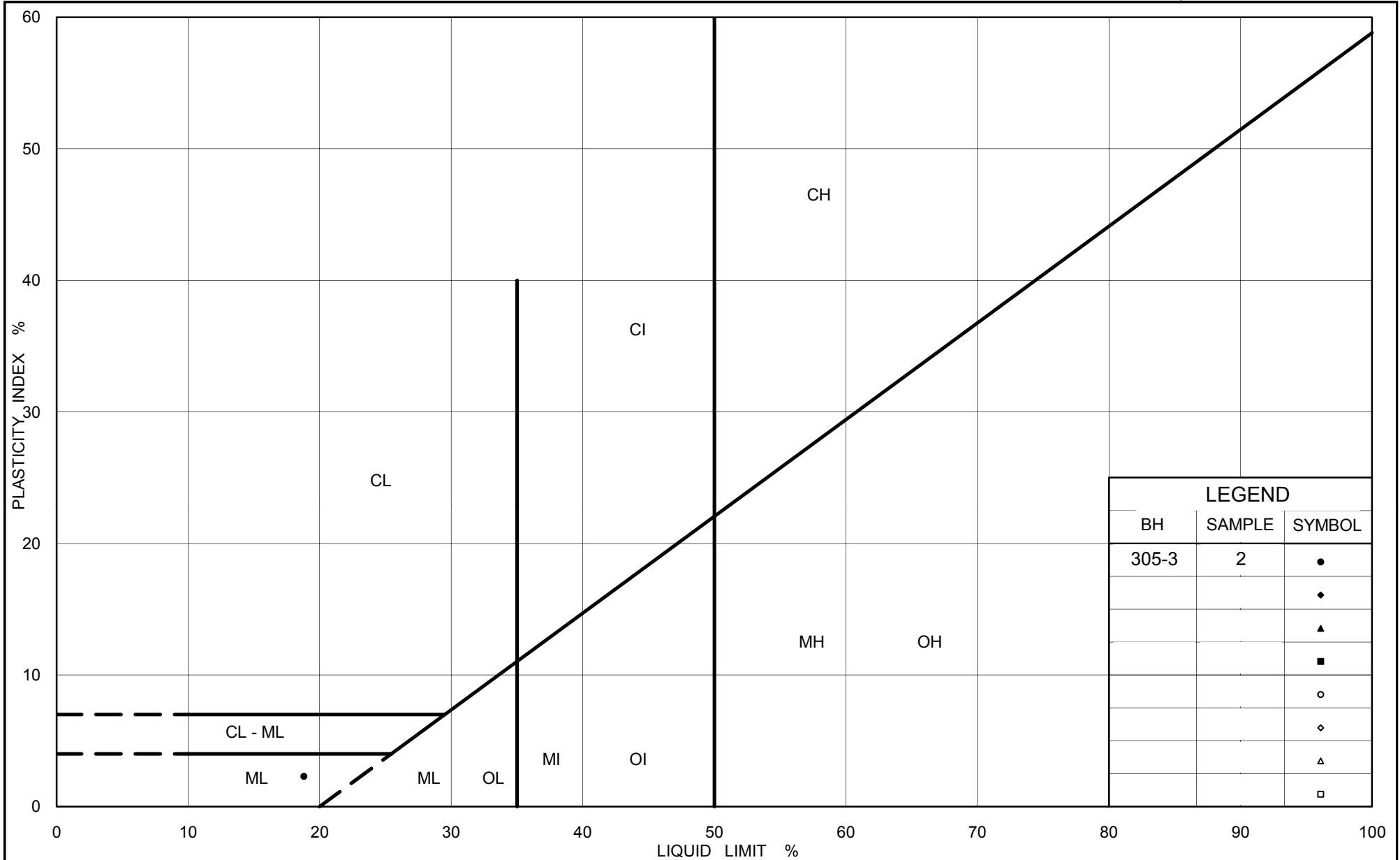
| SYMBOL | BOREHOLE | SAMPLE | ELEVATION(m) |
|--------|----------|--------|--------------|
| •      | 305-2    | 1      | 185.2        |

Project Number: 06-1111-025

Checked By: TVA

**Golder Associates**

Date: 01-Feb-10



Ministry of Transportation

Ontario

# PLASTICITY CHART Silt

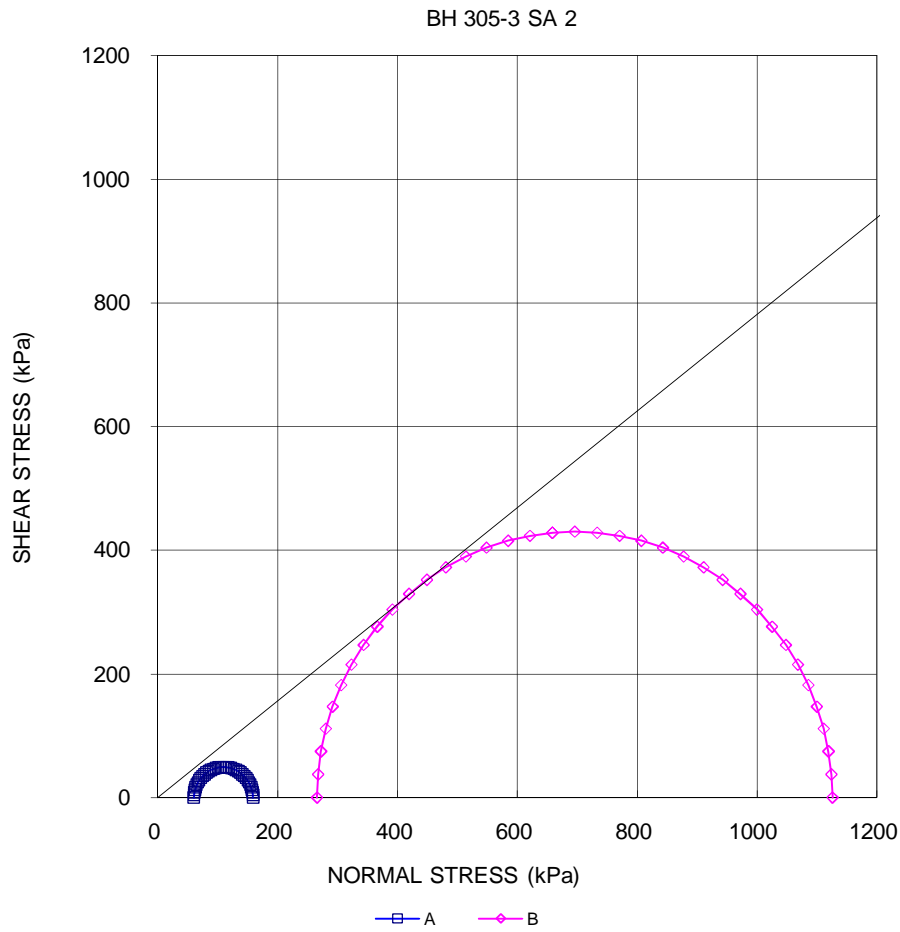
Highway 69 (SBL) STA 16+050 to 16+350

Figure No. B.S305-2

Project No. 06-1111-025

Checked By: TVA

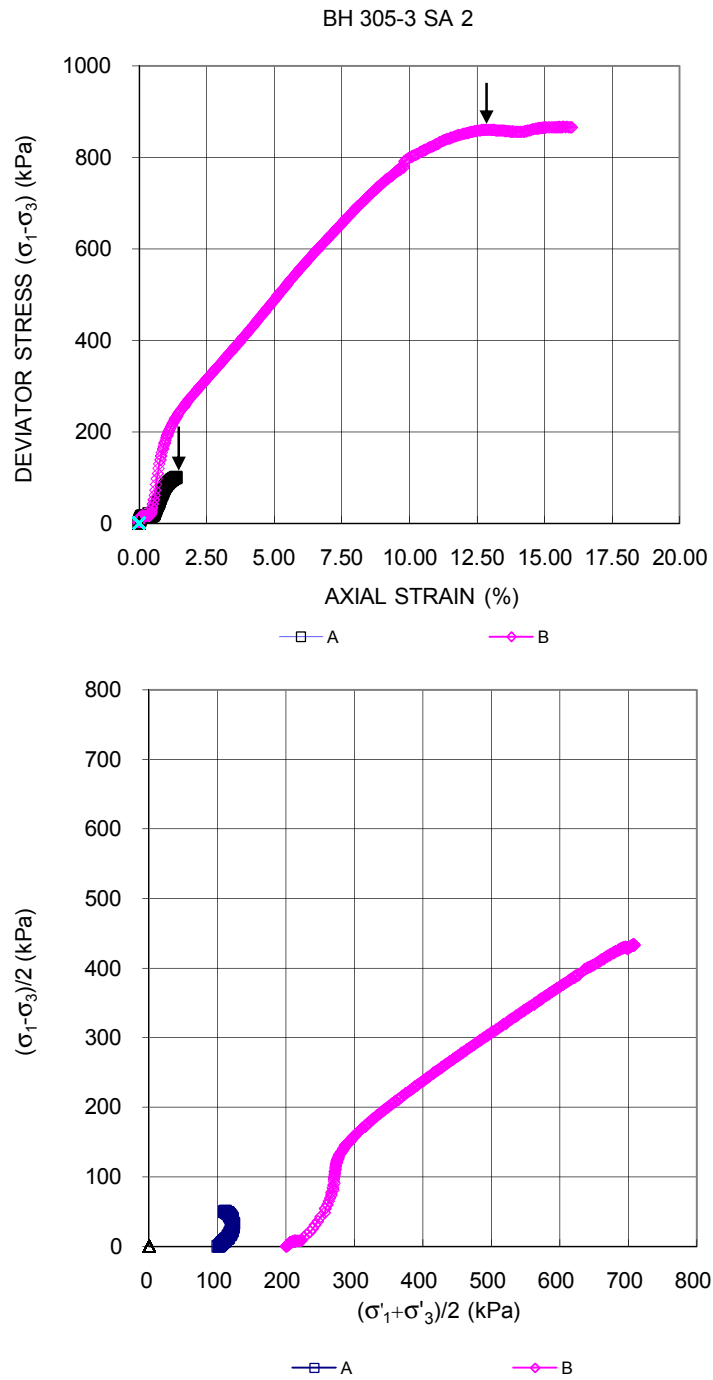
| CONSOLIDATED UNDRAINED TRIAXIAL<br>WITH PORE PRESSURE MEASUREMENTS      |       | FIGURE B.S305-3<br>Sheet 1 of 4   |
|---|-------|-----------------------------------|
| TEST STAGE  | A     | B                                 |
| BOREHOLE NUMBER   | 305-3 | 305-3                             |
| SAMPLE  | 2     | 2                                 |
| SPECIMEN DIAMETER, cm   | 7.06  | 6.74                              |
| SPECIMEN HEIGHT, cm   | 14.20 | 13.35                             |
| WATER CONTENT BEFORE CONSOLIDATION, %                                   | 23.9  | 20.6                              |
| CELL PRESSURE, $\sigma_3$ , kPa   | 165.0 | 265.0                             |
| BACK PRESSURE, kPa  | 65.0  | 65.0                              |
| PORE PRESSURE PARAMETER "B"   | 0.99  | -                                 |
| CONSOLIDATION PRESSURE, $\sigma_c$ , kPa                                | 100.0 | 200.0                             |
| VOLUMETRIC STRAIN DURING CONSOLIDATION, %                               | 5.3   | 1.0                               |
| WATER CONTENT AFTER CONSOLIDATION, %                                    | 20.6  | 20.1                              |
| AVERAGE RATE OF STRAIN, %/hr  | 0.5   | 0.5                               |
| TIME TO FAILURE, hours  | 3     | 25                                |
| WATER CONTENT AFTER TEST, %   | 20.6  | 18.6                              |
| MAX. DEVIATOR STRESS, $(\sigma_1 - \sigma_3)$ , kPa                     | 101.0 | 859.5                             |
| AXIAL STRAIN AT $(\sigma_1 - \sigma_3)$ maximum, %                      | 1.4   | 12.7                              |
| MAX EFFECTIVE PRINCIPAL STRESS RATIO, $(\sigma'_1 / \sigma'_3)$ maximum | 2.7   | 4.3                               |
| DEVIATOR STRESS AT $(\sigma'_1 / \sigma'_3)$ maximum, kPa               | 101.0 | 791.2                             |
| AXIAL STRAIN AT $(\sigma'_1 / \sigma'_3)$ maximum, %                    | 1.4   | 9.8                               |
| PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 - \sigma_3)$ maximum         | 0.40  | -0.08                             |
| PORE PRESSURE PARAMETER, Af, AT $(\sigma'_1 / \sigma'_3)$ maximum       | 0.40  | -0.05                             |
| NATURAL WATER CONTENT, %  | 23.8  | -                                 |
| DRY DENSITY, Mg/m <sup>3</sup>  | 1.62  | -                                 |
| FILTER DRAINS USED, y/n   | y     | y                                 |
| TEST NOTES:   |       |                                   |
| CHANGED RATE OF STRAIN, %/hr  | -     | -                                 |
| AXIAL STRAIN WHERE RATE OF STRAIN WAS CHANGED, %                        | -     | -                                 |
| FAILURE PLANE NUMBER  | -     | -                                 |
| ANGLE OF FAILURE, DEGREES   | -     | bulged                            |
| Date: 01/27/2010<br>Project No. 06-1111-025<br><b>Golder Associates</b> |       | Prepared By: LH<br>Checked By: MM |



Date: 01/27/2010  
Project No. 06-1111-025

**Golder Associates**

Prepared By: LH  
Checked By: MM



Date: 01/27/2010  
Project No. 06-1111-025

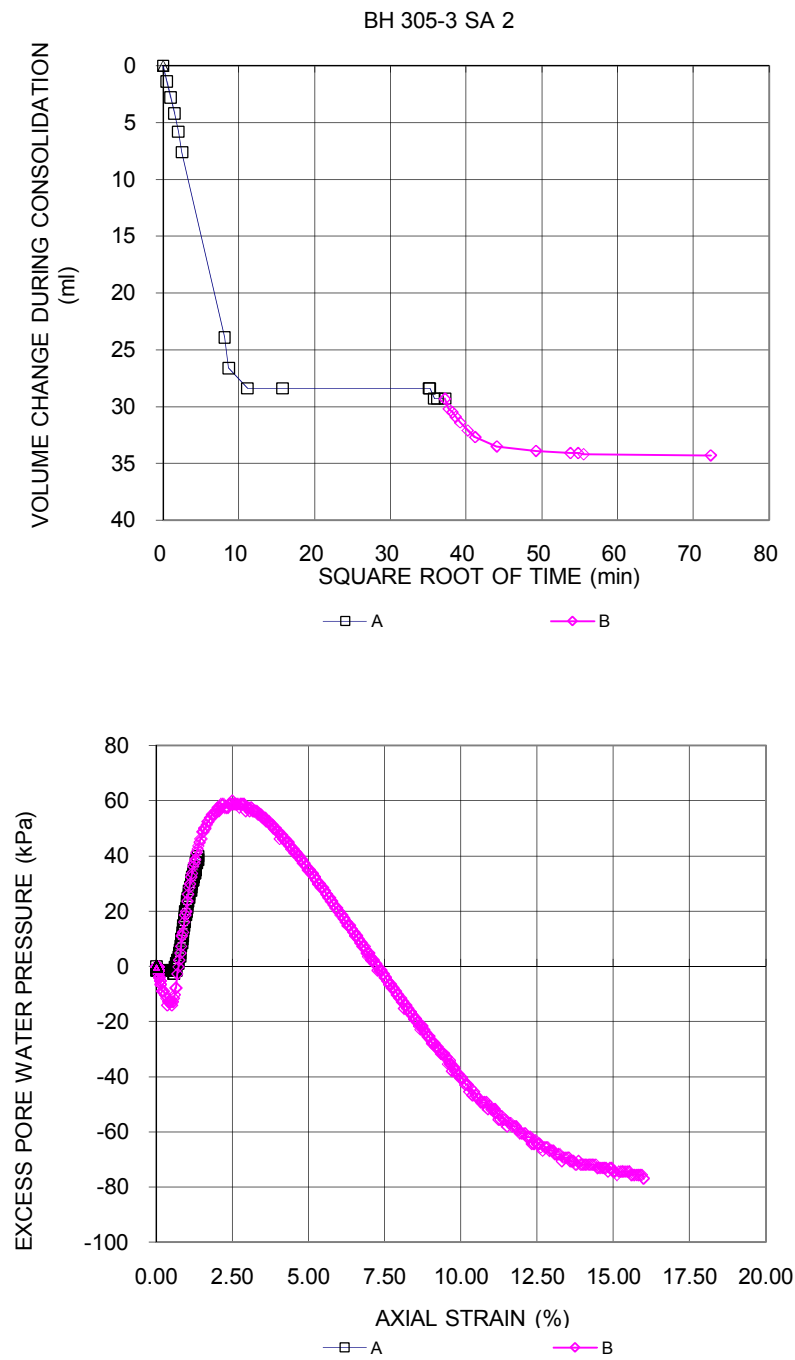
**Golder Associates**

Prepared By: LH  
Checked By: MM

**CONSOLIDATED UNDRAINED TRIAXIAL  
WITH PORE PRESSURE MEASUREMENTS**

**FIGURE B.S305-3**

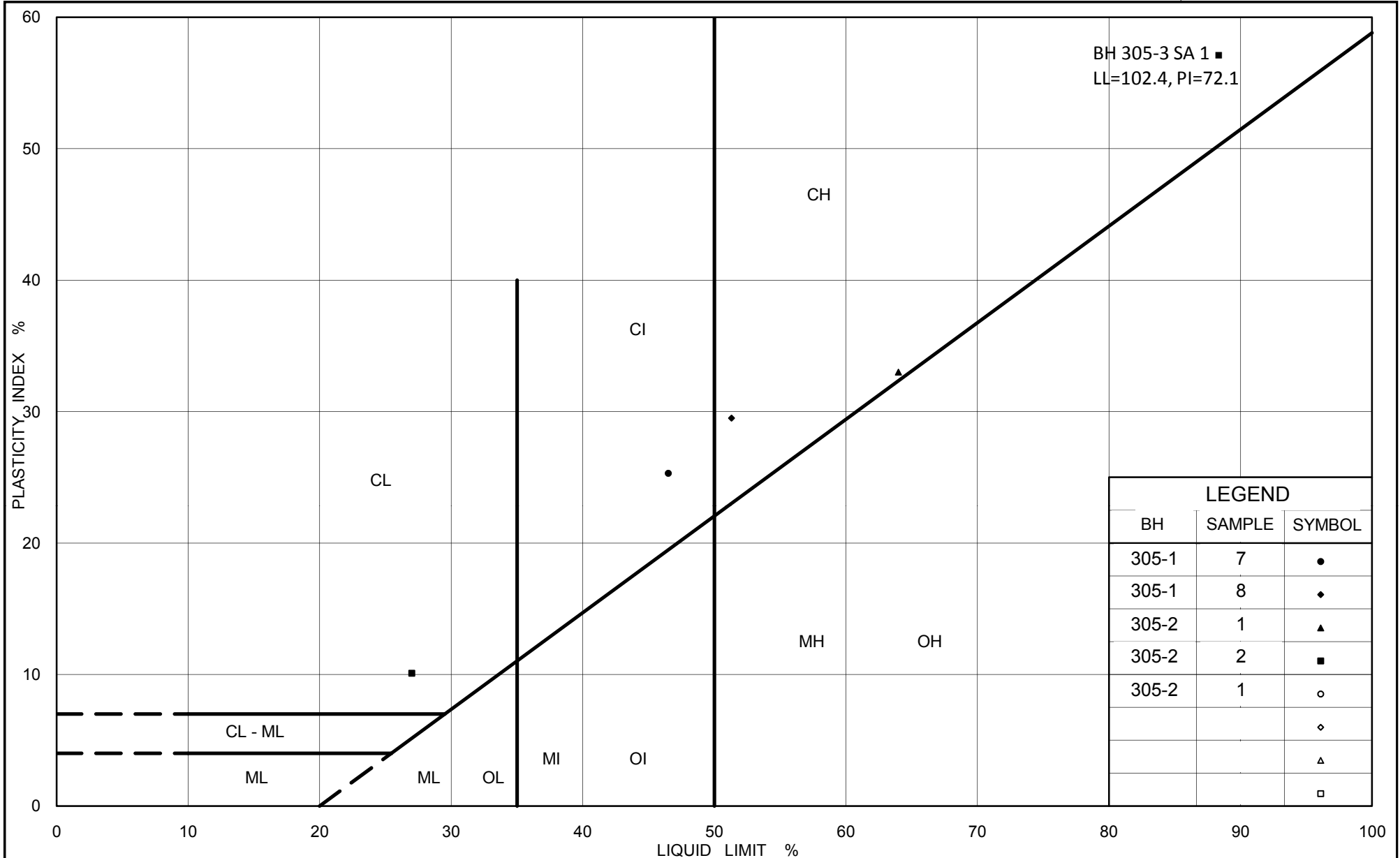
**Sheet 4 of 4**



Date: 01/27/2010  
Project No. 06-1111-025

**Golder Associates**

Prepared By: LH  
Checked By: MM



Ministry of Transportation

Ontario

PLASTICITY CHART  
Clay to Clayey Silt (Lower)  
Highway 69 (SBL) STA 16+050 to 16+350

Figure No. B.S305-4

Project No. 06-1111-025

Checked By: TVA

**CONSOLIDATION TEST SUMMARY****Highway 69 (SBL) STA 16+050 to 16+350****FIGURE B.S305-5****Sheet 1 of 4****SAMPLE IDENTIFICATION**

|                 |             |                 |      |
|-----------------|-------------|-----------------|------|
| Project Number  | 06-1111-025 | Sample Number   | 7    |
| Borehole Number | 305-1       | Sample Depth, m | 13.8 |

**TEST CONDITIONS**

|                  |            |                   |    |
|------------------|------------|-------------------|----|
| Test Type        | Standard   | Load Duration, hr | 24 |
| Oedometer Number | 6          |                   |    |
| Date Started     | 04/23/2009 |                   |    |
| Date Completed   | 05/12/2009 |                   |    |

**SAMPLE DIMENSIONS AND PROPERTIES - INITIAL**

|                         |        |                                    |       |
|-------------------------|--------|------------------------------------|-------|
| Sample Height, cm       | 1.90   | Unit Weight, kN/m <sup>3</sup>     | 16.79 |
| Sample Diameter, cm     | 6.34   | Dry Unit Weight, kN/m <sup>3</sup> | 10.97 |
| Area, cm <sup>2</sup>   | 31.57  | Specific Gravity, measured         | 2.78  |
| Volume, cm <sup>3</sup> | 59.86  | Solids Height, cm                  | 0.763 |
| Water Content, %        | 53.10  | Volume of Solids, cm <sup>3</sup>  | 24.08 |
| Wet Mass, g             | 102.49 | Volume of Voids, cm <sup>3</sup>   | 35.78 |
| Dry Mass, g             | 66.94  | Degree of Saturation, %            | 99.4  |

**TEST COMPUTATIONS**

| Pressure<br>kPa | Corr.<br>Height<br>cm | Void<br>Ratio | Average<br>Height<br>cm | t <sub>90</sub><br>sec | cv.<br>cm <sup>2</sup> /s | mv<br>m <sup>2</sup> /kN | k<br>cm/s |
|-----------------|-----------------------|---------------|-------------------------|------------------------|---------------------------|--------------------------|-----------|
| 0.00            | 1.896                 | 1.486         | 1.896                   |                        |                           |                          |           |
| 4.84            | 1.886                 | 1.473         | 1.891                   | 9                      | 8.42E-02                  | 1.08E-03                 | 8.91E-06  |
| 9.53            | 1.882                 | 1.468         | 1.884                   | 17                     | 4.43E-02                  | 4.16E-04                 | 1.81E-06  |
| 19.47           | 1.871                 | 1.453         | 1.877                   | 60                     | 1.24E-02                  | 6.00E-04                 | 7.31E-07  |
| 38.81           | 1.854                 | 1.431         | 1.863                   | 26                     | 2.83E-02                  | 4.58E-04                 | 1.27E-06  |
| 77.64           | 1.821                 | 1.387         | 1.837                   | 60                     | 1.19E-02                  | 4.58E-04                 | 5.35E-07  |
| 155.06          | 1.706                 | 1.237         | 1.764                   | 46                     | 1.43E-02                  | 7.78E-04                 | 1.09E-06  |
| 310.20          | 1.531                 | 1.007         | 1.619                   | 240                    | 2.31E-03                  | 5.97E-04                 | 1.35E-07  |
| 620.91          | 1.410                 | 0.848         | 1.470                   | 24                     | 1.91E-02                  | 2.06E-04                 | 3.85E-07  |
| 1241.59         | 1.309                 | 0.716         | 1.359                   | 60                     | 6.53E-03                  | 8.55E-05                 | 5.47E-08  |
| 2482.16         | 1.230                 | 0.612         | 1.269                   | 25                     | 1.37E-02                  | 3.36E-05                 | 4.50E-08  |
| 1241.59         | 1.244                 | 0.631         | 1.237                   |                        |                           |                          |           |
| 310.20          | 1.259                 | 0.650         | 1.251                   |                        |                           |                          |           |
| 77.64           | 1.290                 | 0.691         | 1.274                   |                        |                           |                          |           |
| 19.47           | 1.321                 | 0.732         | 1.305                   |                        |                           |                          |           |
| 4.84            | 1.343                 | 0.760         | 1.332                   |                        |                           |                          |           |

Note:

k calculated using cv based on t<sub>90</sub> values.**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

|                         |       |                                    |       |
|-------------------------|-------|------------------------------------|-------|
| Sample Height, cm       | 1.34  | Unit Weight, kN/m <sup>3</sup>     | 20.12 |
| Sample Diameter, cm     | 6.34  | Dry Unit Weight, kN/m <sup>3</sup> | 15.49 |
| Area, cm <sup>2</sup>   | 31.57 | Specific Gravity, measured         | 2.78  |
| Volume, cm <sup>3</sup> | 42.39 | Solids Height, cm                  | 0.763 |
| Water Content, %        | 29.90 | Volume of Solids, cm <sup>3</sup>  | 24.08 |
| Wet Mass, g             | 86.96 | Volume of Voids, cm <sup>3</sup>   | 18.30 |
| Dry Mass, g             | 66.94 |                                    |       |

Prepared By: LH

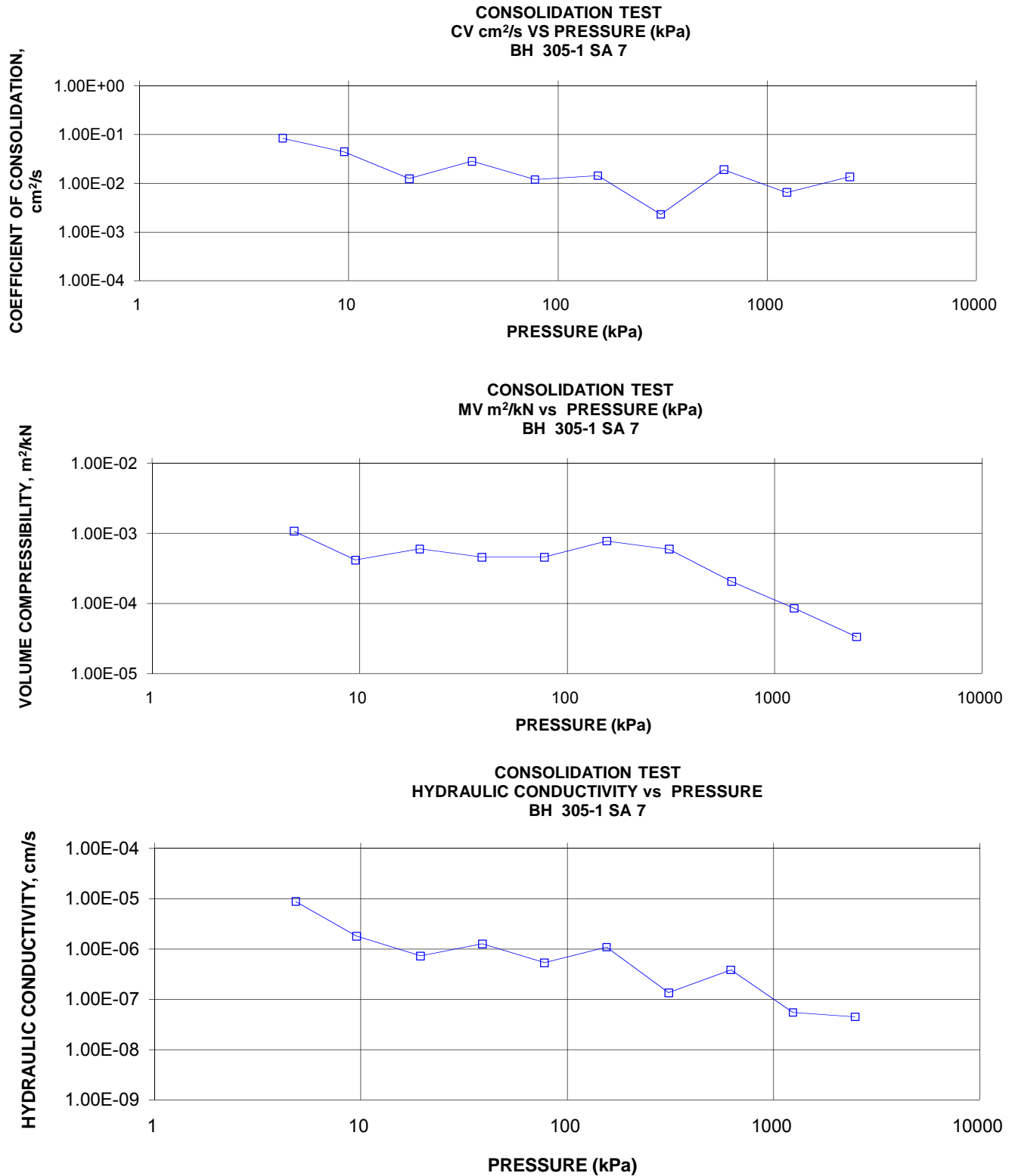
**Golder Associates**

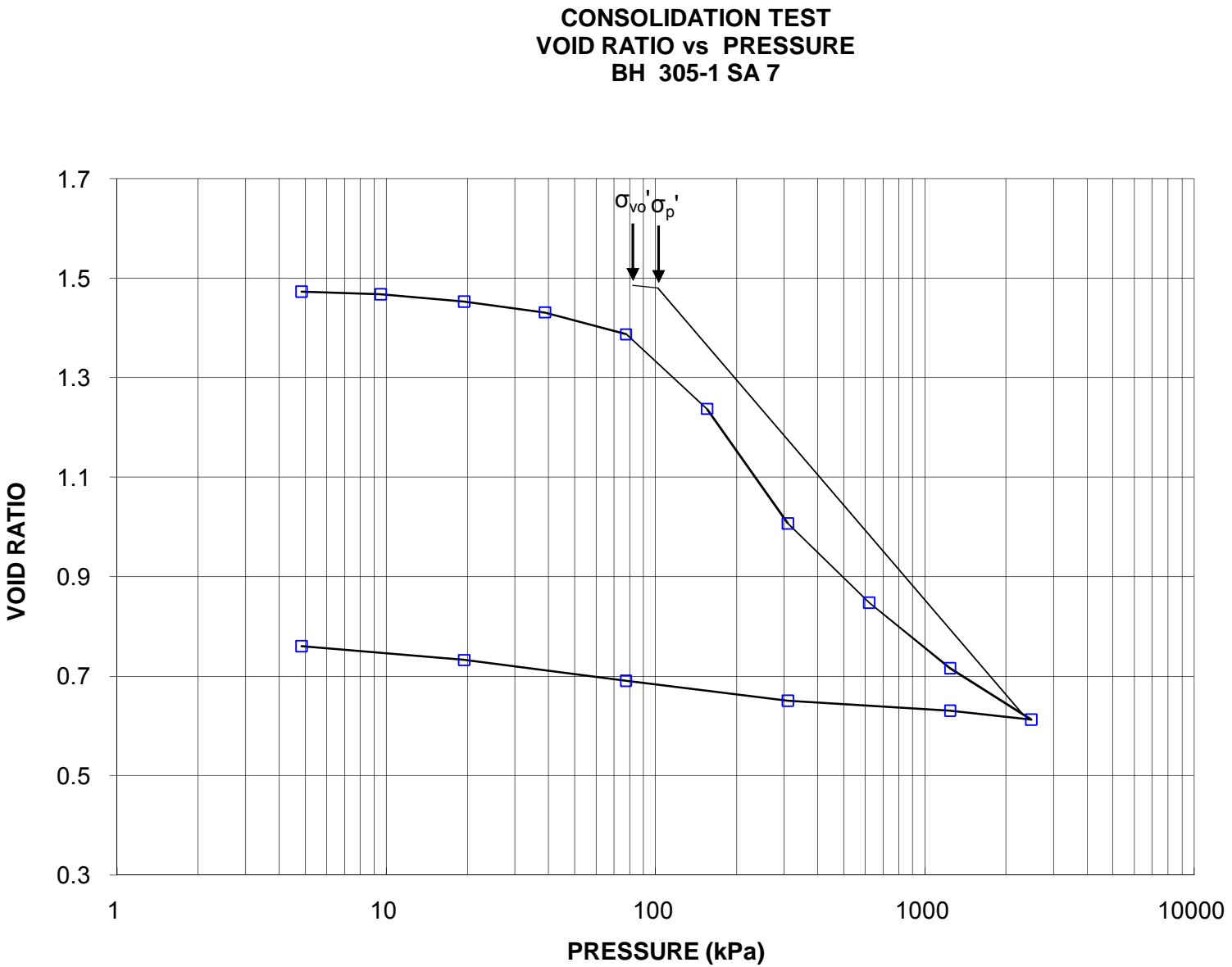
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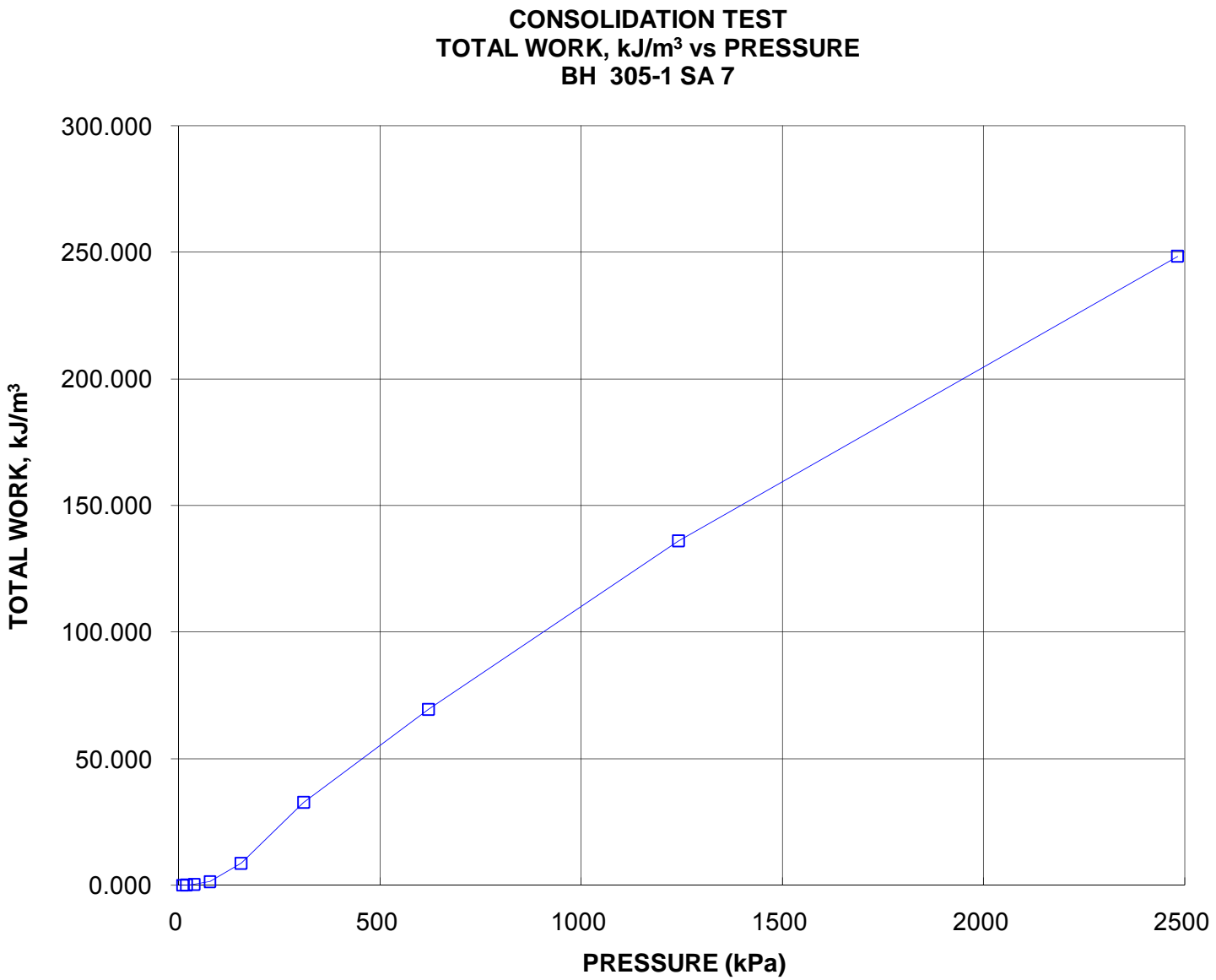


**CONSOLIDATION TEST SUMMARY**  
**Highway 69 (SBL) STA 16+050 to 16+350**

**FIGURE B.S305-5**  
**Sheet 2 of 4**







**CONSOLIDATION TEST SUMMARY****Highway 69 (SBL) STA 16+050 to 16+350****FIGURE B.S305-6****Sheet 1 of 4****SAMPLE IDENTIFICATION**

|                 |             |                 |     |
|-----------------|-------------|-----------------|-----|
| Project Number  | 06-1111-025 | Sample Number   | 1   |
| Borehole Number | 305-3       | Sample Depth, m | 3.4 |

**TEST CONDITIONS**

|                  |            |                   |    |
|------------------|------------|-------------------|----|
| Test Type        | Standard   | Load Duration, hr | 24 |
| Oedometer Number | 5          |                   |    |
| Date Started     | 04/30/2009 |                   |    |
| Date Completed   | 05/30/2009 |                   |    |

**SAMPLE DIMENSIONS AND PROPERTIES - INITIAL**

|                         |       |                                    |       |
|-------------------------|-------|------------------------------------|-------|
| Sample Height, cm       | 1.91  | Unit Weight, kN/m <sup>3</sup>     | 14.96 |
| Sample Diameter, cm     | 6.33  | Dry Unit Weight, kN/m <sup>3</sup> | 8.27  |
| Area, cm <sup>2</sup>   | 31.51 | Specific Gravity, measured         | 2.78  |
| Volume, cm <sup>3</sup> | 60.06 | Solids Height, cm                  | 0.578 |
| Water Content, %        | 80.81 | Volume of Solids, cm <sup>3</sup>  | 18.22 |
| Wet Mass, g             | 91.60 | Volume of Voids, cm <sup>3</sup>   | 41.83 |
| Dry Mass, g             | 50.66 | Degree of Saturation, %            | 97.9  |

**TEST COMPUTATIONS**

| Pressure<br>kPa | Corr.<br>Height<br>cm | Void<br>Ratio | Average<br>Height<br>cm | t <sub>90</sub><br>sec | cv.<br>cm <sup>2</sup> /s | mv<br>m <sup>2</sup> /kN | k<br>cm/s |
|-----------------|-----------------------|---------------|-------------------------|------------------------|---------------------------|--------------------------|-----------|
| 0.00            | 1.906                 | 2.296         | 1.906                   |                        |                           |                          |           |
| 4.78            | 1.896                 | 2.278         | 1.901                   | 8                      | 9.58E-02                  | 1.11E-03                 | 1.04E-05  |
| 9.58            | 1.882                 | 2.254         | 1.889                   | 10                     | 7.56E-02                  | 1.53E-03                 | 1.13E-05  |
| 19.35           | 1.855                 | 2.207         | 1.868                   | 60                     | 1.23E-02                  | 1.46E-03                 | 1.76E-06  |
| 38.88           | 1.789                 | 2.093         | 1.822                   | 175                    | 4.02E-03                  | 1.77E-03                 | 6.99E-07  |
| 77.82           | 1.613                 | 1.789         | 1.701                   | 416                    | 1.47E-03                  | 2.37E-03                 | 3.43E-07  |
| 155.56          | 1.427                 | 1.467         | 1.520                   | 960                    | 5.10E-04                  | 1.25E-03                 | 6.27E-08  |
| 311.03          | 1.273                 | 1.201         | 1.350                   | 679                    | 5.69E-04                  | 5.20E-04                 | 2.90E-08  |
| 621.76          | 1.149                 | 0.986         | 1.211                   | 329                    | 9.45E-04                  | 2.09E-04                 | 1.94E-08  |
| 1244.19         | 1.045                 | 0.806         | 1.097                   | 315                    | 8.10E-04                  | 8.77E-05                 | 6.96E-09  |
| 2486.52         | 0.957                 | 0.654         | 1.001                   | 46                     | 4.62E-03                  | 3.72E-05                 | 1.68E-08  |
| 1244.19         | 0.969                 | 0.675         | 0.963                   |                        |                           |                          |           |
| 311.03          | 0.992                 | 0.715         | 0.980                   |                        |                           |                          |           |
| 77.82           | 1.033                 | 0.786         | 1.012                   |                        |                           |                          |           |
| 19.35           | 1.077                 | 0.862         | 1.055                   |                        |                           |                          |           |
| 4.78            | 1.116                 | 0.930         | 1.096                   |                        |                           |                          |           |

Note:

k calculated using cv based on t<sub>90</sub> values.**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

|                         |       |                                    |       |
|-------------------------|-------|------------------------------------|-------|
| Sample Height, cm       | 1.12  | Unit Weight, kN/m <sup>3</sup>     | 19.24 |
| Sample Diameter, cm     | 6.33  | Dry Unit Weight, kN/m <sup>3</sup> | 14.13 |
| Area, cm <sup>2</sup>   | 31.51 | Specific Gravity, measured         | 2.78  |
| Volume, cm <sup>3</sup> | 35.16 | Solids Height, cm                  | 0.578 |
| Water Content, %        | 36.20 | Volume of Solids, cm <sup>3</sup>  | 18.22 |
| Wet Mass, g             | 69.00 | Volume of Voids, cm <sup>3</sup>   | 16.94 |
| Dry Mass, g             | 50.66 |                                    |       |

Prepared By: LH

**Golder Associates**

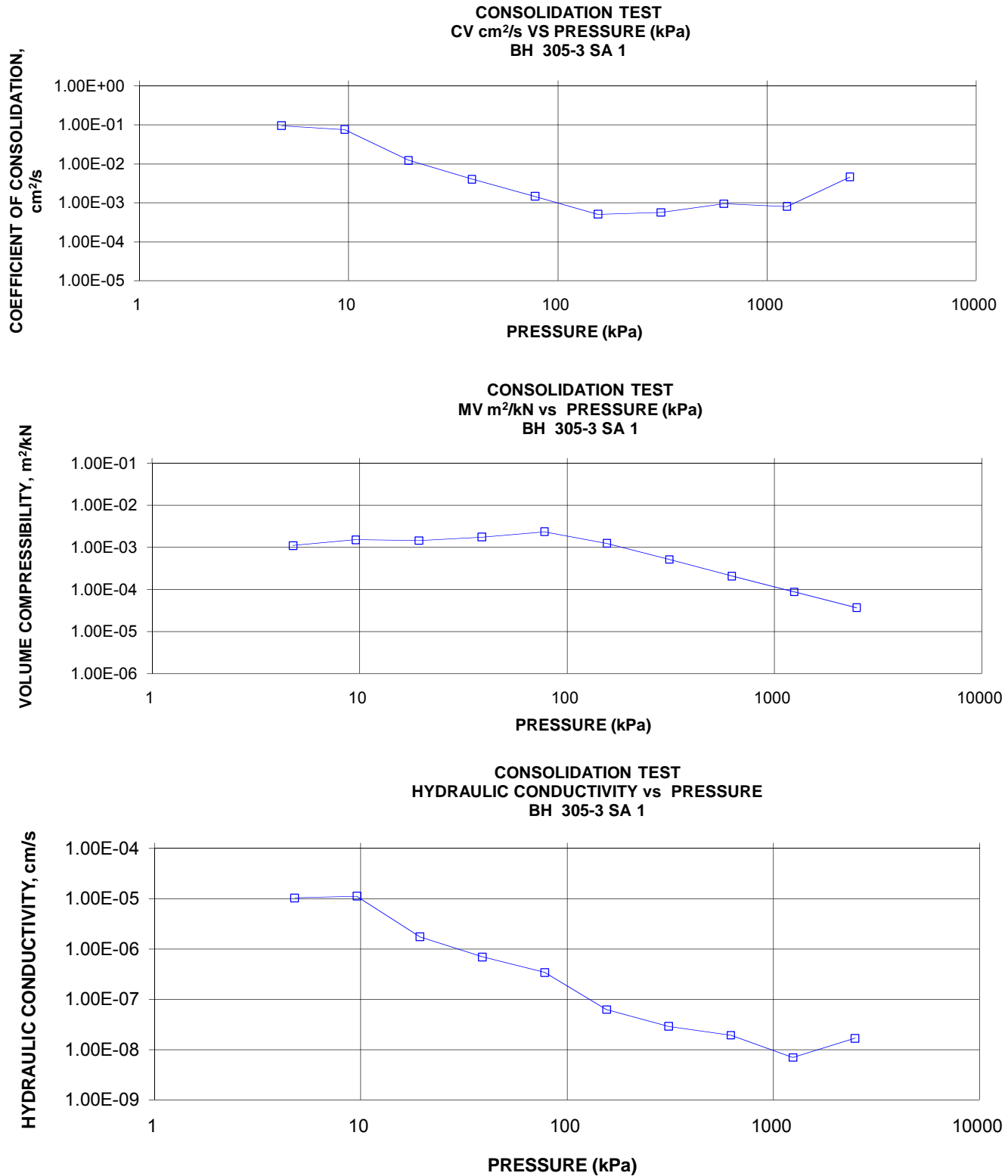
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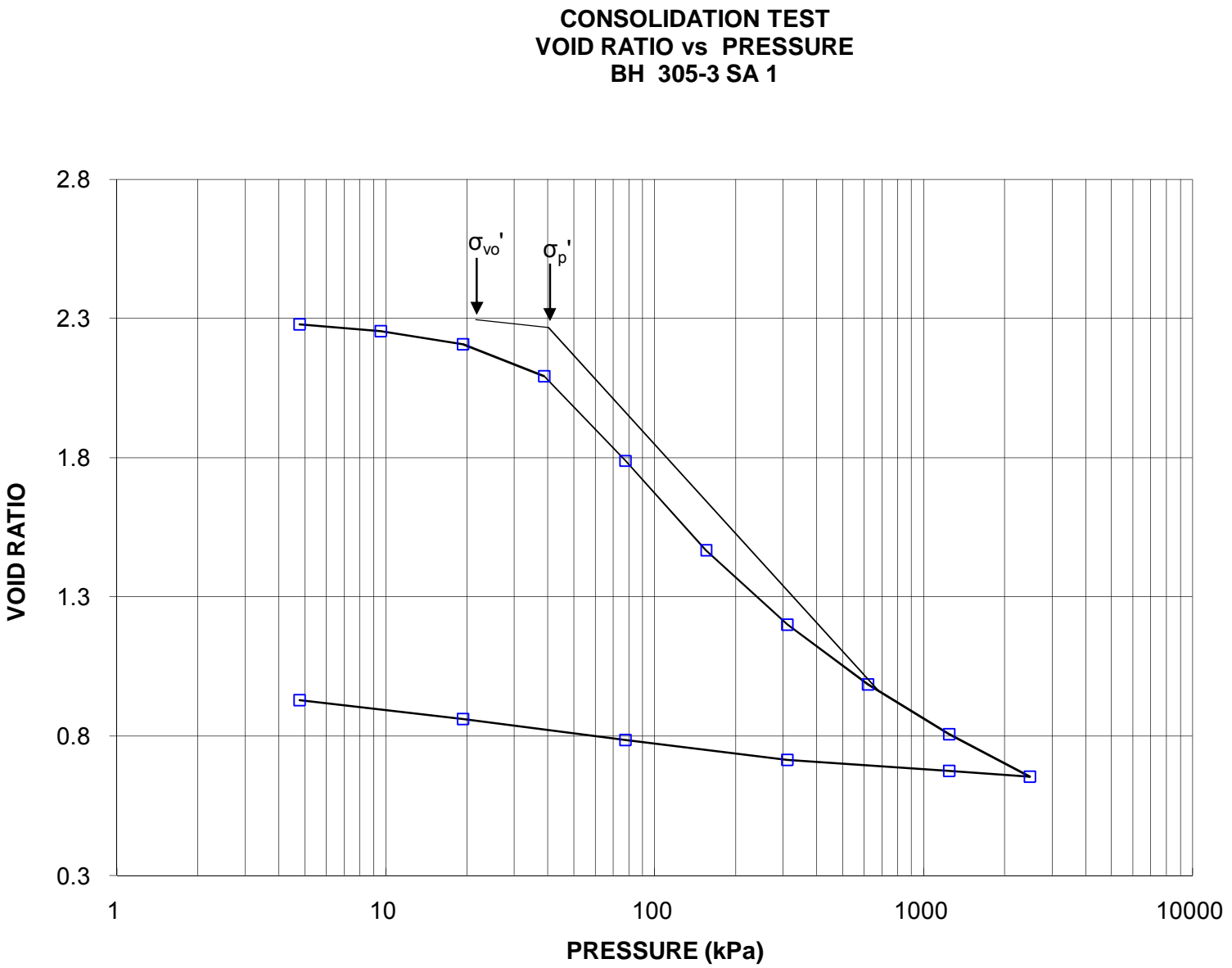
# CONSOLIDATION TEST SUMMARY

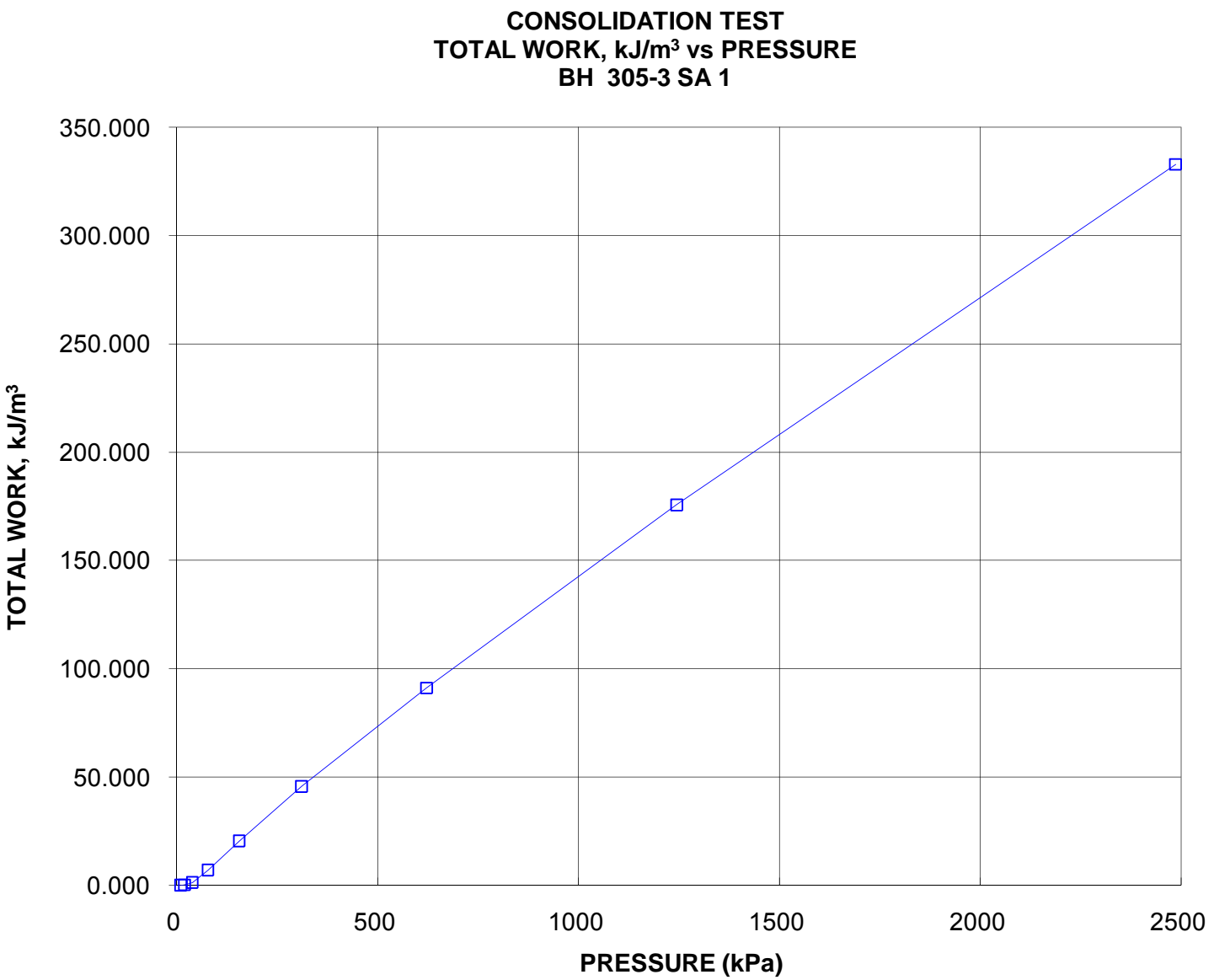
Highway 69 (SBL) STA 16+050 to 16+350

FIGURE B.S305-6

Sheet 2 of 4

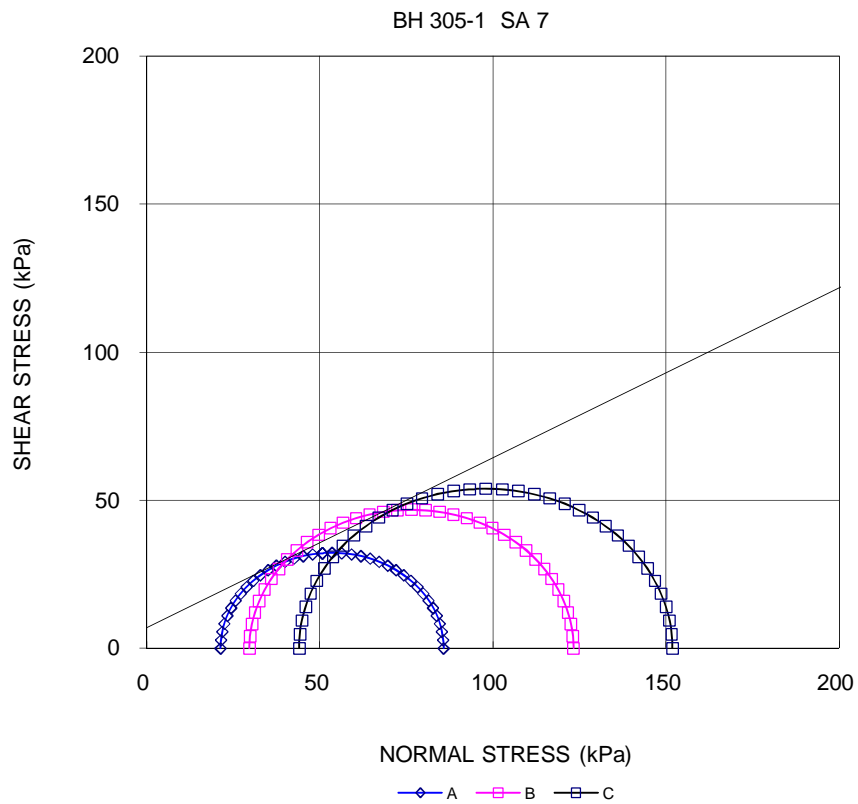






| CONSOLIDATED UNDRAINED TRIAXIAL<br>WITH PORE PRESSURE MEASUREMENTS  |       |       | FIGURE B.S305-7<br>Sheet 1 of 4 |
|---|-------|-------|---------------------------------|
| TEST STAGE  | A     | B     | C                               |
| BOREHOLE NUMBER   | 305-1 | 305-1 | 305-1                           |
| SAMPLE  | 7     | 7     | 7                               |
| SPECIMEN DIAMETER, cm   | 5.07  | 5.05  | 5.06                            |
| SPECIMEN HEIGHT, cm   | 10.16 | 10.16 | 10.17                           |
| WATER CONTENT BEFORE CONSOLIDATION, %   | 52.4  | 59.8  | 68.5                            |
| CELL PRESSURE, $\sigma_3$ , kPa   | 615.0 | 390.0 | 660.0                           |
| BACK PRESSURE, kPa  | 555.0 | 275.0 | 485.0                           |
| PORE PRESSURE PARAMETER "B"   | 0.96  | 0.99  | 0.97                            |
| CONSOLIDATION PRESSURE, $\sigma_c$ , kPa  | 60.0  | 115.0 | 175.0                           |
| VOLUMETRIC STRAIN DURING CONSOLIDATION, %   | 2.4   | 8.8   | 18.2                            |
| WATER CONTENT AFTER CONSOLIDATION, %  | 50.3  | 51.4  | 49.2                            |
| AVERAGE RATE OF STRAIN, %/hr  | 0.5   | 0.5   | 0.5                             |
| TIME TO FAILURE, DAYS   | 2     | 2     | 2                               |
| WATER CONTENT AFTER TEST, %   | 48.8  | 51.0  | 49.9                            |
| MAX. DEVIATOR STRESS, $(\sigma_1 - \sigma_3)$ , kPa   | 64.4  | 93.6  | 107.8                           |
| AXIAL STRAIN AT $(\sigma_1 - \sigma_3)$ MAXIMUM, %  | 3.2   | 4.7   | 6.9                             |
| MAX EFFECTIVE PRINCIPAL STRESS<br>RATIO, $(\sigma_1 / \sigma_3)$ MAXIMUM  | 4.2   | 5.1   | 3.8                             |
| DEVIATOR STRESS AT $(\sigma_1 / \sigma_3)$ MAXIMUM, kPa   | 62.5  | 81.9  | 106.0                           |
| AXIAL STRAIN AT $(\sigma_1 / \sigma_3)$ MAXIMUM, %  | 5.1   | 11.7  | 8.4                             |
| PORE PRESSURE PARAMETER, $A_f$ , AT $(\sigma_1 - \sigma_3)$ MAXIMUM   | 0.60  | 0.91  | 1.21                            |
| PORE PRESSURE PARAMETER, $A_f$ , AT $(\sigma_1 / \sigma_3)$ MAXIMUM   | 0.65  | 1.16  | 1.29                            |
| NATURAL WATER CONTENT, %  | 48.6  | 56.6  | 64.8                            |
| DRY DENSITY, Mg/m <sup>3</sup>  | 1.15  | 1.06  | 0.98                            |
| FILTER DRAINS USED, y/n   | y     | y     | y                               |
| TEST NOTES:   |       |       |                                 |
| CHANGED RATE OF STRAIN, %/hr  | -     | -     | -                               |
| AXIAL STRAIN WHERE RATE OF STRAIN WAS CHANGED, %  | -     | -     | -                               |
| FAILURE PLANE NUMBER  | 1     | 1     | 1                               |
| ANGLE OF FAILURE, DEGREES   | 75    | 75    | 60                              |
| <div> <div>Date: 06/11/2009</div> <div>Project No. 06-1111-025</div> <div>Golder Associates</div> <div>Prepared By: MM</div> <div>Checked By: RO</div> </div> |       |       |                                 |





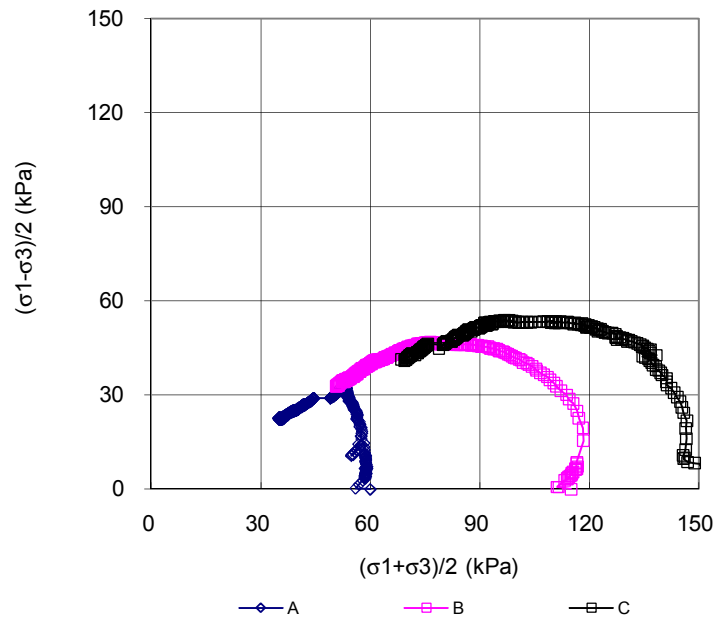
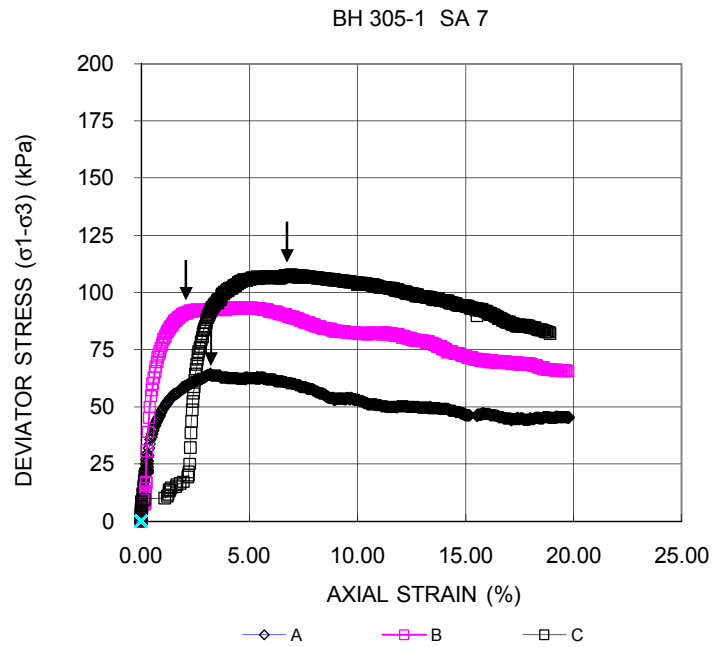
Date: 06/11/2009  
Project No. 06-1111-025

**Golder Associates**

Prepared By: MM  
Checked By: RO

**CONSOLIDATED UNDRAINED TRIAXIAL  
WITH PORE PRESSURE MEASUREMENTS**

**FIGURE B.S305-7  
Sheet 3 of 4**



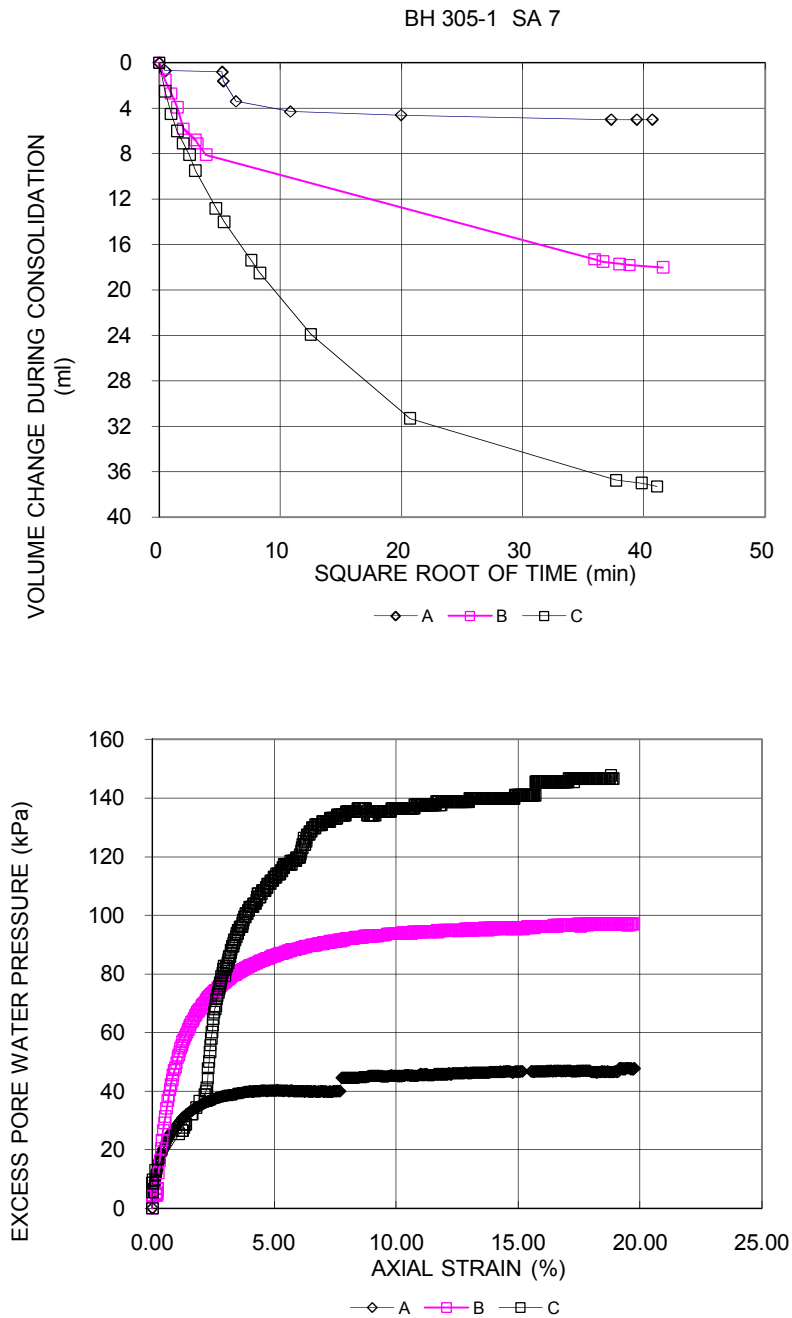
Date: 06/11/2009  
Project No. 06-1111-025

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Prepared By: MM  
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**CONSOLIDATED UNDRAINED TRIAXIAL  
WITH PORE PRESSURE MEASUREMENTS**

**FIGURE B.S305-7**  
**Sheet 4 of 4**

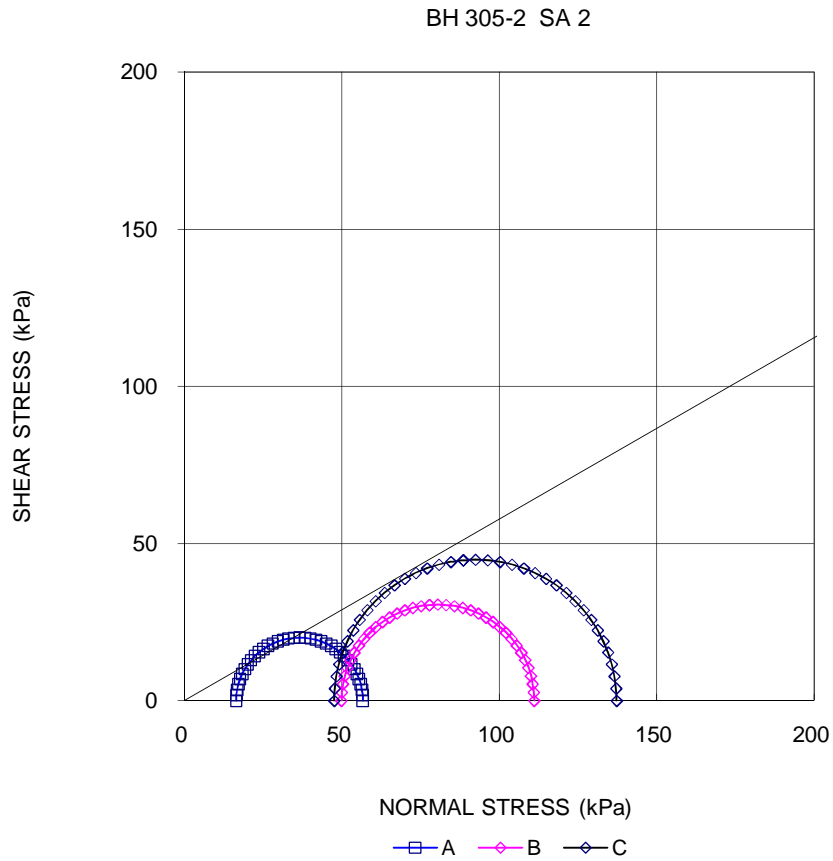


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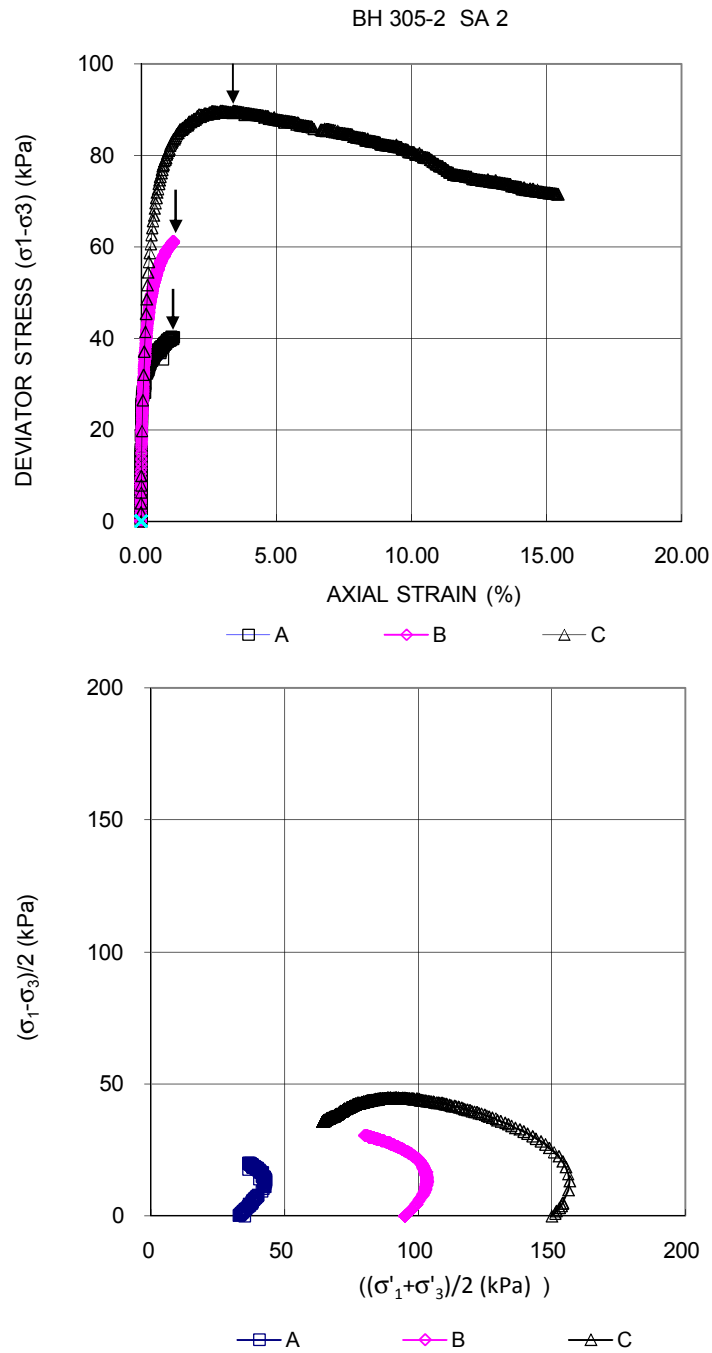
| MULTISTAGE CONSOLIDATED UNDRAINED TRIAXIAL<br>WITH PORE PRESSURE MEASUREMENTS   |       |       | FIGURE B.S305-8<br>Sheet 1 of 4 |
|---|-------|-------|---------------------------------|
| TEST STAGE  | A     | B     | C                               |
| BOREHOLE NUMBER   | 305-2 | 305-2 | 305-2                           |
| SAMPLE  | 2     | 2     | 2                               |
| SPECIMEN DIAMETER, cm   | 7.05  | 6.92  | 6.69                            |
| SPECIMEN HEIGHT, cm   | 13.82 | 13.40 | 12.83                           |
| WATER CONTENT BEFORE CONSOLIDATION, %   | 50.2  | 45.3  | 37.4                            |
| CELL PRESSURE, $\sigma_3$ , kPa   | 170.0 | 230.0 | 285.0                           |
| BACK PRESSURE, kPa  | 135.0 | 135.0 | 135.0                           |
| PORE PRESSURE PARAMETER "B"   | 0.97  | -     | -                               |
| CONSOLIDATION PRESSURE, $\sigma_c$ , kPa  | 35.0  | 95.0  | 150.0                           |
| VOLUMETRIC STRAIN DURING CONSOLIDATION, %   | 5.6   | 9.6   | 3.8                             |
| WATER CONTENT AFTER CONSOLIDATION, %  | 45.3  | 37.4  | 34.6                            |
| AVERAGE RATE OF STRAIN, %/hr  | 0.5   | 0.5   | 0.5                             |
| TIME TO FAILURE, hours  | 2     | 2     | 4                               |
| WATER CONTENT AFTER TEST, %   | -     | -     | -                               |
| MAX. DEVIATOR STRESS, $(\sigma_1 - \sigma_3)$ , kPa   | 40.2  | 61.2  | 89.6                            |
| AXIAL STRAIN AT $(\sigma_1 - \sigma_3)$ MAXIMUM, %  | 1.2   | 1.2   | 2.9                             |
| MAX EFFECTIVE PRINCIPAL STRESS<br>RATIO, $(\sigma_1 / \sigma_3)$ MAXIMUM  | 3.5   | 2.2   | 3.4                             |
| DEVIATOR STRESS AT $(\sigma_1 / \sigma_3)$ MAXIMUM, kPa   | 40.2  | 61.2  | 86.2                            |
| AXIAL STRAIN AT $(\sigma_1 / \sigma_3)$ MAXIMUM, %  | 1.2   | 1.2   | 6.2                             |
| PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 - \sigma_3)$ MAXIMUM   | 0.46  | 0.74  | 1.14                            |
| PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 / \sigma_3)$ MAXIMUM   | 0.46  | 0.75  | 1.33                            |
| NATURAL WATER CONTENT, %  | 40.7  | -     | -                               |
| DRY DENSITY, Mg/m <sup>3</sup>  | 1.13  | -     | -                               |
| FILTER DRAINS USED, y/n   | y     | y     | y                               |
| TEST NOTES:   |       |       |                                 |
| CHANGED RATE OF STRAIN, %/hr  | -     | -     | -                               |
| AXIAL STRAIN WHERE RATE OF STRAIN WAS CHANGED, %  | -     | -     | -                               |
| FAILURE PLANE NUMBER  | -     | -     | 1                               |
| ANGLE OF FAILURE, DEGREES   | -     | -     | 60                              |
| <div> <div>Date: 07/31/2009</div> <div>Project No. 06-1111-025</div> </div> <div> <b>Golder Associates</b> </div> <div> <div>Prepared By: MM</div> <div>Checked By: RO</div> </div> |       |       |                                 |



Date: 07/31/2009  
Project No. 06-1111-025

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Checked By: RO



Date: 07/31/2009  
Project No. 06-1111-025

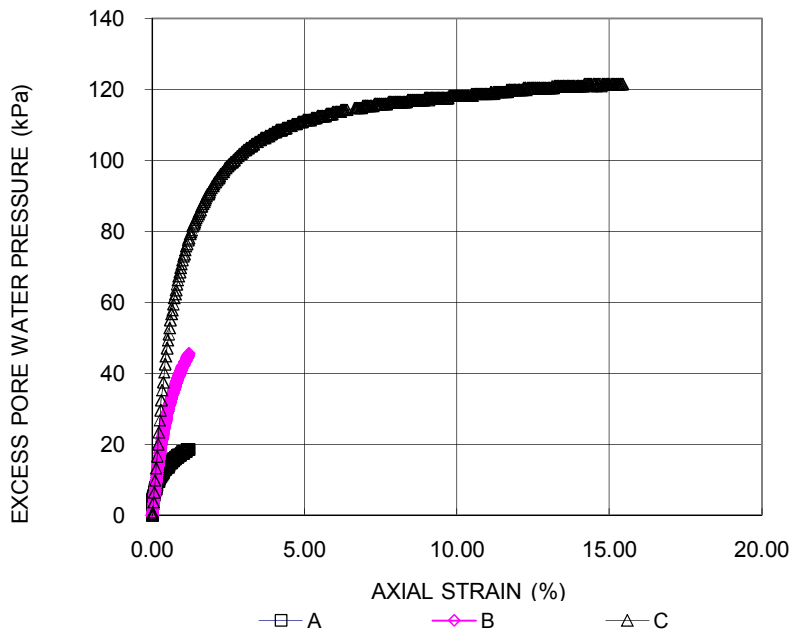
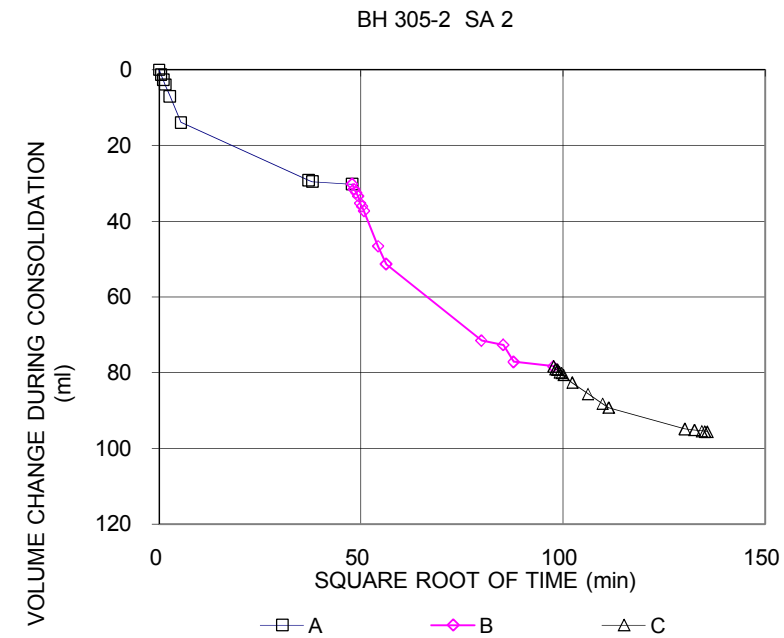
**Golder Associates**

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Checked By: RO

**MULTISTAGE CONSOLIDATED UNDRAINED TRIAXIAL  
WITH PORE PRESSURE MEASUREMENTS**

**FIGURE B.S305-8**

**Sheet 4 of 4**



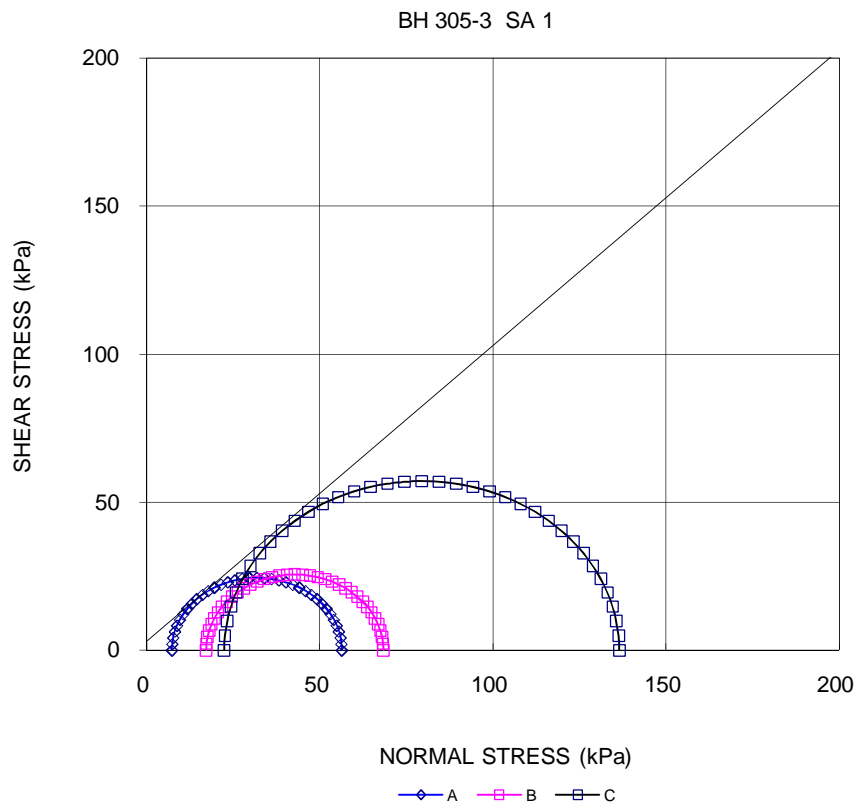
Date: 07/31/2009  
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| CONSOLIDATED UNDRAINED TRIAXIAL<br>WITH PORE PRESSURE MEASUREMENTS  |        |       | FIGURE B.S305-9<br>Sheet 1 of 4 |
|---|--------|-------|---------------------------------|
| TEST STAGE  | A      | B     | C                               |
| BOREHOLE NUMBER   | 305-3  | 305-3 | 305-3                           |
| SAMPLE  | 1      | 1     | 1                               |
| SPECIMEN DIAMETER, cm   | 4.99   | 5.03  | 5.02                            |
| SPECIMEN HEIGHT, cm   | 10.18  | 10.17 | 10.20                           |
| WATER CONTENT BEFORE CONSOLIDATION, %   | 75.4   | 80.0  | 85.7                            |
| CELL PRESSURE, $\sigma_3$ , kPa   | 300.0  | 190.0 | 505.0                           |
| BACK PRESSURE, kPa  | 275.0  | 135.0 | 415.0                           |
| PORE PRESSURE PARAMETER "B"   | 0.98   | 0.98  | 0.97                            |
| CONSOLIDATION PRESSURE, $\sigma_c$ , kPa  | 25.0   | 55.0  | 90.0                            |
| VOLUMETRIC STRAIN DURING CONSOLIDATION, %   | 5.1    | 15.9  | 19.8                            |
| WATER CONTENT AFTER CONSOLIDATION, %  | 70.0   | 74.3  | 61.5                            |
| AVERAGE RATE OF STRAIN, %/hr  | 0.5    | 0.5   | 0.5                             |
| TIME TO FAILURE, DAYS   | 2      | 2     | 2                               |
| WATER CONTENT AFTER TEST, %   | 56.3   | 60.8  | 52.1                            |
| MAX. DEVIATOR STRESS, $(\sigma_1 - \sigma_3)$ , kPa   | 49.1   | 51.2  | 114.2                           |
| AXIAL STRAIN AT $(\sigma_1 - \sigma_3)$ MAXIMUM, %  | 16.1   | 7.6   | 13.0                            |
| MAX EFFECTIVE PRINCIPAL STRESS<br>RATIO, $(\sigma_1 / \sigma_3)$ MAXIMUM  | 7.8    | 4.7   | 6.8                             |
| DEVIATOR STRESS AT $(\sigma_1 / \sigma_3)$ MAXIMUM, kPa   | 49.1   | 48.9  | 113.3                           |
| AXIAL STRAIN AT $(\sigma_1 / \sigma_3)$ MAXIMUM, %  | 16.1   | 14.1  | 19.5                            |
| PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 - \sigma_3)$ MAXIMUM   | 0.36   | 0.74  | 0.59                            |
| PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 / \sigma_3)$ MAXIMUM   | 0.36   | 0.85  | 0.62                            |
| NATURAL WATER CONTENT, %  | 69.4   | 77.7  | 80.7                            |
| DRY DENSITY, Mg/m <sup>3</sup>  | 0.93   | 0.86  | 0.83                            |
| FILTER DRAINS USED, y/n   | y      | y     | y                               |
| TEST NOTES:   |        |       |                                 |
| CHANGED RATE OF STRAIN, %/hr  | -      | -     | -                               |
| AXIAL STRAIN WHERE RATE OF STRAIN WAS CHANGED, %  | -      | -     | -                               |
| FAILURE PLANE NUMBER  | -      | 1.0   | -                               |
| ANGLE OF FAILURE, DEGREES   | bulged | 70.0  | bulged                          |
| <div> <div>Date: 05/21/2009</div> <div>Project No. 06-1111-025</div> </div> <div> <b>Golder Associates</b> </div> <div> <div>Prepared By: MM</div> <div>Checked By: RO</div> </div> |        |       |                                 |





Date: 05/21/2009  
Project No. 06-1111-025

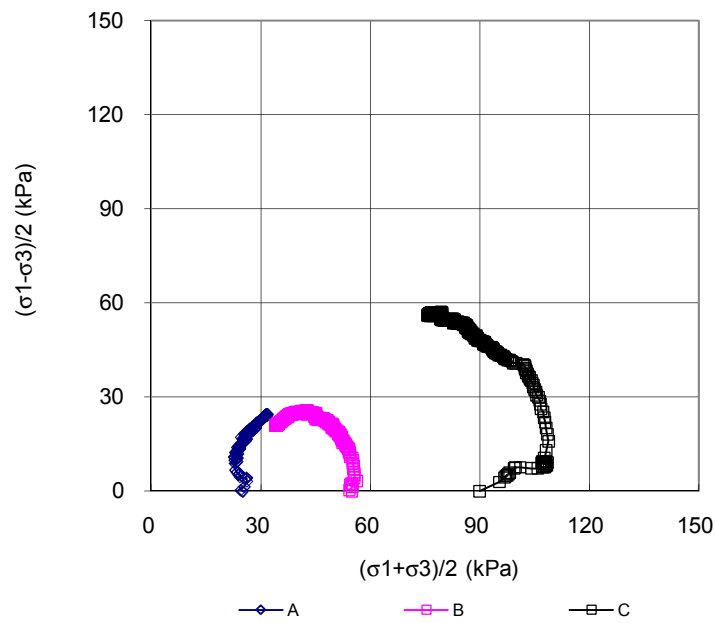
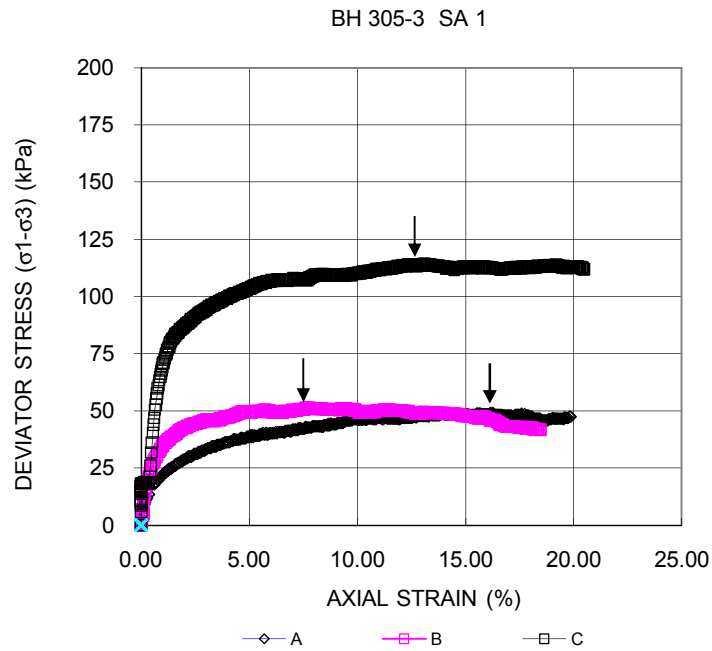
**Golder Associates**

Prepared By: MM  
Checked By: RO

**CONSOLIDATED UNDRAINED TRIAXIAL  
WITH PORE PRESSURE MEASUREMENTS**

**FIGURE B.S305-9**

**Sheet 3 of 4**



Date: 05/21/2009  
Project No. 06-1111-025

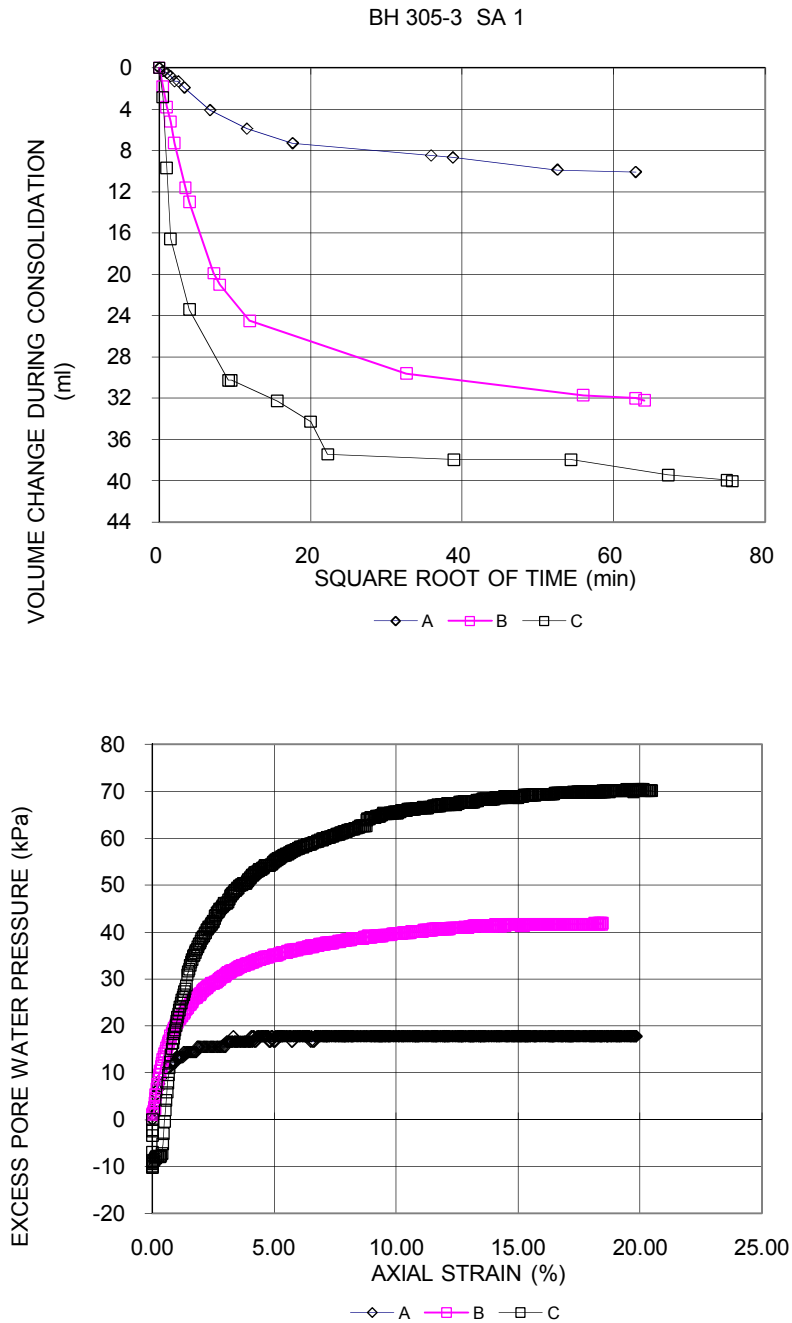
**Golder Associates**

Prepared By: MM  
Checked By: RO

**CONSOLIDATED UNDRAINED TRIAXIAL  
WITH PORE PRESSURE MEASUREMENTS**

**FIGURE B.S305-9**

**Sheet 4 of 4**



Date: 05/21/2009  
Project No. 06-1111-025

**Golder Associates**

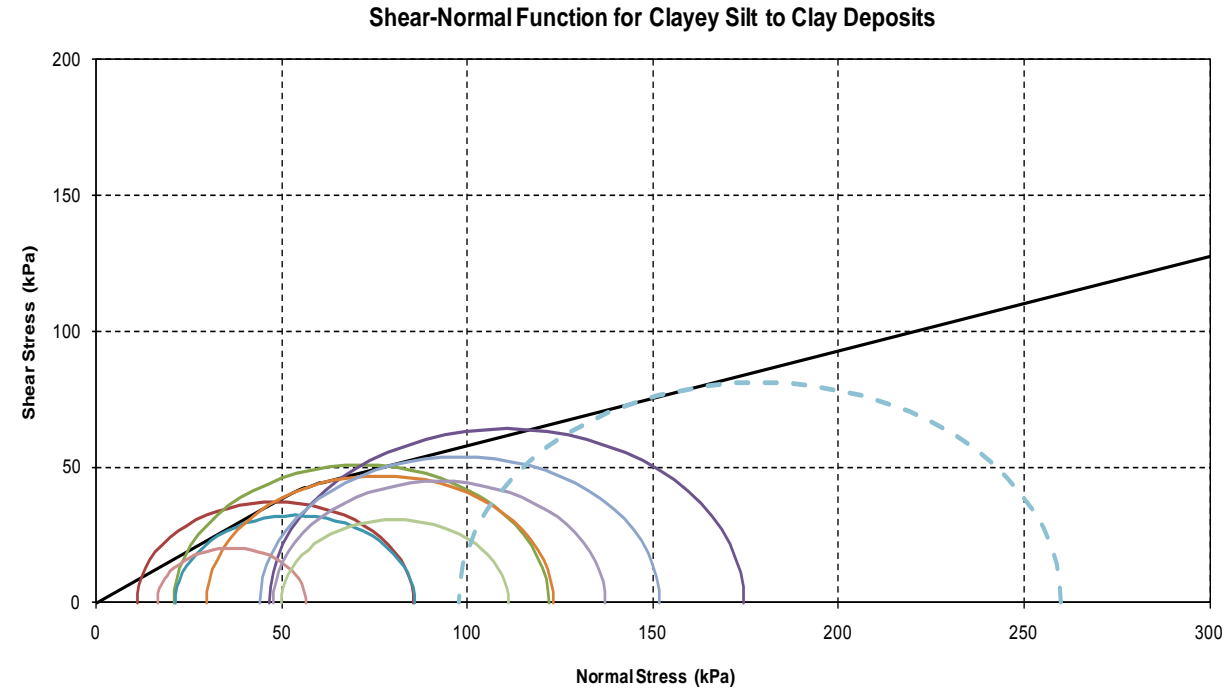
Prepared By: MM  
Checked By: RO



TABLE B1 – SUMMARY OF FOUNDATION ENGINEERING PARAMETERS  
HIGHWAY 69 FOUR-LANING – PHASE 3

| Swamp Crossing   | Stratigraphic Unit          | Top Elevation<br>(m) | Thickness<br>(m) | $\gamma'$<br>(kN/m <sup>3</sup> ) | $\phi'$<br>(°)  | $c'$<br>(kPa)  | $s_u$<br>(kPa) | $\sigma_p'$<br>(kPa) | $e_o$       | $C_c$       | $C_r$         | $E'$<br>(MPa) | $C_{\alpha(\epsilon)}$ |     | $c_h$<br>(cm <sup>2</sup> /s) |
|--|-----------------------------|----------------------|------------------|-----------------------------------|-----------------|----------------|----------------|----------------------|-------------|-------------|---------------|---------------|------------------------|-----|-------------------------------|
|  |                             |                      |                  |                                   |                 |                |                |                      |             |             |               |               | N/C                    | O/C |                               |
| Swamp 305 SBL<br><br>Highway 69 SBL - STA 16+050 to 16+350 | Sand Blanket                | 191.5 – 187.5        | 3.5 – 4.4        | 18.5                              | 32              | 0              | --             | --                   | --          | --          | --            | 30            | --                     | --  | --                            |
|  | Peat / Topsoil              | 192.1 – 185.0        | 0.1 – 3.2        | 12                                | 27              | 1              | --             | --                   | --          | --          | --            | --            | --                     | --  | --                            |
|  | Sand to Silt                | 191.8 – 180.3        | 0.4 – 3.8        | 18.5 – 18                         | 28              | 0              | --             | --                   | --          | --          | --            | 5             | --                     | --  | --                            |
|  | Organic Clayey Silt to Clay | 186.9 – 184.7        | 0.3 – 2.6        | 16                                | 19              | 0              | --             | --                   | --          | --          | --            | --            | --                     | --  | --                            |
|  | Organic Silt                | ~ 184.1              | ~ 1.4            | 15.5                              | 19              | 0              | --             | --                   | --          | --          | --            | --            | --                     | --  | --                            |
|  | Sand                        | ~ 182.7              | ~ 4.5            | 18.5                              | 28              | 0              | --             | --                   | --          | --          | --            | 5             | --                     | --  | --                            |
|  | Clayey Silt to Clay         | 187.4 – 167.0        | 0.5 – 12.2       | 16.5                              | 27 <sup>1</sup> | 4 <sup>1</sup> | 21 – 57        | 97 – 259             | 1.45 – 1.88 | 0.54 – 0.98 | 0.040 – 0.087 | --            | 1.5                    | 0.3 | 3.54 x 10 <sup>-3</sup>       |
|  | Silt to Sand                | 183.9 – 163.2        | 0.3 – 3.3        | 18                                | 28              | 0              | --             | --                   | --          | --          | --            | 3             | --                     | --  | --                            |

Note: <sup>1</sup> Clayey silt to clay deposits use a fully defined shear-normal function based on results of triaxial tests (approximately equivalent to  $c' = 4$  kPa and  $\phi' = 27^\circ$  over the stress range of  $0 \text{ kPa} \leq \sigma_n' \leq 200 \text{ kPa}$ ). See Inset below.



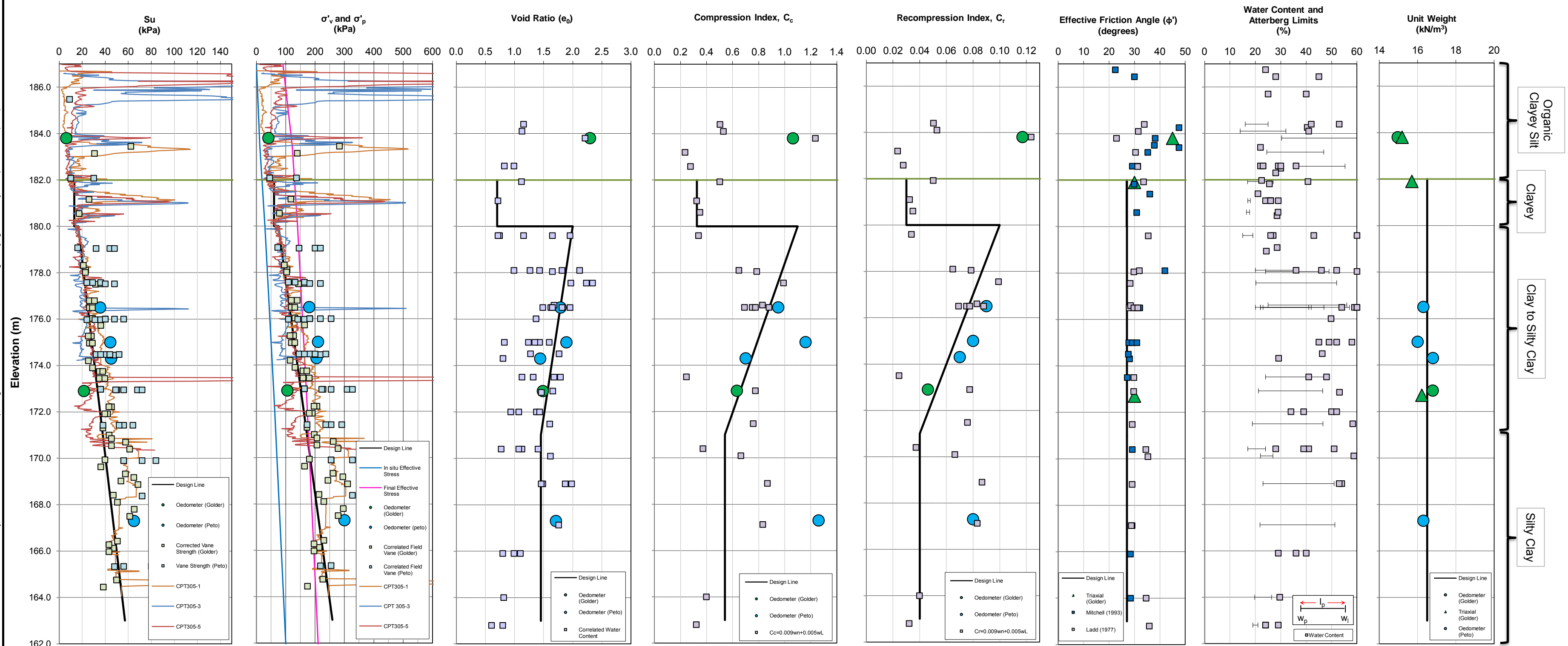
\\mis1-s-filesrv1\data\active\2006\1111\06-1111-025 mrc hwy 69-522 to 64 french river\reporting\wick drain embankments\final\tables\06-1111-025-1 tblb1 summary of foundation engineering parameters.docx

Prepared By: TZ

Reviewed By: JPD/JMAC

SUMMARY PLOT OF ENGINEERING PARAMETERS FOR COHESIVE DEPOSITS  
Swamp 305 SBL - Highway 69 (SBL) - STA 16+075 to 16+325

FIGURE B1



NOTES:

Average original ground surface at the critical section is at about Elevation 185 m.  
Minimum sand blanket thickness below the original ground surface is about 3.5 m, with base extending to no lower than Elevation 181.8 m.

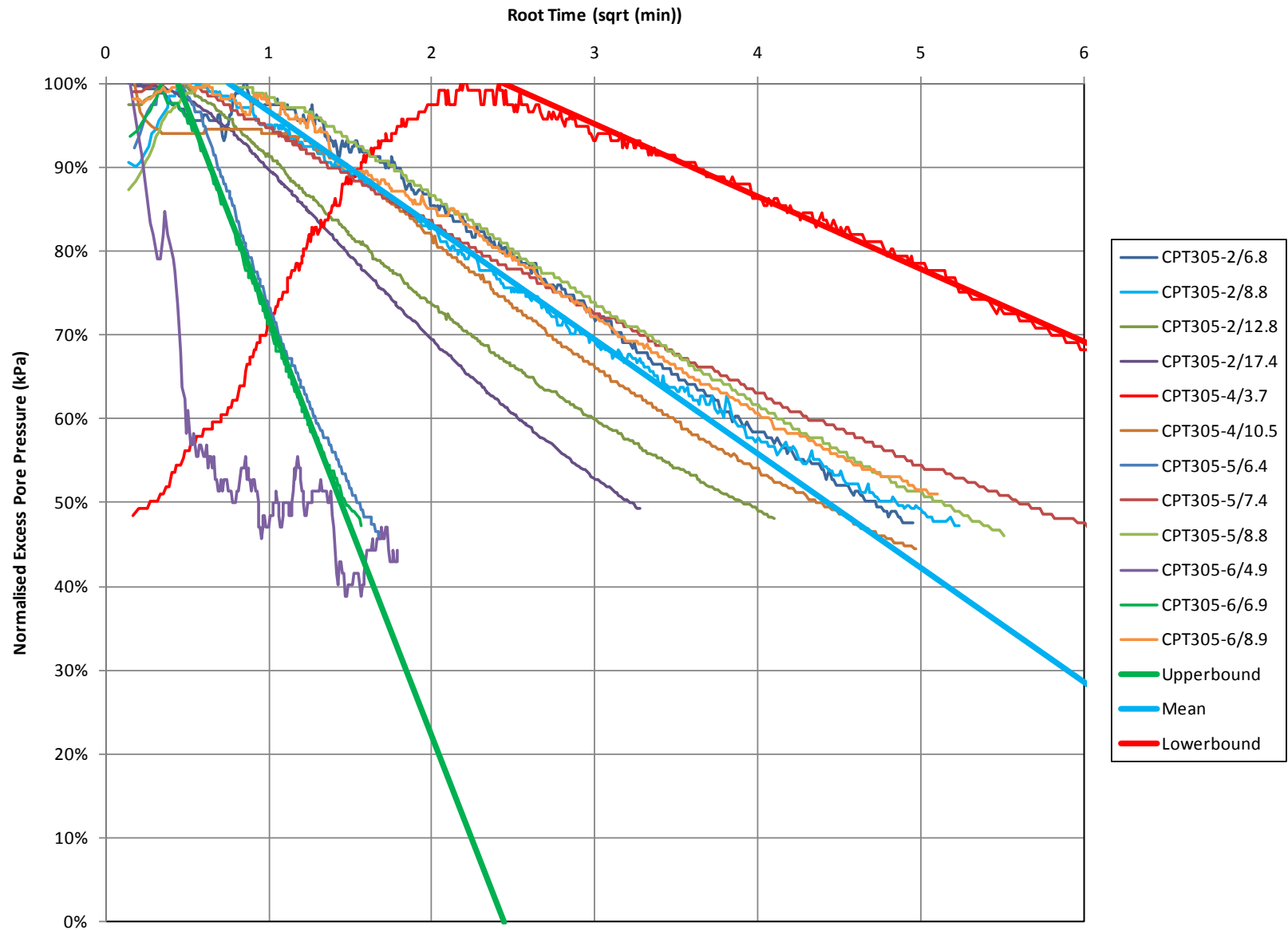
Golder Associates

Date: April 2012  
Project No: 06-1111-025-1  
DB: TZ / MWK  
CHK: JPD



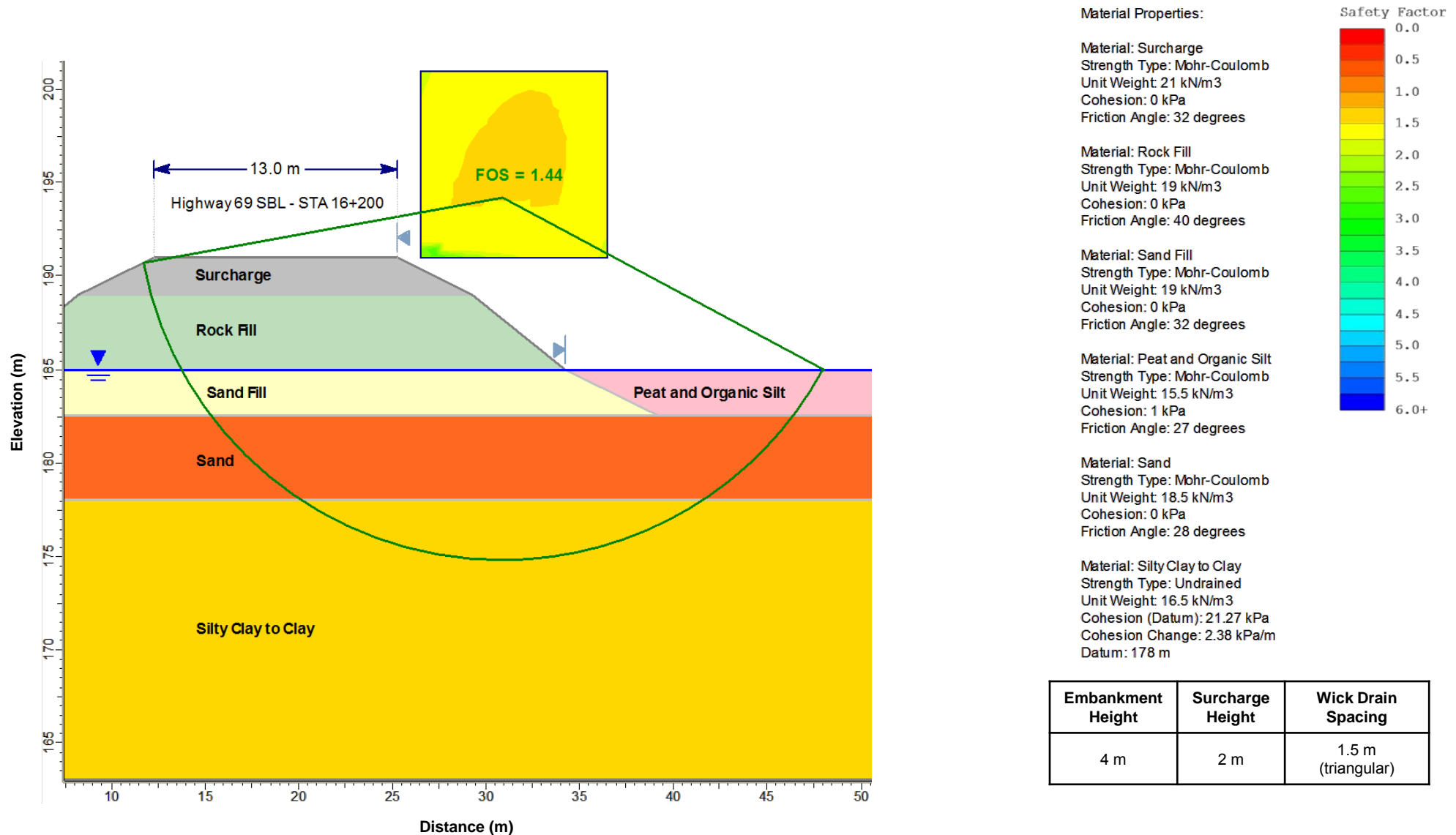
# CPT Pore Pressure Dissipation Tests Swamp 305 SBL

Figure B2



# Slope Stability – Total Stress Analysis – STA 16+200 (Swamp 305 SBL)

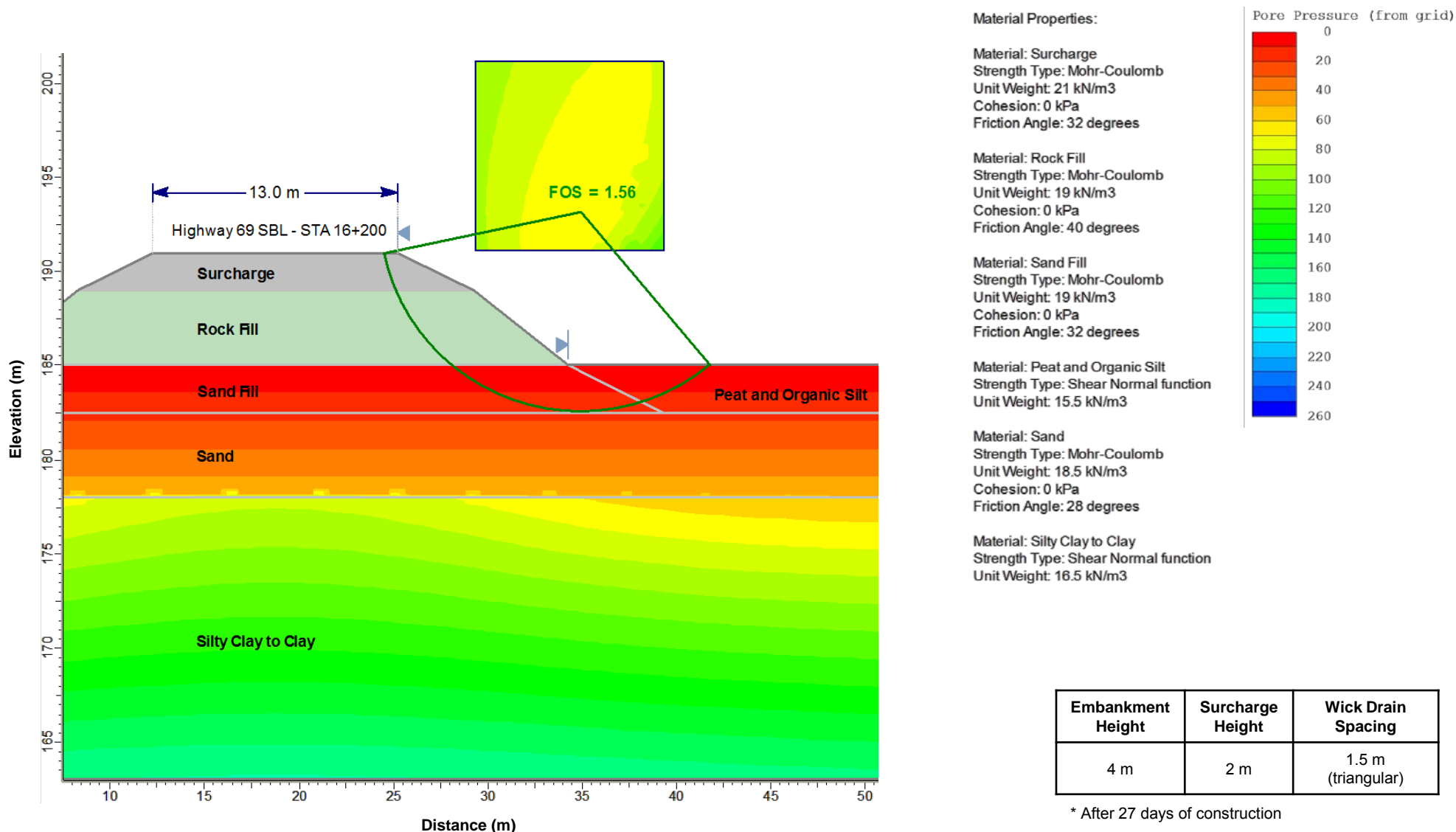
Figure B3





# Slope Stability – Effective Stress Analysis – STA 16+200 (Swamp 305 SBL)

Figure B4

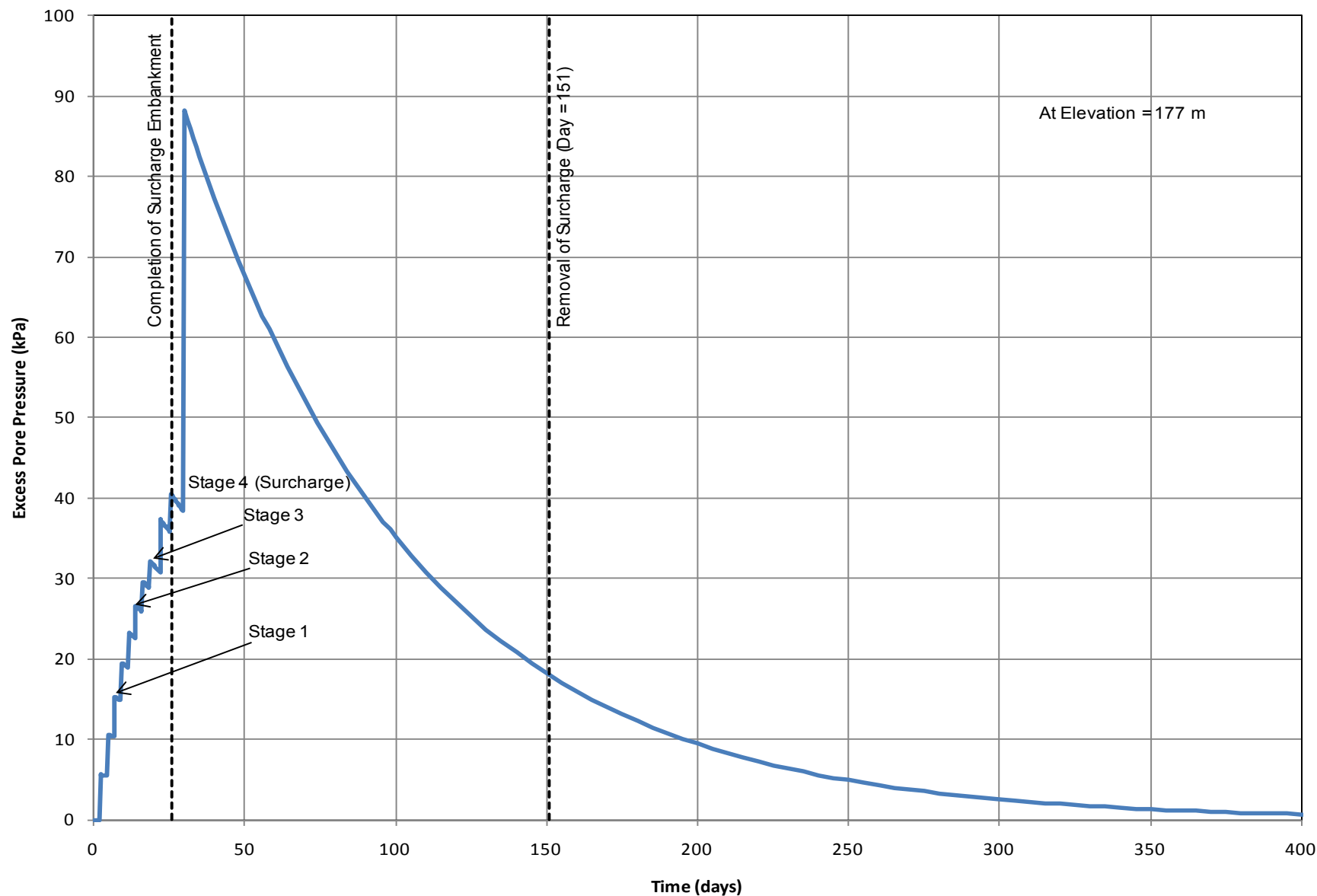






## Excess Pore Pressure Response below Embankment Centreline – STA 16+200 (Swamp 305 SBL)

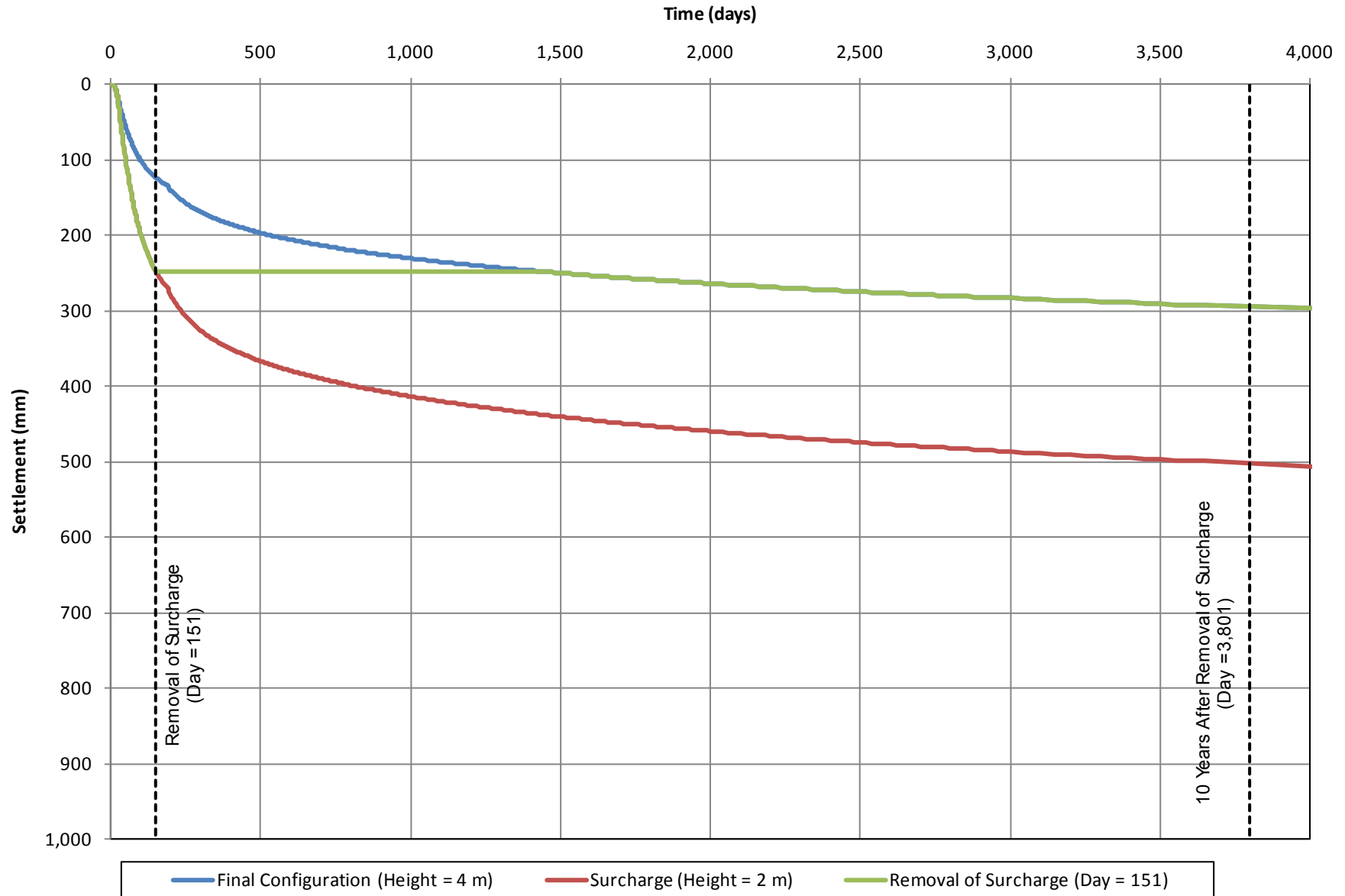
Figure B5





## Time – Rate Consolidation Settlement at Embankment Centreline – STA 16+200 (Swamp 305)

Figure B6





# APPENDIX C

Highway 69 NBL – STA 15+350 to 15+800 (Swamp 306 SBL)

| PROJECT 06-1111-025 |   |            |         | <b>RECORD OF BOREHOLE No 306-1</b>                             |            |                            |                 | 1 OF 1 <b>METRIC</b>  |  |  |  |  |  |
|---------------------|---|------------|---------|--|------------|----------------------------|-----------------|---|--|--|--|--|--|
| G.W.P. 5203-06-00   |   |            |         | LOCATION N 5091511.9 ; E 221015.8                              |            |                            |                 | ORIGINATED BY MWK   |  |  |  |  |  |
| DIST _____ HWY 69   |   |            |         | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers |            |                            |                 | COMPILED BY MWK   |  |  |  |  |  |
| DATUM Geodetic      |   |            |         | DATE March 17, 2009  |            |                            |                 | CHECKED BY VA   |  |  |  |  |  |
| SOIL PROFILE        |   |            | SAMPLES |  |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT                                     |  | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT      |  | UNIT WEIGHT<br>$\gamma$<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
| ELEV<br>DEPTH       | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE   | "N" VALUES |                            |                 | SHEAR STRENGTH kPa<br>○ UNCONFINED + FIELD VANE<br>● QUICK TRIAXIAL × REMOULDED |  | W <sub>p</sub> — W — W <sub>L</sub><br>WATER CONTENT (%) |  |  |  |
| 189.4               | GROUND SURFACE  |            |         |  |            |                            |                 |   |  |  |  |  |  |
| 0.0                 | Organic CLAYEY SILT, containing<br>shell fragments<br>Very soft<br>Grey<br>Wet                                    |            |         |  |            |                            |                 |   |  |  |  |  |  |
| 187.3               |   |            | 1       | SS   | WH         |                            |                 |   |  |  |  | 106.4  | OC = 6.2%  |
| 2.1                 | CLAY, some silt<br>Very soft to soft<br>Grey<br>Wet   |            | 2       | SS   | WH         |                            |                 |   |  |  |  | 90.7   |  |
|                     |   |            | 3       | TO   | PH         |                            |                 |   |  |  |  |  |  |
|                     |   |            | 4       | TO   | PH         |                            |                 |   |  |  |  |  |  |
|                     |   |            | 5       | TO   | PH         |                            |                 |   |  |  |  | 81   | C/CIU  |
| 180.3               |   |            | 6       | SS   | 1          |                            |                 |   |  |  |  | 52.7   |  |
| 9.1                 | SILTY CLAY to CLAYEY SILT<br>Very soft<br>Grey<br>Wet   |            | 7       | SS   | WR         |                            |                 |   |  |  |  |  |  |
| 178.0               | END OF BOREHOLE<br>AUGER REFUSAL  |            |         |  |            |                            |                 |   |  |  |  |  |  |
| 11.4                | NOTE:<br><br>1. Water level in open borehole at<br>ground surface (Elev. 189.4 m)<br>upon completion of drilling. |            |         |  |            |                            |                 |   |  |  |  |  |  |

GTA-MTO 001 06-1111-025.GPJ GAL-MISS GDT 1/27/12 SAC

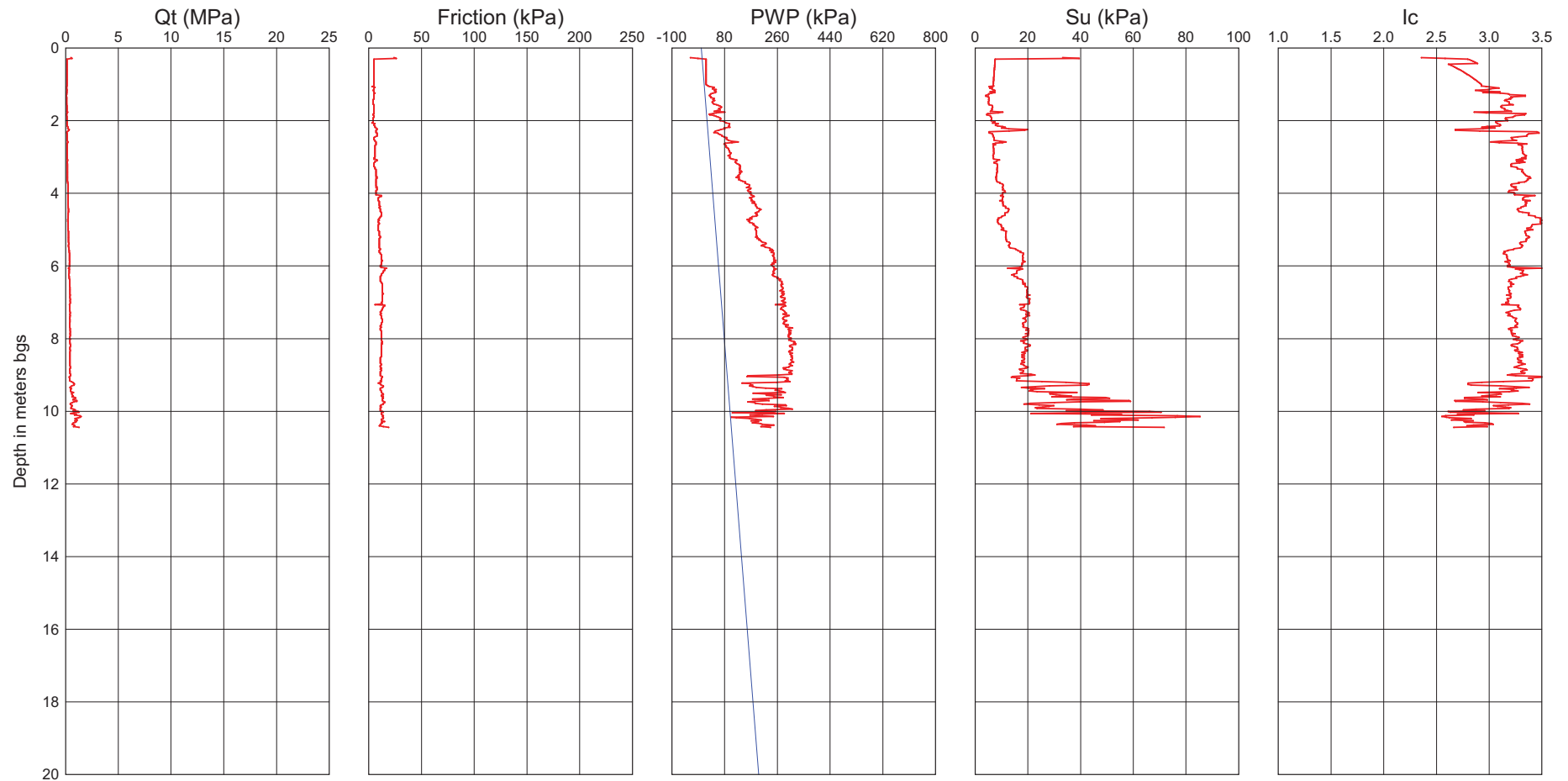
+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○<sup>3%</sup> STRAIN AT FAILURE

# Cone Penetration Test - CPT306-1

Test Date : March 10, 2009  
Location : Highway 69 - STA 15+450 o/s 21 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 189.40  
Water Table Depth : 0.00



Qt normalized for  
unequal end area effects

$Su = (Qt - \sigma_v) / Nk$   
 $Nk = 15.5$   
 $\gamma = 16 \text{ kN/m}^3$

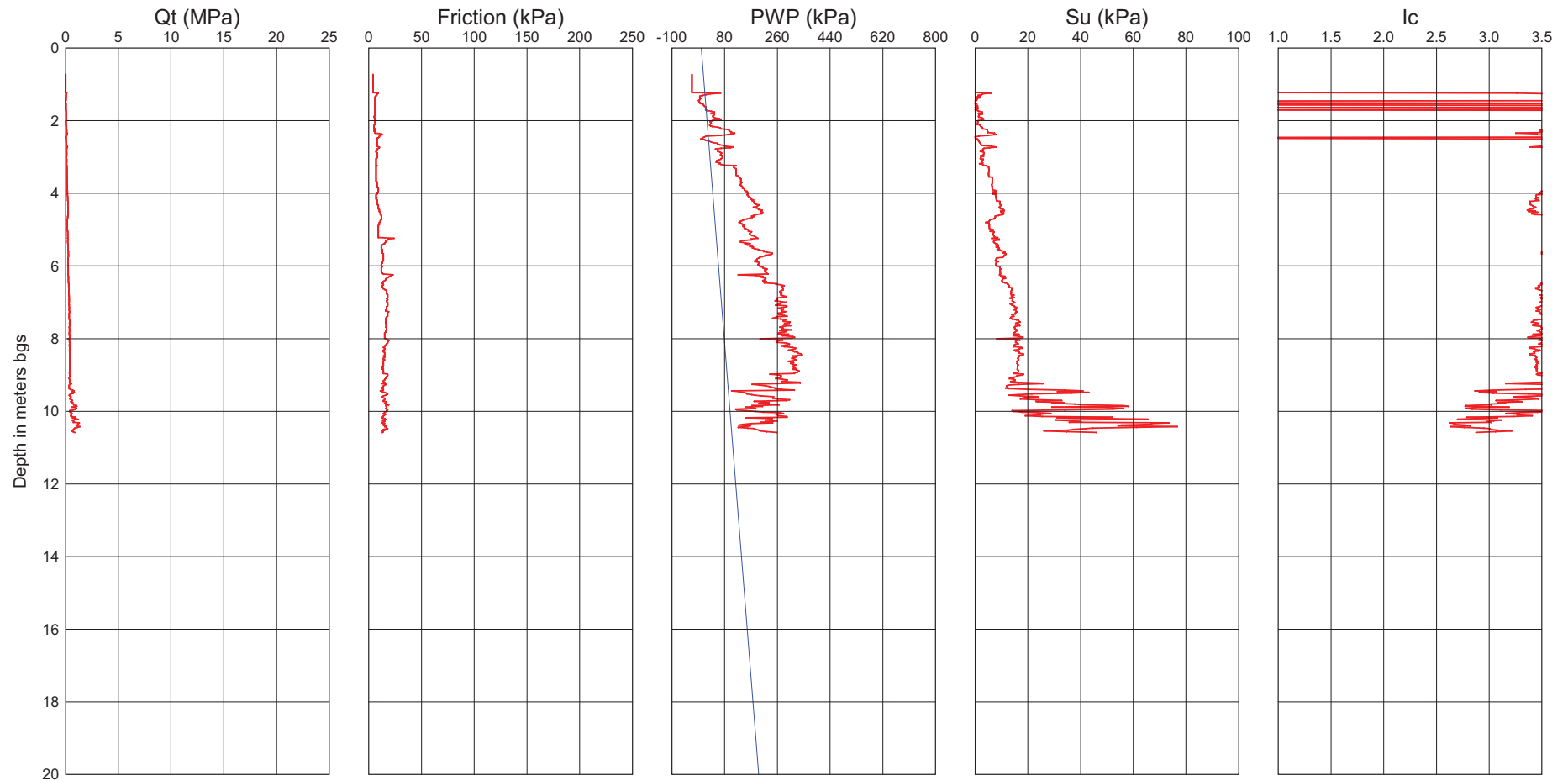
After Robertson and (Fear) Wride (1998)  
 $Ic < 1.31$  - Gravelly sands  
 $1.31 < Ic < 2.05$  - Clean to silty sand  
 $2.05 < Ic < 2.60$  - Silty sand to sandy silt  
 $2.60 < Ic < 2.95$  - Clayey silt to silty clay  
 $2.95 < Ic < 3.60$  - Clays

# Cone Penetration Test - CPT306-2

Test Date : March 10, 2009  
Location : Highway 69 - STA 15+450 o/s 22 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 189.40  
Water Table Depth : 0.00



Qt normalized for  
unequal end area effects

$Su = (Qt - \sigma_v) / N_k$   
 $N_k = 15.5$   
 $\gamma = 16.5 \text{ kN/m}^3$

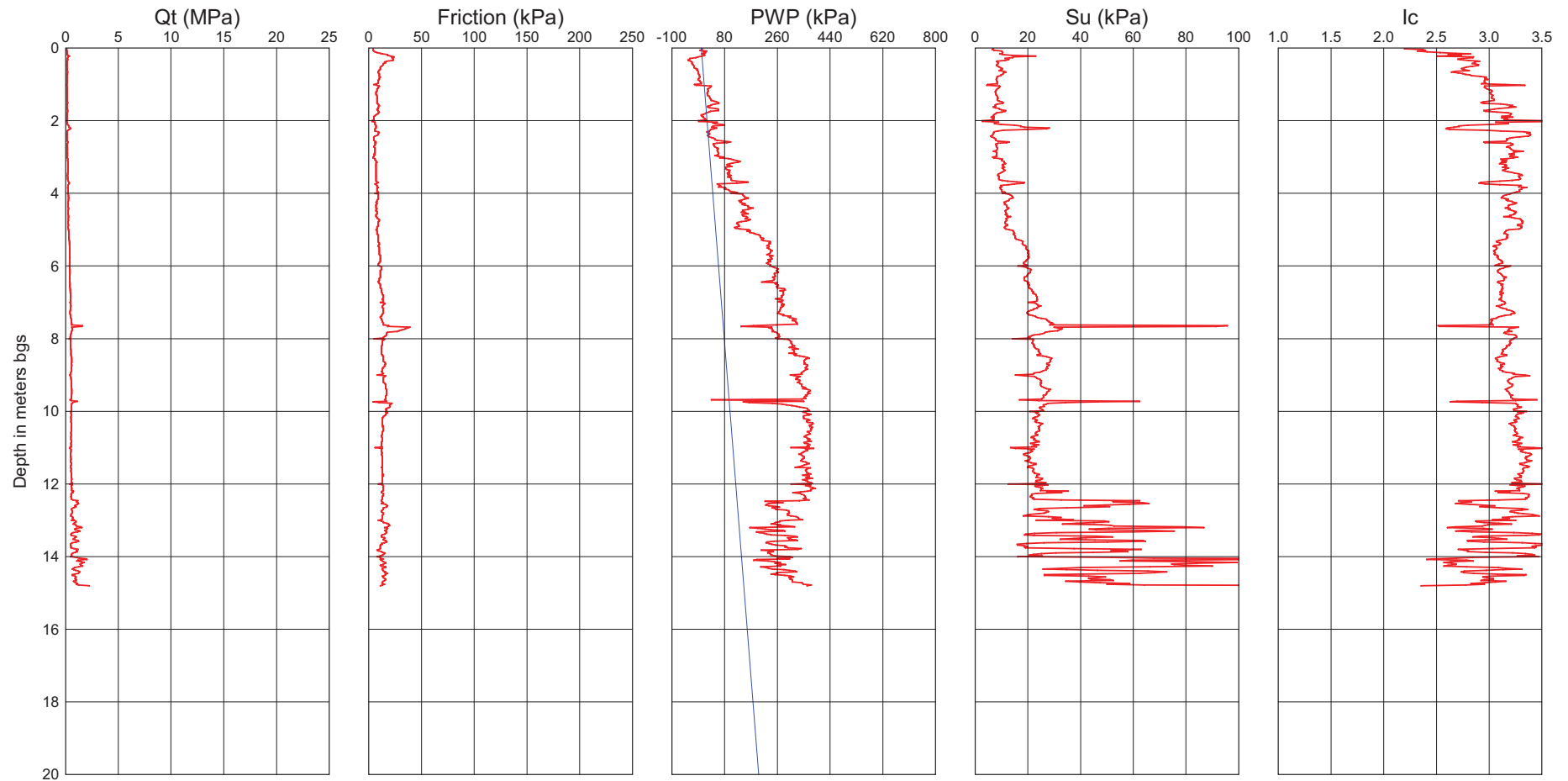
After Robertson and (Fear) Wride (1998)  
Ic < 1.31 - Gravelly sands  
1.31 < Ic < 2.05 - Clean to silty sand  
2.05 < Ic < 2.60 - Silty sand to sandy silt  
2.60 < Ic < 2.95 - Clayey silt to silty clay  
2.95 < Ic < 3.60 - Clays

# Cone Penetration Test - CPT306-3

Test Date : March 10, 2009  
Location : Highway 69 - STA 15+575 o/s 22 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 188.70  
Water Table Depth : 0.00



Qt normalized for  
unequal end area effects

$Su = (Qt - \sigma_v) / Nk$   
 $Nk = 15.5$   
 $\gamma = 16 \text{ kN/m}^3$

After Robertson and (Fear) Wride (1998)  
Ic < 1.31 - Gravelly sands  
1.31 < Ic < 2.05 - Clean to silty sand  
2.05 < Ic < 2.60 - Silty sand to sandy silt  
2.60 < Ic < 2.95 - Clayey silt to silty clay  
2.95 < Ic < 3.60 - Clays

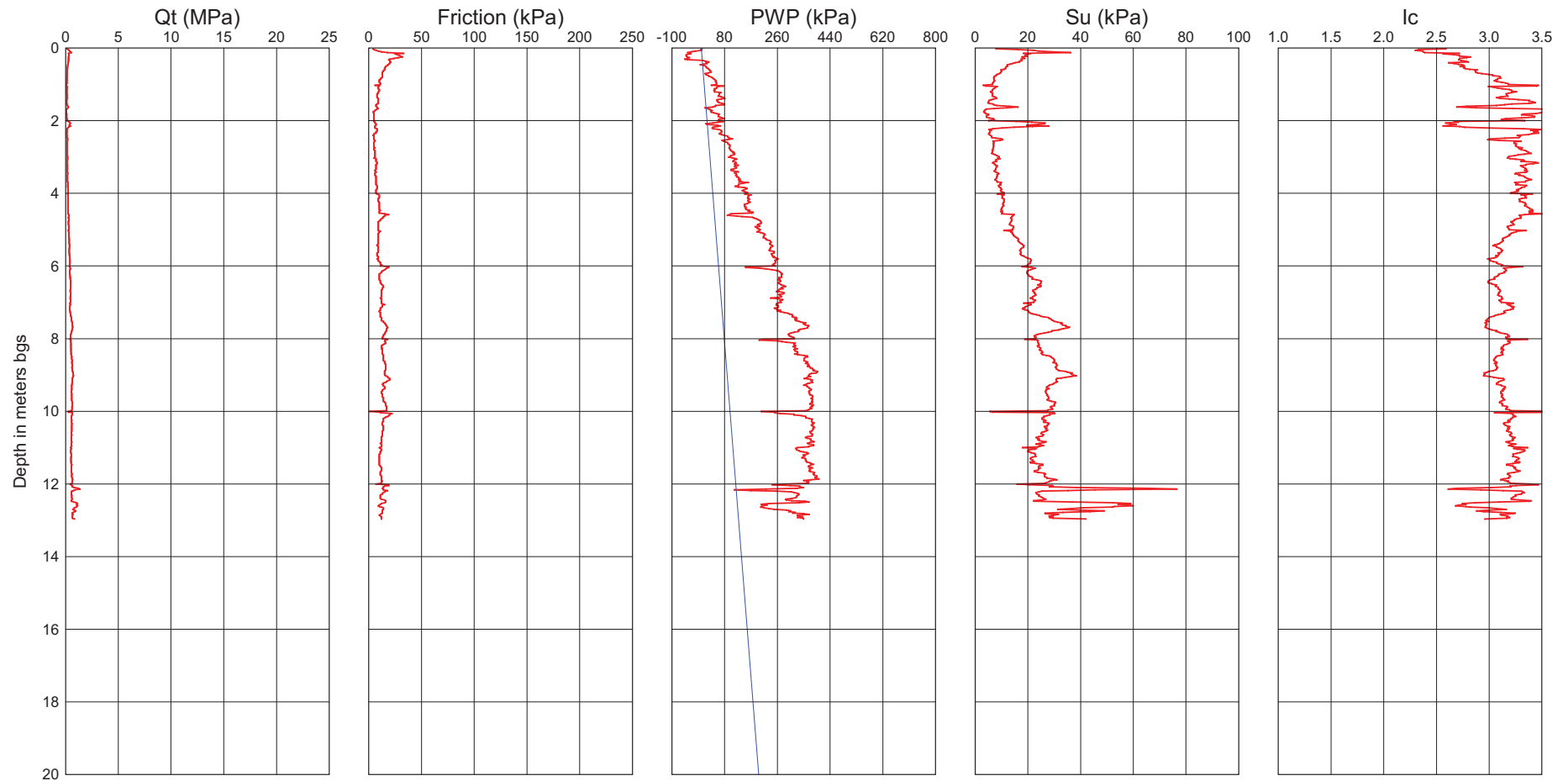


# Cone Penetration Test - CPT306-4

Test Date : March 11, 2009  
Location : Highway 69 - STA 15+575 o/s 23 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 188.70  
Water Table Depth : 0.00



Qt normalized for  
unequal end area effects

$S_u = (Q_t - \sigma_v) / N_k$   
 $N_k = 15.5$   
 $\gamma = 16 \text{ kN/m}^3$

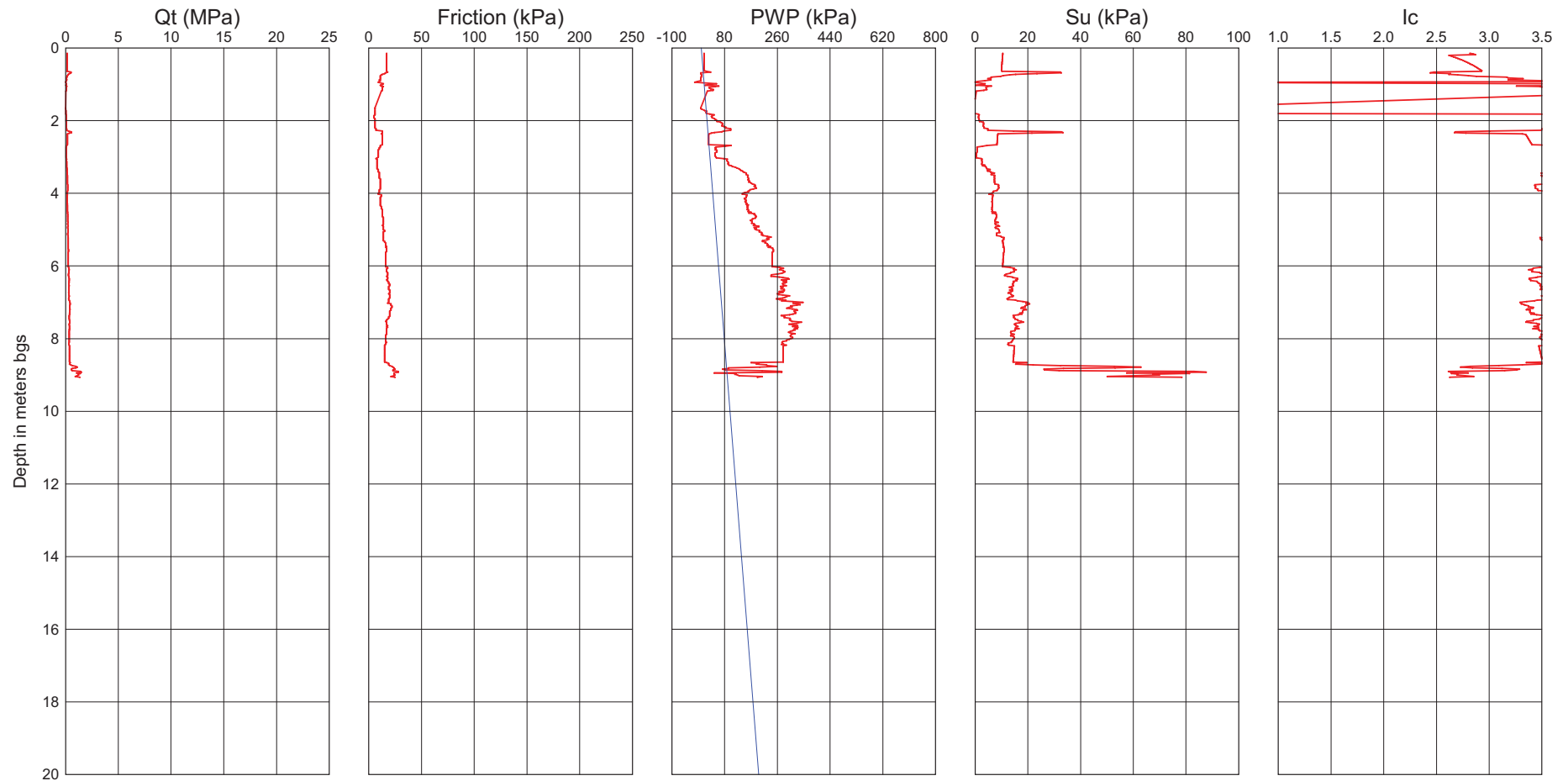
After Robertson and (Fear) Wride (1998)  
 $I_c < 1.31$  - Gravelly sands  
 $1.31 < I_c < 2.05$  - Clean to silty sand  
 $2.05 < I_c < 2.60$  - Silty sand to sandy silt  
 $2.60 < I_c < 2.95$  - Clayey silt to silty clay  
 $2.95 < I_c < 3.60$  - Clays

# Cone Penetration Test - CPT306-5

Test Date : March 18, 2009  
Location : Highway 69 - STA 15+576 o/s 39 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 189.40  
Water Table Depth : 0.00



Qt normalized for  
unequal end area effects

$S_u = (Q_t - \sigma_v) / N_k$   
 $N_k = 15.5$   
 $\gamma = 16 \text{ kN/m}^3$

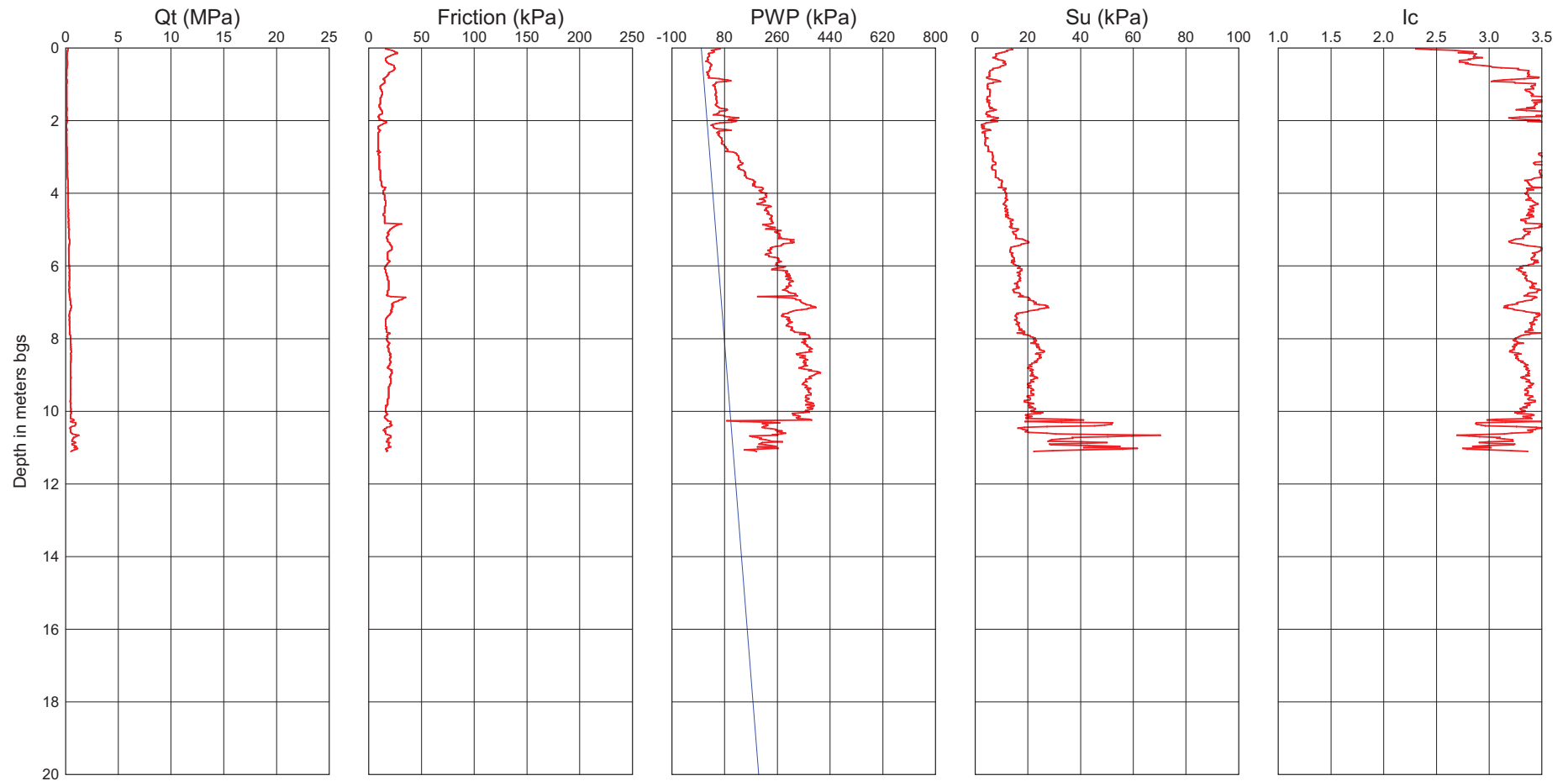
After Robertson and (Fear) Wride (1998)  
Ic < 1.31 - Gravelly sands  
1.31 < Ic < 2.05 - Clean to silty sand  
2.05 < Ic < 2.60 - Silty sand to sandy silt  
2.60 < Ic < 2.95 - Clayey silt to silty clay  
2.95 < Ic < 3.60 - Clays

# Cone Penetration Test - CPT306-6

Test Date : March 19, 2009  
Location : Highway 69 - STA 15+452 o/s 39 m Left

Operator : Golder Associates Ltd.

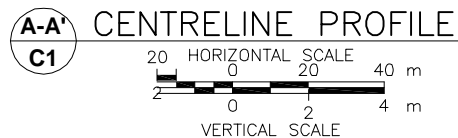
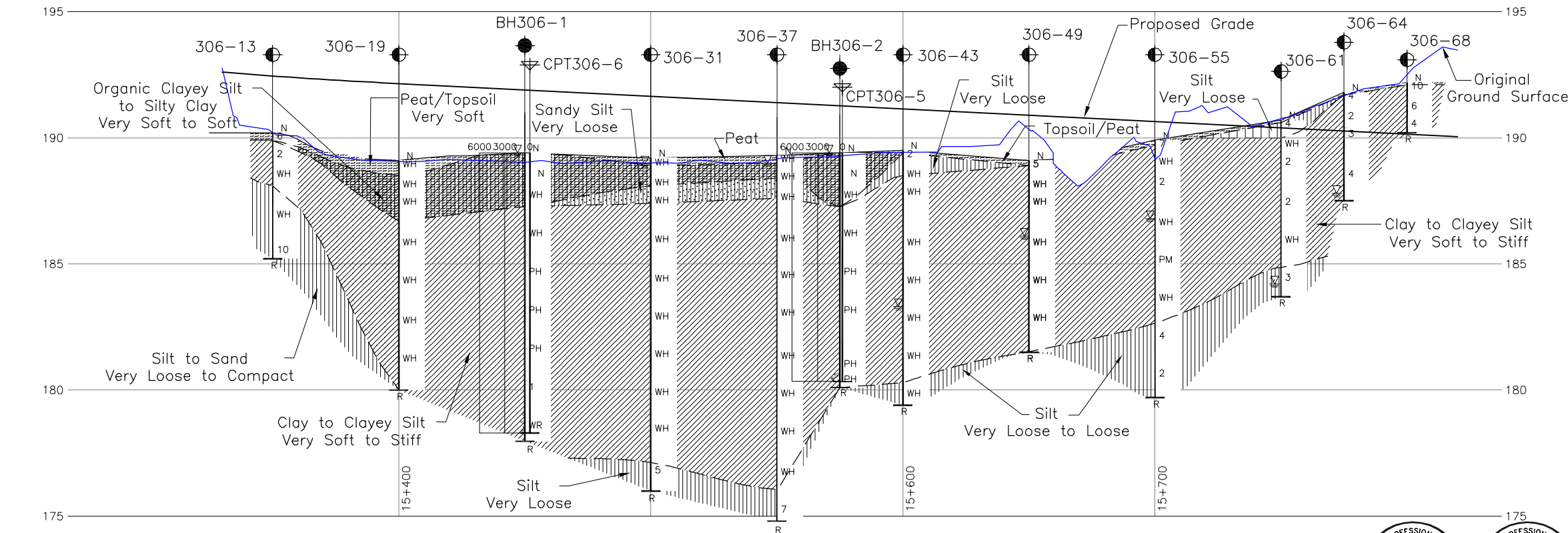
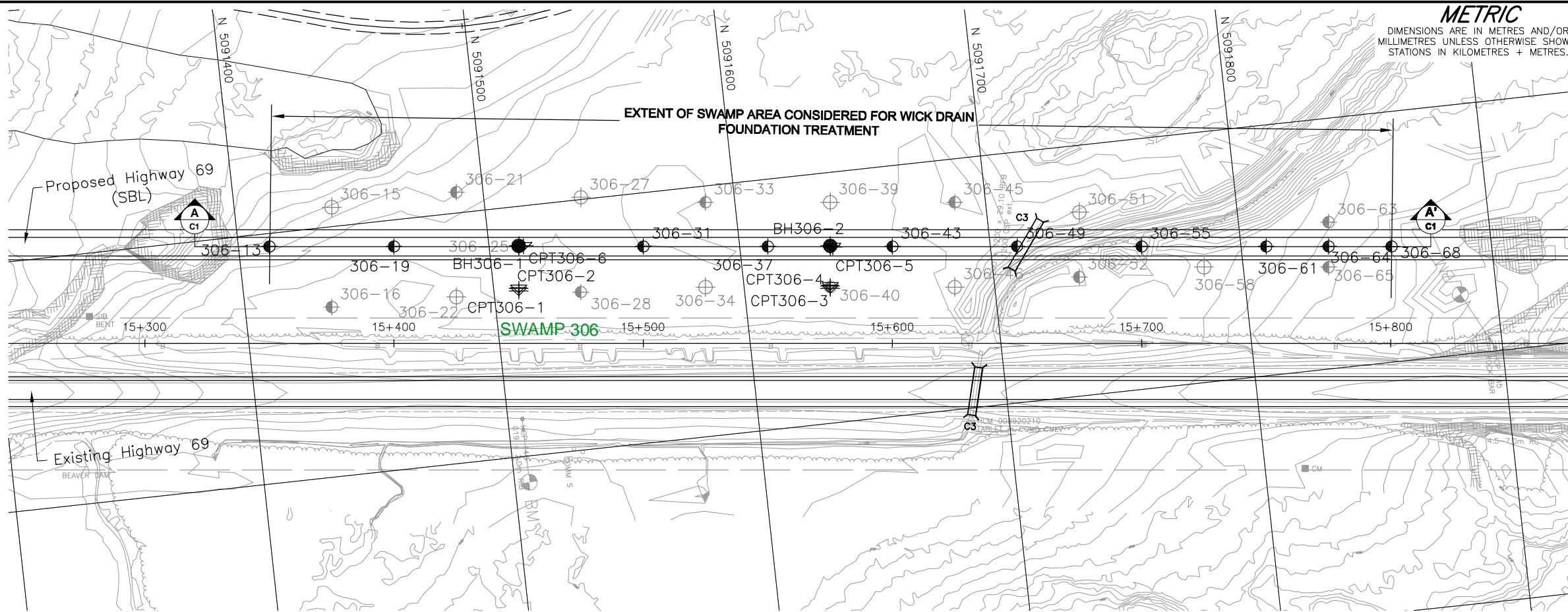
Ground Surf. Elev. : 189.40  
Water Table Depth : 0.00



Qt normalized for  
unequal end area effects

$S_u = (Q_t - \sigma_v) / N_k$   
 $N_k = 15.5$   
 $\gamma = 16 \text{ kN/m}^3$

After Robertson and (Fear) Wride (1998)  
 $I_c < 1.31$  - Gravelly sands  
 $1.31 < I_c < 2.05$  - Clean to silty sand  
 $2.05 < I_c < 2.60$  - Silty sand to sandy silt  
 $2.60 < I_c < 2.95$  - Clayey silt to silty clay  
 $2.95 < I_c < 3.60$  - Clays



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

CONT No.  
 GWP No. 5230-06-00

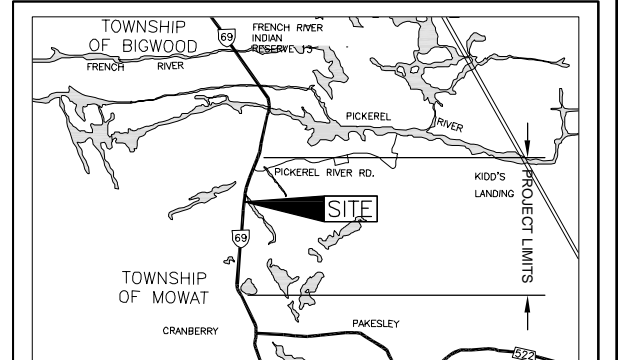


HIGHWAY 69 (SBL)  
 STA 15+350 TO 15+800  
 BOREHOLE LOCATION AND SOIL STRATA

SHEET



**Golder Associates Ltd.**  
 MISSISSAUGA, ONTARIO, CANADA



KEY PLAN

### LEGEND

- Borehole - Current Investigation
- ▽ CPT - Current Investigation
- ⊕ Borehole - Previous Investigation (Peto MacCallum Ltd.)
- ⊕ Dynamic Cone Penetration Test - Previous Investigation (Peto MacCallum Ltd.)
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL observed during or upon completion of drilling
- R Refusal

| No.      | ELEVATION | CO-ORDINATES |          |
|----------|-----------|--------------|----------|
|          |           | NORTHING     | EASTING  |
| BH306-1  | 189.4     | 5091511.8    | 221015.8 |
| BH306-2  | 189.4     | 5091636.1    | 221029.3 |
| CPT306-1 | 189.4     | 5091509.9    | 221033.7 |
| CPT306-2 | 189.4     | 5091510.0    | 221032.7 |
| CPT306-3 | 188.7     | 5091634.3    | 221046.2 |
| CPT306-4 | 188.7     | 5091634.4    | 221045.2 |
| CPT306-5 | 189.4     | 5091637.1    | 221029.4 |
| CPT306-6 | 189.4     | 5091513.9    | 221016.0 |

### NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

The boundaries between soil strata have been established only at borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

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

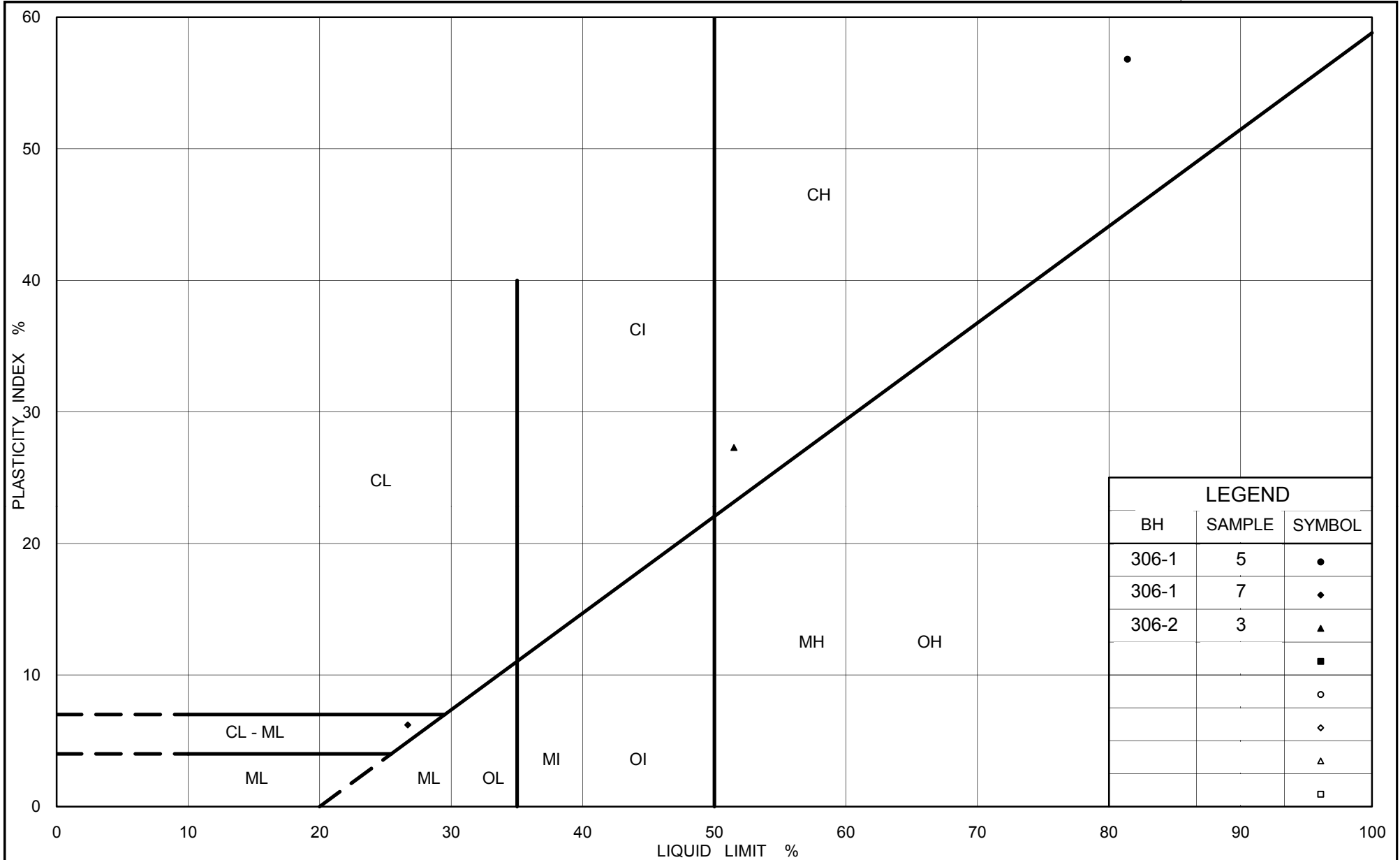
### REFERENCE

Base plans and Profile provided in digital format by MRC, drawing file's no. PHASE 3 Plan 090211 - Golder.dwg, received February 11, 2009.  
 1-6454\_ Phase3-ML PROFILE-Mar 26-09.dwg, received Sept. 30, 2009.



| NO.                 | DATE                    | BY              | REVISION |
|---------------------|-------------------------|-----------------|----------|
|                     |                         |                 |          |
| Geocres No. 41H-106 |                         |                 |          |
| HWY. 69             | PROJECT NO. 06-1111-025 |                 | DIST.    |
| SUBM'D. MWK         | CHKD. MWK               | DATE: Feb. 2012 | SITE:    |
| DRAWN: RJ/JFC       | CHKD. VA                | APPD. JPD/JMAC  | DWG. C1  |





Ministry of Transportation

Ontario

PLASTICITY CHART  
Clay to Clayey Silt  
Highway 69 (SBL) STA 15+350 to 15+800

Figure No. C.S306-2

Project No. 06-1111-025

Checked By: TVA

**CONSOLIDATION TEST SUMMARY****Highway 69 (SBL) STA 15+350 to 15+800****FIGURE C.S306-3****Sheet 1 of 4****SAMPLE IDENTIFICATION**

|                 |             |                 |     |
|-----------------|-------------|-----------------|-----|
| Project Number  | 06-1111-025 | Sample Number   | 5   |
| Borehole Number | 306-1       | Sample Depth, m | 7.9 |

**TEST CONDITIONS**

|                  |            |                   |    |
|------------------|------------|-------------------|----|
| Test Type        | Standard   | Load Duration, hr | 24 |
| Oedometer Number | 6          |                   |    |
| Date Started     | 04/19/2009 |                   |    |
| Date Completed   | 06/11/2009 |                   |    |

**SAMPLE DIMENSIONS AND PROPERTIES - INITIAL**

|                         |       |                                    |       |
|-------------------------|-------|------------------------------------|-------|
| Sample Height, cm       | 1.90  | Unit Weight, kN/m <sup>3</sup>     | 14.87 |
| Sample Diameter, cm     | 6.34  | Dry Unit Weight, kN/m <sup>3</sup> | 8.12  |
| Area, cm <sup>2</sup>   | 31.57 | Specific Gravity, measured         | 2.76  |
| Volume, cm <sup>3</sup> | 59.86 | Solids Height, cm                  | 0.569 |
| Water Content, %        | 83.02 | Volume of Solids, cm <sup>3</sup>  | 17.96 |
| Wet Mass, g             | 90.74 | Volume of Voids, cm <sup>3</sup>   | 41.89 |
| Dry Mass, g             | 49.58 | Degree of Saturation, %            | 98.3  |

**TEST COMPUTATIONS**

| Pressure<br>kPa | Corr.<br>Height<br>cm | Void<br>Ratio | Average<br>Height<br>cm | t <sub>90</sub><br>sec | cv.<br>cm <sup>2</sup> /s | mv<br>m <sup>2</sup> /kN | k<br>cm/s |
|-----------------|-----------------------|---------------|-------------------------|------------------------|---------------------------|--------------------------|-----------|
| 0.00            | 1.896                 | 2.332         | 1.896                   |                        |                           |                          |           |
| 4.87            | 1.889                 | 2.320         | 1.892                   | 6                      | 1.27E-01                  | 7.69E-04                 | 9.54E-06  |
| 9.58            | 1.883                 | 2.309         | 1.886                   | 17                     | 4.44E-02                  | 6.72E-04                 | 2.92E-06  |
| 19.47           | 1.876                 | 2.297         | 1.879                   | 28                     | 2.67E-02                  | 3.79E-04                 | 9.92E-07  |
| 38.76           | 1.859                 | 2.267         | 1.867                   | 22                     | 3.36E-02                  | 4.65E-04                 | 1.53E-06  |
| 77.68           | 1.751                 | 2.077         | 1.805                   | 52                     | 1.33E-02                  | 1.46E-03                 | 1.91E-06  |
| 155.14          | 1.455                 | 1.557         | 1.603                   | 585                    | 9.31E-04                  | 2.01E-03                 | 1.84E-07  |
| 310.29          | 1.295                 | 1.275         | 1.375                   | 270                    | 1.48E-03                  | 5.44E-04                 | 7.91E-08  |
| 620.45          | 1.164                 | 1.045         | 1.229                   | 208                    | 1.54E-03                  | 2.23E-04                 | 3.36E-08  |
| 1241.21         | 1.062                 | 0.866         | 1.113                   | 146                    | 1.80E-03                  | 8.67E-05                 | 1.53E-08  |
| 2481.81         | 0.970                 | 0.704         | 1.016                   | 52                     | 4.21E-03                  | 3.91E-05                 | 1.61E-08  |
| 1241.21         | 0.986                 | 0.732         | 0.978                   |                        |                           |                          |           |
| 310.29          | 1.013                 | 0.780         | 0.999                   |                        |                           |                          |           |
| 77.68           | 1.056                 | 0.855         | 1.034                   |                        |                           |                          |           |
| 19.47           | 1.102                 | 0.936         | 1.079                   |                        |                           |                          |           |
| 4.87            | 1.135                 | 0.994         | 1.118                   |                        |                           |                          |           |

Note:

k calculated using cv based on t<sub>90</sub> values.**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

|                         |       |                                    |       |
|-------------------------|-------|------------------------------------|-------|
| Sample Height, cm       | 1.13  | Unit Weight, kN/m <sup>3</sup>     | 18.86 |
| Sample Diameter, cm     | 6.34  | Dry Unit Weight, kN/m <sup>3</sup> | 13.57 |
| Area, cm <sup>2</sup>   | 31.57 | Specific Gravity, measured         | 2.76  |
| Volume, cm <sup>3</sup> | 35.83 | Solids Height, cm                  | 0.569 |
| Water Content, %        | 39.01 | Volume of Solids, cm <sup>3</sup>  | 17.96 |
| Wet Mass, g             | 68.92 | Volume of Voids, cm <sup>3</sup>   | 17.86 |
| Dry Mass, g             | 49.58 |                                    |       |

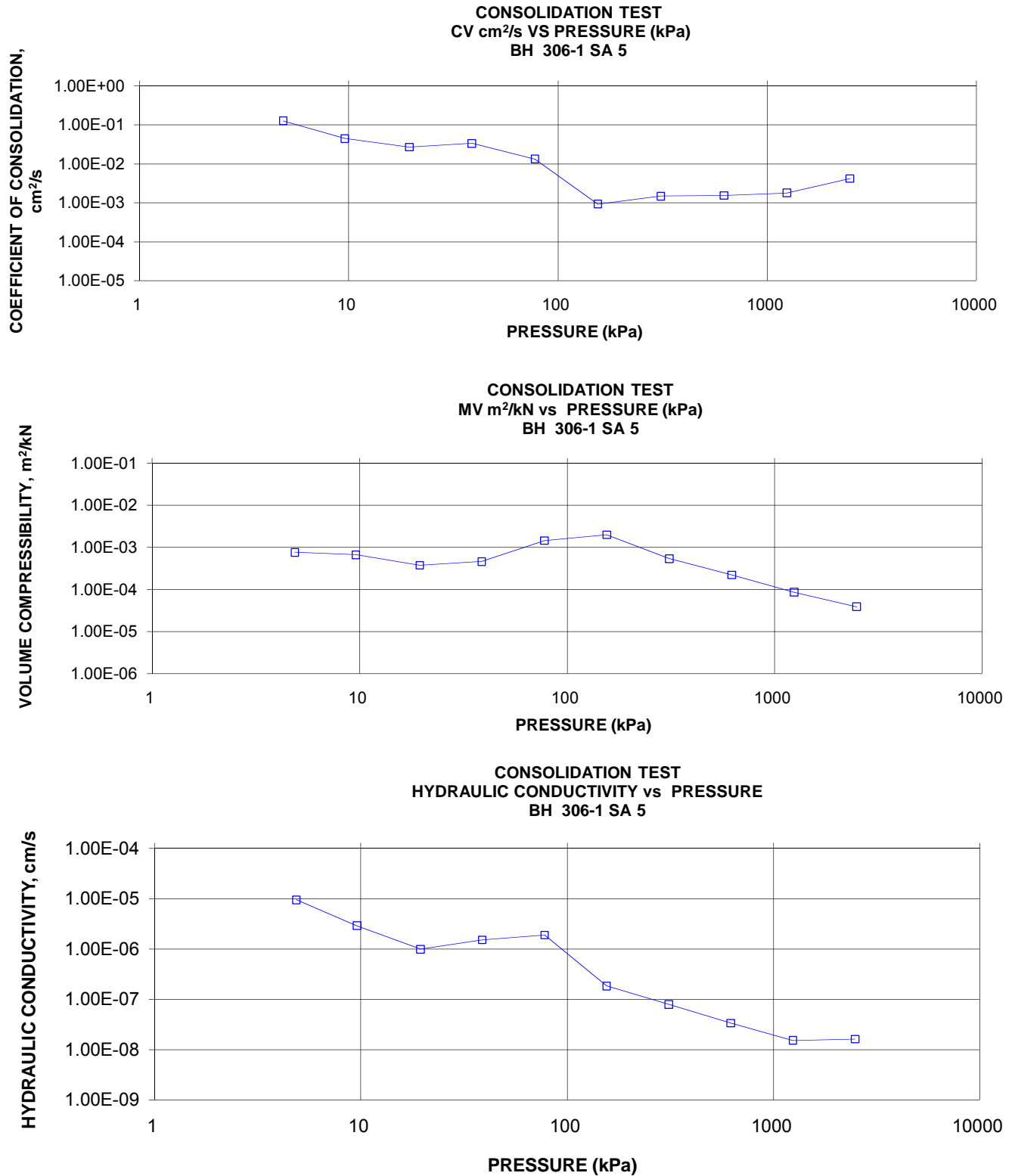
Prepared By: LH

**Golder Associates**

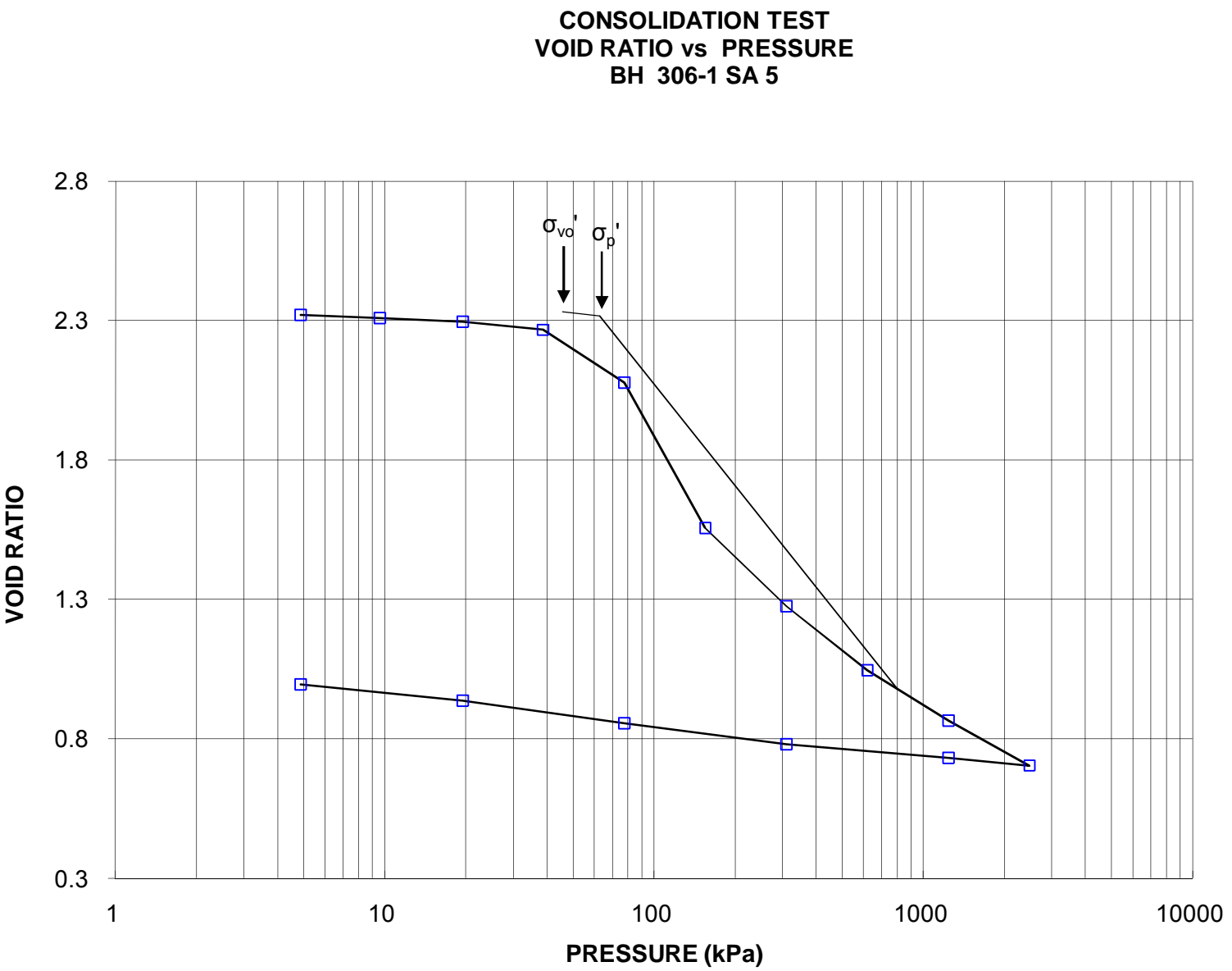
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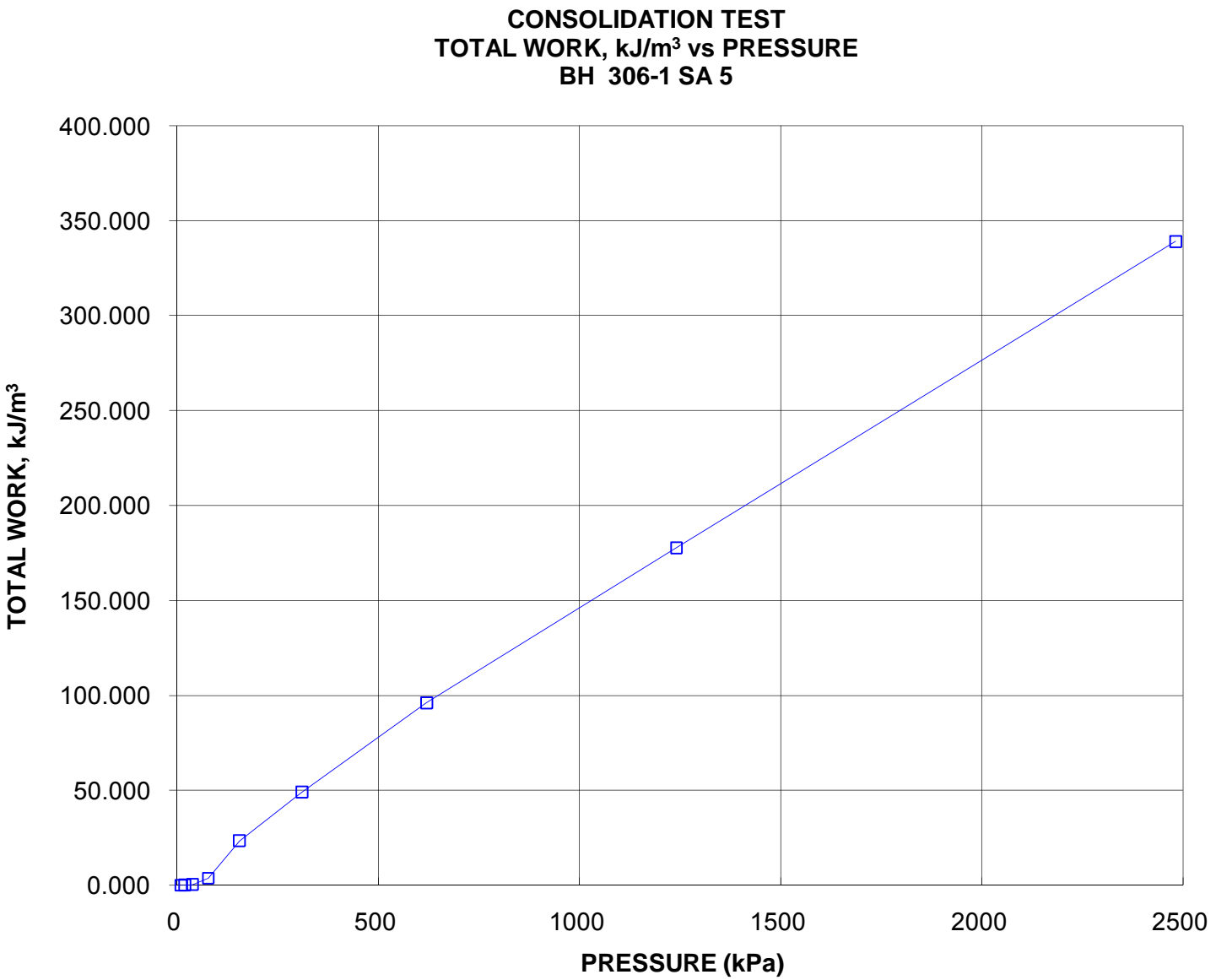
**CONSOLIDATION TEST SUMMARY**  
**Highway 69 (SBL) STA 15+350 to 15+800**

**FIGURE C.S306-3**  
**Sheet 2 of 4**









**CONSOLIDATION TEST SUMMARY****Highway 69 (SBL) STA 15+350 to 15+800****FIGURE C.S306-4****Sheet 1 of 4****SAMPLE IDENTIFICATION**

|                 |             |                 |     |
|-----------------|-------------|-----------------|-----|
| Project Number  | 06-1111-025 | Sample Number   | 3   |
| Borehole Number | 306-2       | Sample Depth, m | 4.9 |

**TEST CONDITIONS**

|                  |            |                   |    |
|------------------|------------|-------------------|----|
| Test Type        | Standard   | Load Duration, hr | 24 |
| Oedometer Number | 1          |                   |    |
| Date Started     | 05/26/2009 |                   |    |
| Date Completed   | 06/15/2009 |                   |    |

**SAMPLE DIMENSIONS AND PROPERTIES - INITIAL**

|                         |        |                                    |       |
|-------------------------|--------|------------------------------------|-------|
| Sample Height, cm       | 2.54   | Unit Weight, kN/m <sup>3</sup>     | 14.45 |
| Sample Diameter, cm     | 6.34   | Dry Unit Weight, kN/m <sup>3</sup> | 7.33  |
| Area, cm <sup>2</sup>   | 31.61  | Specific Gravity, measured         | 2.75  |
| Volume, cm <sup>3</sup> | 80.38  | Solids Height, cm                  | 0.691 |
| Water Content, %        | 97.09  | Volume of Solids, cm <sup>3</sup>  | 21.85 |
| Wet Mass, g             | 118.43 | Volume of Voids, cm <sup>3</sup>   | 58.53 |
| Dry Mass, g             | 60.09  | Degree of Saturation, %            | 99.7  |

**TEST COMPUTATIONS**

| Pressure<br>kPa | Corr.<br>Height<br>cm | Void<br>Ratio | Average<br>Height<br>cm | t <sub>90</sub><br>sec | cv.<br>cm <sup>2</sup> /s | mv<br>m <sup>2</sup> /kN | k<br>cm/s |
|-----------------|-----------------------|---------------|-------------------------|------------------------|---------------------------|--------------------------|-----------|
| 0.00            | 2.543                 | 2.679         | 2.543                   |                        |                           |                          |           |
| 4.70            | 2.508                 | 2.628         | 2.525                   | 240                    | 5.63E-03                  | 2.94E-03                 | 1.62E-06  |
| 9.56            | 2.484                 | 2.593         | 2.496                   | 142                    | 9.30E-03                  | 1.97E-03                 | 1.79E-06  |
| 19.44           | 2.426                 | 2.509         | 2.455                   | 308                    | 4.15E-03                  | 2.30E-03                 | 9.37E-07  |
| 38.76           | 2.310                 | 2.341         | 2.368                   | 432                    | 2.75E-03                  | 2.36E-03                 | 6.37E-07  |
| 77.54           | 2.095                 | 2.030         | 2.202                   | 540                    | 1.90E-03                  | 2.18E-03                 | 4.06E-07  |
| 154.86          | 1.859                 | 1.689         | 1.977                   | 699                    | 1.19E-03                  | 1.20E-03                 | 1.39E-07  |
| 309.84          | 1.660                 | 1.401         | 1.759                   | 371                    | 1.77E-03                  | 5.05E-04                 | 8.76E-08  |
| 619.54          | 1.512                 | 1.187         | 1.586                   | 72                     | 7.40E-03                  | 1.88E-04                 | 1.37E-07  |
| 1240.32         | 1.380                 | 0.996         | 1.446                   | 44                     | 1.01E-02                  | 8.33E-05                 | 8.22E-08  |
| 2488.11         | 1.268                 | 0.834         | 1.324                   | 47                     | 7.90E-03                  | 3.55E-05                 | 2.75E-08  |
| 1240.32         | 1.274                 | 0.844         | 1.271                   |                        |                           |                          |           |
| 309.84          | 1.315                 | 0.902         | 1.295                   |                        |                           |                          |           |
| 77.54           | 1.360                 | 0.968         | 1.337                   |                        |                           |                          |           |
| 19.44           | 1.405                 | 1.032         | 1.382                   |                        |                           |                          |           |
| 4.70            | 1.435                 | 1.076         | 1.420                   |                        |                           |                          |           |

Note:

k calculated using cv based on t<sub>90</sub> values.**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

|                         |       |                                    |       |
|-------------------------|-------|------------------------------------|-------|
| Sample Height, cm       | 1.44  | Unit Weight, kN/m <sup>3</sup>     | 18.18 |
| Sample Diameter, cm     | 6.34  | Dry Unit Weight, kN/m <sup>3</sup> | 12.99 |
| Area, cm <sup>2</sup>   | 31.61 | Specific Gravity, measured         | 2.75  |
| Volume, cm <sup>3</sup> | 45.37 | Solids Height, cm                  | 0.691 |
| Water Content, %        | 40.01 | Volume of Solids, cm <sup>3</sup>  | 21.85 |
| Wet Mass, g             | 84.13 | Volume of Voids, cm <sup>3</sup>   | 23.52 |
| Dry Mass, g             | 60.09 |                                    |       |

Prepared By: LH

**Golder Associates**

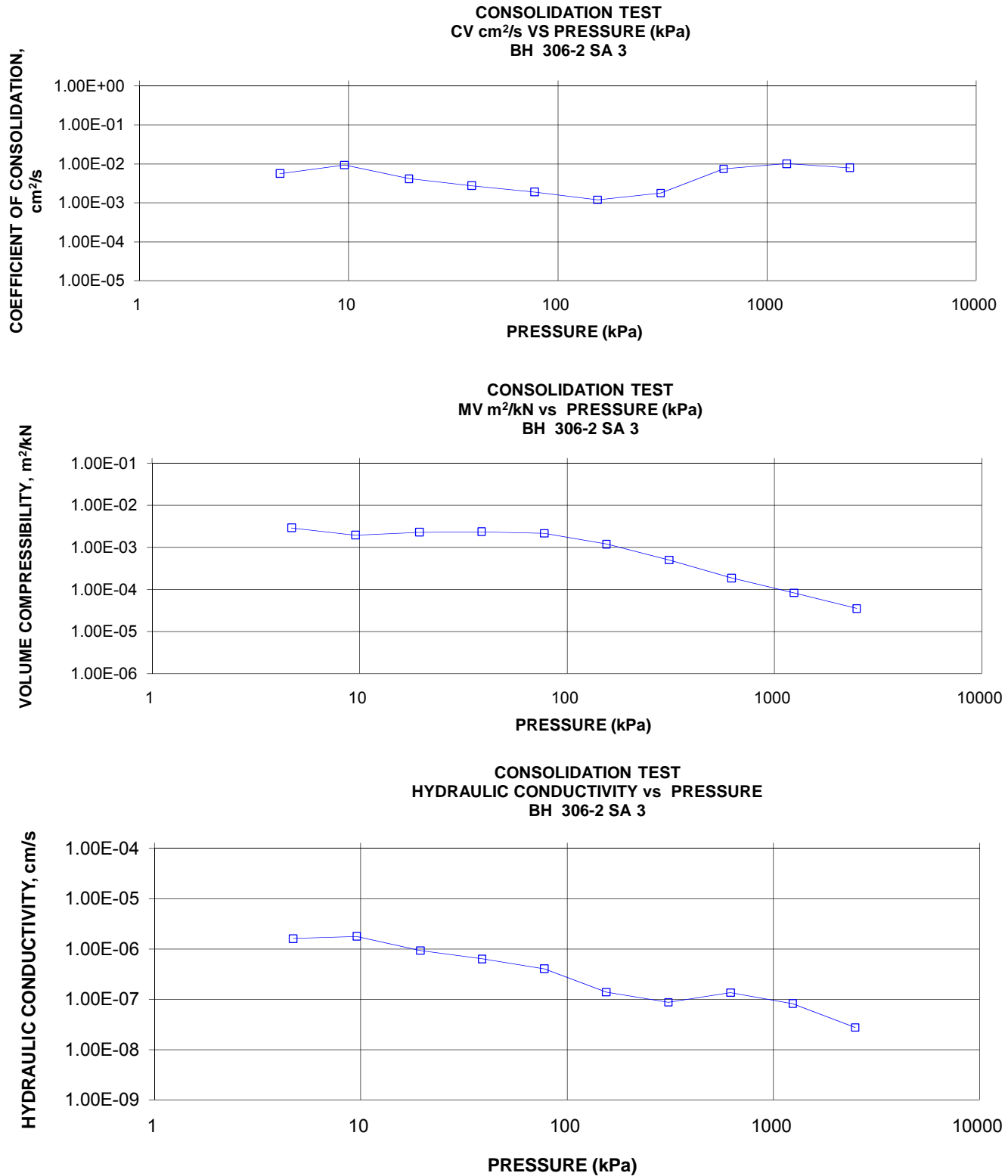
Checked By: MM

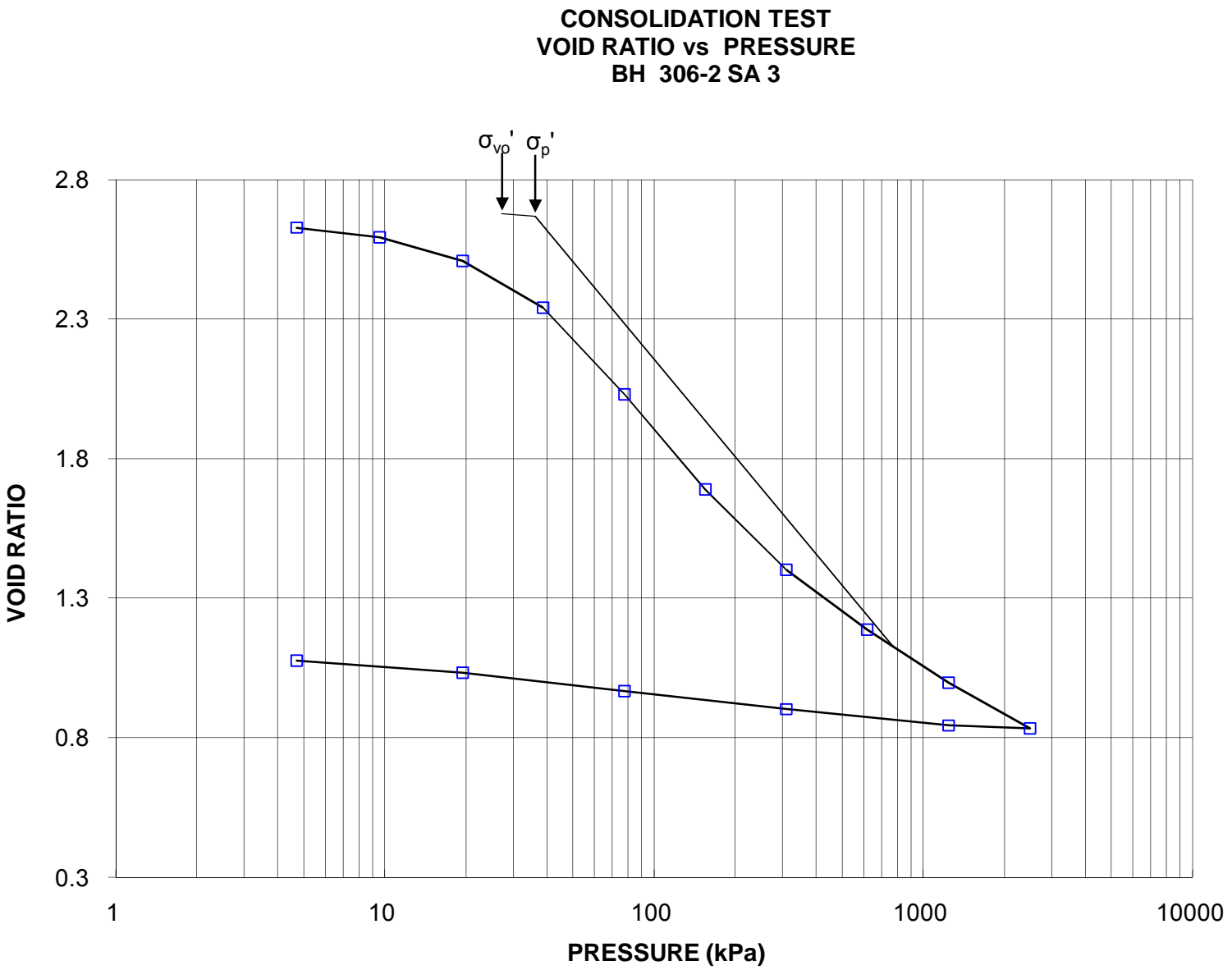
# CONSOLIDATION TEST SUMMARY

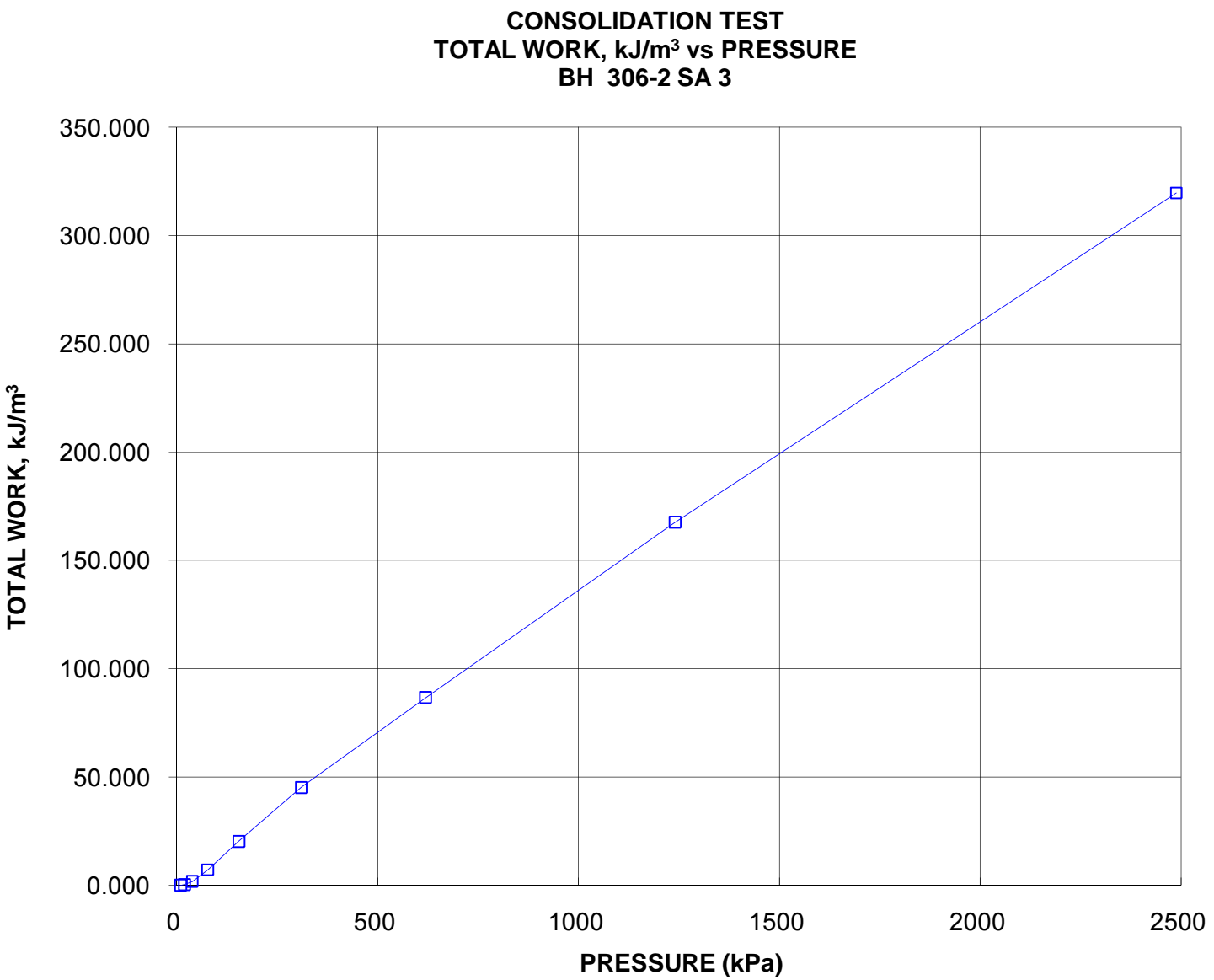
Highway 69 (SBL) STA 15+350 to 15+800

FIGURE C.S306-4

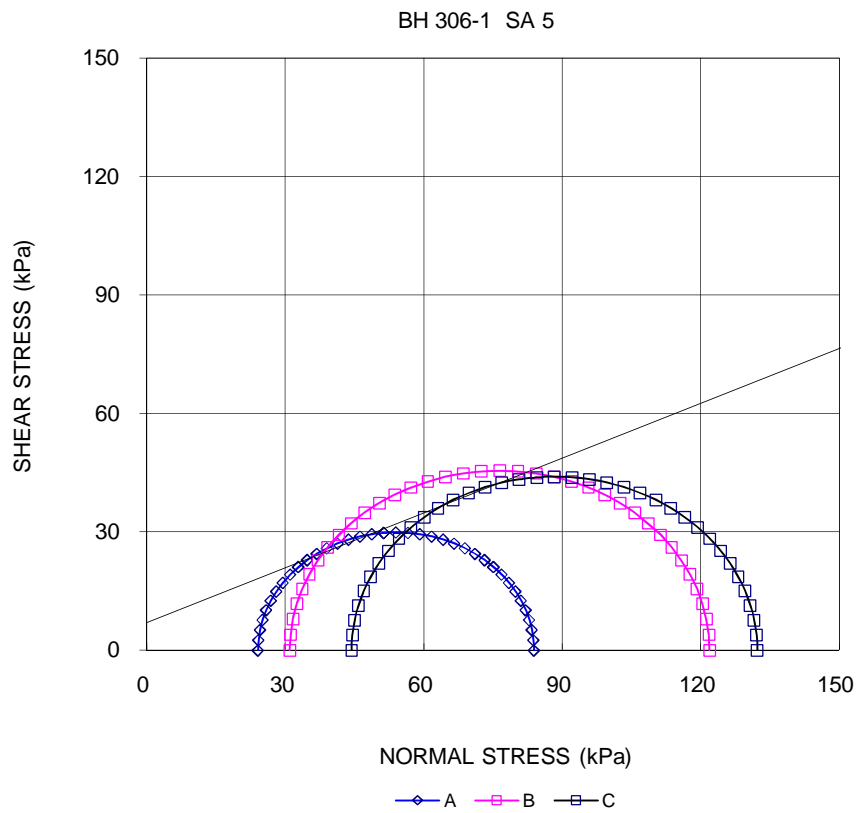
Sheet 2 of 4







| CONSOLIDATED UNDRAINED TRIAXIAL<br>WITH PORE PRESSURE MEASUREMENTS  |       |       | FIGURE C.S306-5<br>Sheet 1 of 4 |
|---|-------|-------|---------------------------------|
| TEST STAGE  | A     | B     | C                               |
| BOREHOLE NUMBER   | 306-1 | 306-1 | 306-1                           |
| SAMPLE  | 5     | 5     | 5                               |
| SPECIMEN DIAMETER, cm   | 5.07  | 5.07  | 5.02                            |
| SPECIMEN HEIGHT, cm   | 10.17 | 10.18 | 10.17                           |
| WATER CONTENT BEFORE CONSOLIDATION, %   | 85.1  | 87.1  | 89.2                            |
| CELL PRESSURE, $\sigma_3$ , kPa   | 195.0 | 365.0 | 470.0                           |
| BACK PRESSURE, kPa  | 135.0 | 275.0 | 345.0                           |
| PORE PRESSURE PARAMETER "B"   | 0.99  | 0.98  | 0.98                            |
| CONSOLIDATION PRESSURE, $\sigma_c$ , kPa  | 60.0  | 90.0  | 125.0                           |
| VOLUMETRIC STRAIN DURING CONSOLIDATION, %   | 8.0   | 6.9   | 13.6                            |
| WATER CONTENT AFTER CONSOLIDATION, %  | 75.3  | 78.7  | 72.6                            |
| AVERAGE RATE OF STRAIN, %/hr  | 0.5   | 0.5   | 0.5                             |
| TIME TO FAILURE, DAYS   | 2     | 2     | 2                               |
| WATER CONTENT AFTER TEST, %   | 80.7  | 82.3  | 71.1                            |
| MAX. DEVIATOR STRESS, $(\sigma_1 - \sigma_3)$ , kPa   | 59.8  | 91.0  | 87.9                            |
| AXIAL STRAIN AT $(\sigma_1 - \sigma_3)$ MAXIMUM, %  | 2.5   | 2.4   | 5.4                             |
| MAX EFFECTIVE PRINCIPAL STRESS<br>RATIO, $(\sigma_1 / \sigma_3)$ MAXIMUM  | 4.3   | 5.1   | 3.8                             |
| DEVIATOR STRESS AT $(\sigma_1 / \sigma_3)$ MAXIMUM, kPa   | 56.8  | 80.5  | 71.2                            |
| AXIAL STRAIN AT $(\sigma_1 / \sigma_3)$ MAXIMUM, %  | 4.9   | 5.0   | 14.3                            |
| PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 - \sigma_3)$ MAXIMUM   | 0.60  | 0.65  | 0.92                            |
| PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 / \sigma_3)$ MAXIMUM   | 0.75  | 0.87  | 1.40                            |
| NATURAL WATER CONTENT, %  | 83.7  | 83.9  | 84.6                            |
| DRY DENSITY, Mg/m <sup>3</sup>  | 0.82  | 0.82  | 0.82                            |
| FILTER DRAINS USED, y/n   | y     | y     | y                               |
| TEST NOTES:   |       |       |                                 |
| CHANGED RATE OF STRAIN, %/hr  | -     | -     | -                               |
| AXIAL STRAIN WHERE RATE OF STRAIN WAS CHANGED, %  | -     | -     | -                               |
| FAILURE PLANE NUMBER  | 1     | 1     | 1                               |
| ANGLE OF FAILURE, DEGREES   | 70    | 62    | 70                              |
| <div> <div>Date: 06/15/2009</div> <div>Project No. 06-1111-025</div> </div> <div> <b>Golder Associates</b> </div> <div> <div>Prepared By: MM</div> <div>Checked By: RO</div> </div> |       |       |                                 |



Date: 06/15/2009  
Project No. 06-1111-025

**Golder Associates**

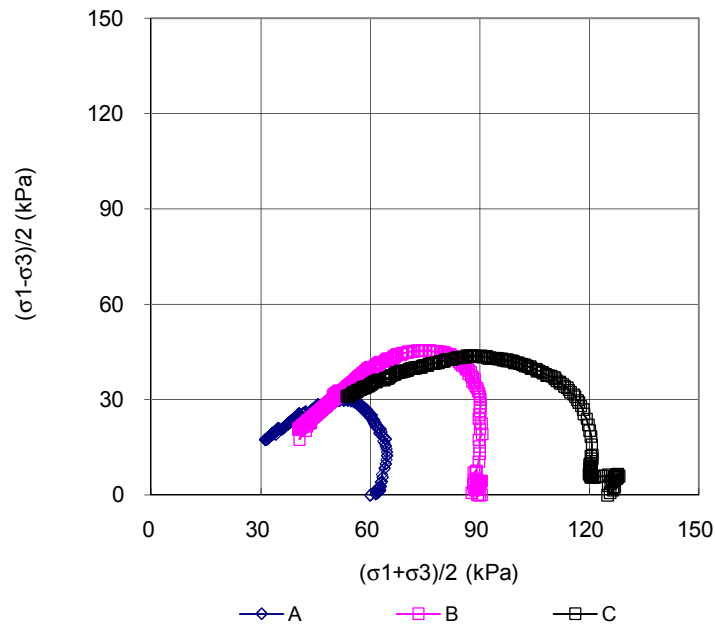
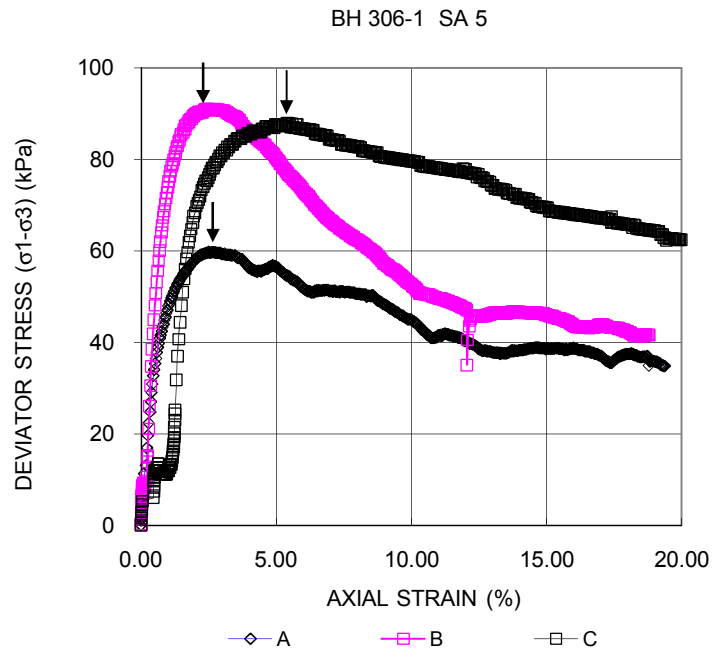
Prepared By: MM  
Checked By: RO



**CONSOLIDATED UNDRAINED TRIAXIAL  
WITH PORE PRESSURE MEASUREMENTS**

**FIGURE C.S306-5**

**Sheet 3 of 4**



Date: 06/15/2009  
Project No. 06-1111-025

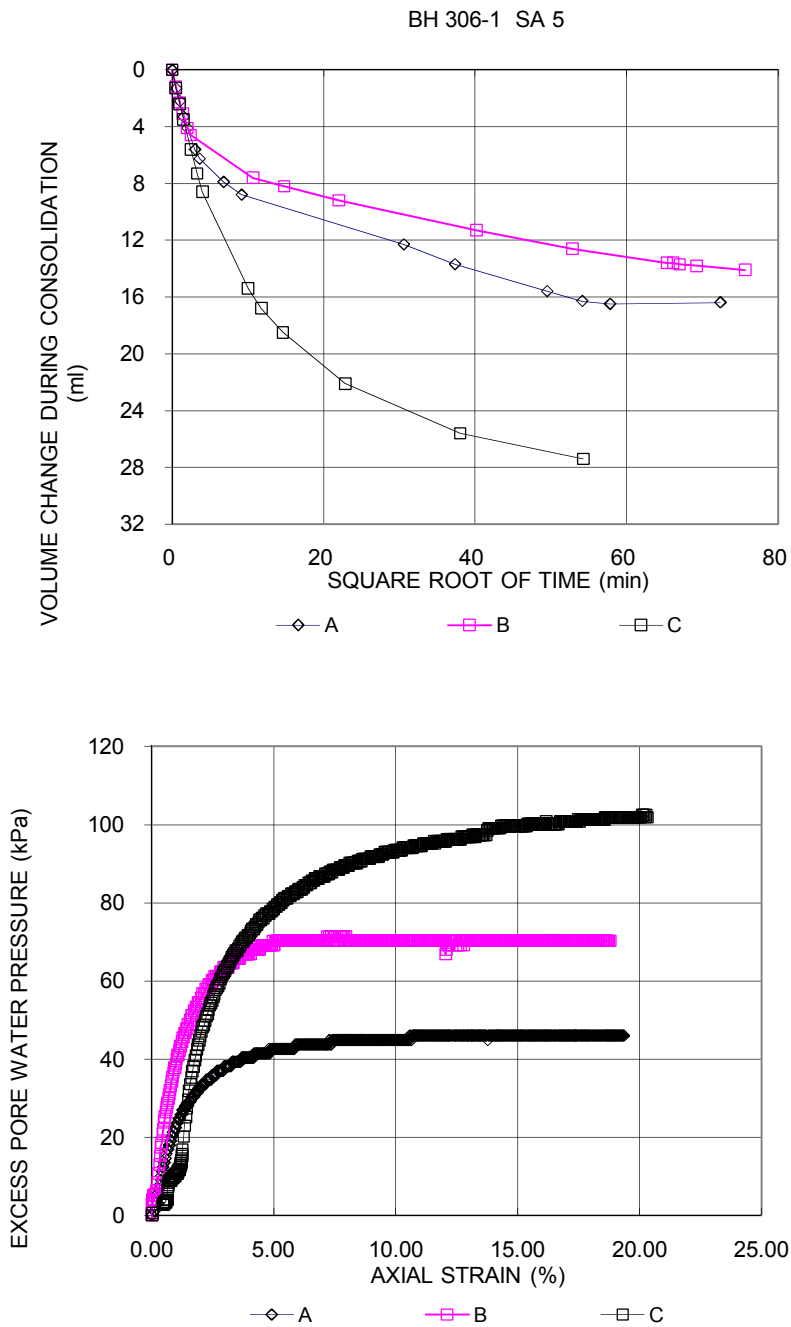
**Golder Associates**

Prepared By: MM  
Checked By: RO

**CONSOLIDATED UNDRAINED TRIAXIAL  
WITH PORE PRESSURE MEASUREMENTS**

**FIGURE C.S306-5**

**Sheet 4 of 4**

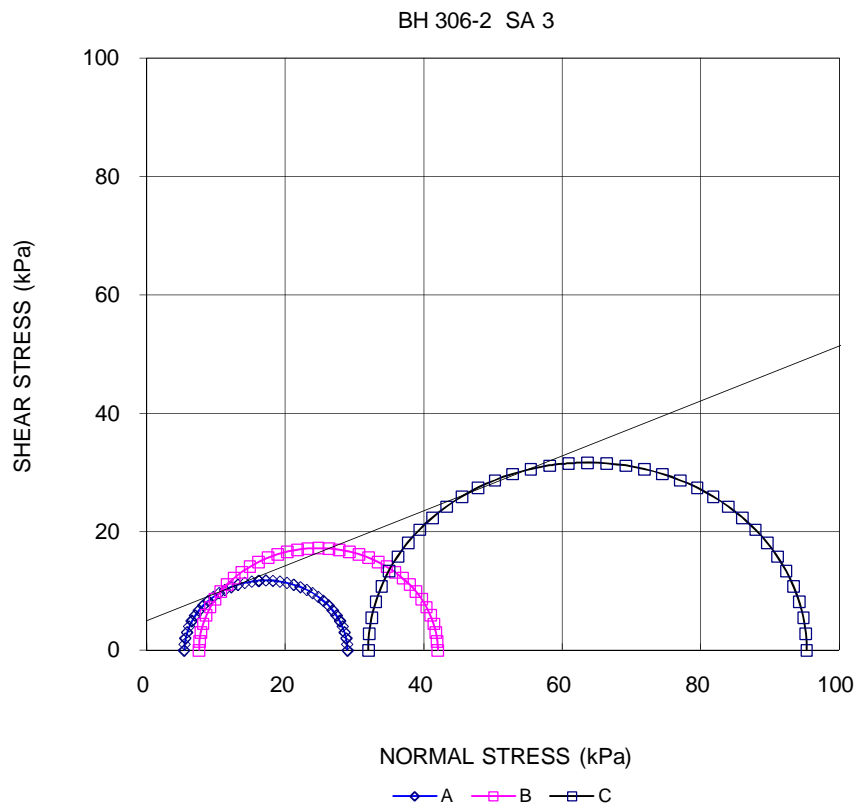


Date: 06/15/2009  
Project No. 06-1111-025

**Golder Associates**

Prepared By: MM  
Checked By: RO

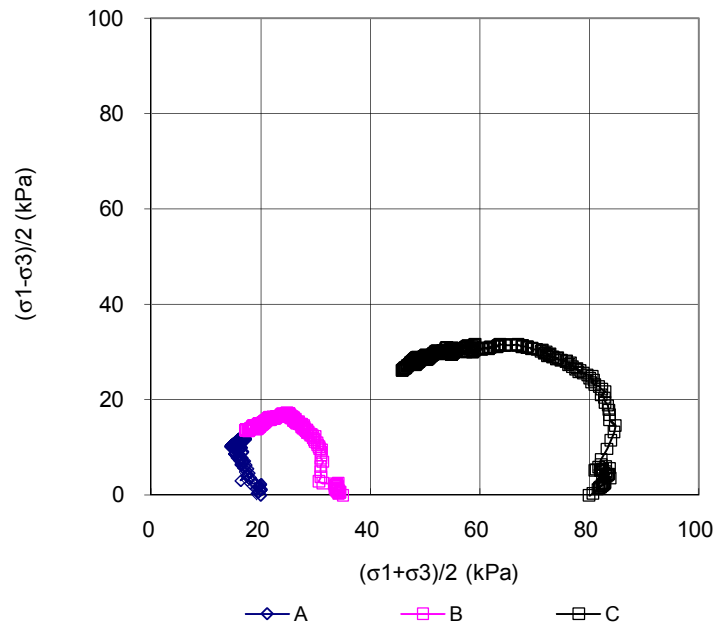
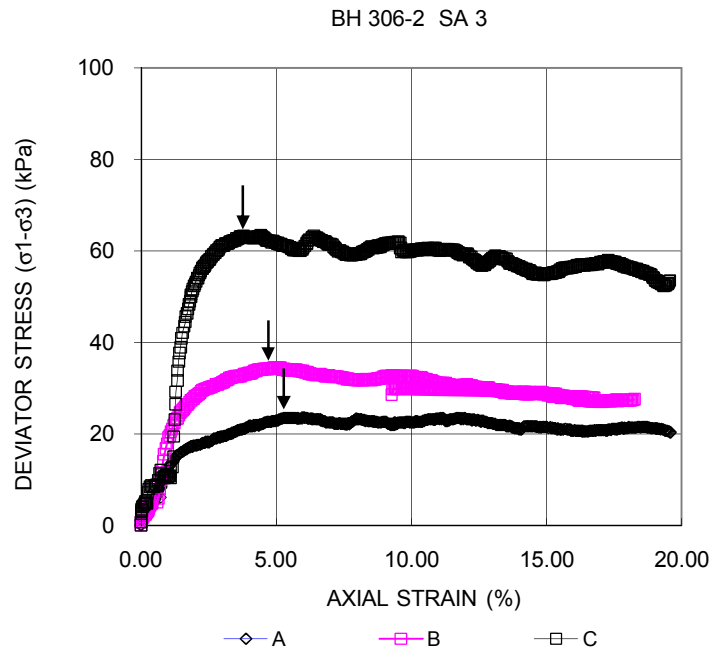
| CONSOLIDATED UNDRAINED TRIAXIAL<br>WITH PORE PRESSURE MEASUREMENTS  |       |       | FIGURE C.S306-6<br>Sheet 1 of 4 |
|---|-------|-------|---------------------------------|
| TEST STAGE  | A     | B     | C                               |
| BOREHOLE NUMBER   | 306-2 | 306-2 | 306-2                           |
| SAMPLE  | 3     | 3     | 3                               |
| SPECIMEN DIAMETER, cm   | 5.10  | 5.13  | 5.06                            |
| SPECIMEN HEIGHT, cm   | 9.90  | 9.89  | 10.05                           |
| WATER CONTENT BEFORE CONSOLIDATION, %   | 92.1  | 93.5  | 98.2                            |
| CELL PRESSURE, $\sigma_3$ , kPa   | 155.0 | 170.0 | 215.0                           |
| BACK PRESSURE, kPa  | 135.0 | 135.0 | 135.0                           |
| PORE PRESSURE PARAMETER "B"   | 0.98  | 0.98  | 0.99                            |
| CONSOLIDATION PRESSURE, $\sigma_c$ , kPa  | 20.0  | 35.0  | 80.0                            |
| VOLUMETRIC STRAIN DURING CONSOLIDATION, %   | 5.2   | 9.5   | 19.9                            |
| WATER CONTENT AFTER CONSOLIDATION, %  | 85.2  | 81.1  | 71.2                            |
| AVERAGE RATE OF STRAIN, %/hr  | 0.5   | 0.5   | 0.5                             |
| TIME TO FAILURE, DAYS   | 2     | 2     | 2                               |
| WATER CONTENT AFTER TEST, %   | 84.9  | 81.2  | 71.4                            |
| MAX. DEVIATOR STRESS, $(\sigma_1 - \sigma_3)$ , kPa   | 23.5  | 34.5  | 63.3                            |
| AXIAL STRAIN AT $(\sigma_1 - \sigma_3)$ MAXIMUM, %  | 6.0   | 4.9   | 4.4                             |
| MAX EFFECTIVE PRINCIPAL STRESS<br>RATIO, $(\sigma_1 / \sigma_3)$ MAXIMUM  | 6.4   | 7.2   | 3.8                             |
| DEVIATOR STRESS AT $(\sigma_1 / \sigma_3)$ MAXIMUM, kPa   | 23.5  | 32.6  | 58.9                            |
| AXIAL STRAIN AT $(\sigma_1 / \sigma_3)$ MAXIMUM, %  | 6.1   | 10.0  | 13.1                            |
| PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 - \sigma_3)$ MAXIMUM   | 0.62  | 0.80  | 0.76                            |
| PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 / \sigma_3)$ MAXIMUM   | 0.67  | 0.91  | 1.01                            |
| NATURAL WATER CONTENT, %  | 94.1  | 94.3  | 97.4                            |
| DRY DENSITY, Mg/m <sup>3</sup>  | 0.76  | 0.76  | 0.74                            |
| FILTER DRAINS USED, y/n   | y     | y     | y                               |
| TEST NOTES:   |       |       |                                 |
| CHANGED RATE OF STRAIN, %/hr  | -     | -     | -                               |
| AXIAL STRAIN WHERE RATE OF STRAIN WAS CHANGED, %  | -     | -     | -                               |
| FAILURE PLANE NUMBER  | 1.0   | 1.0   | -                               |
| ANGLE OF FAILURE, DEGREES   | 65.0  | 60.0  | bulged                          |
| <div> <div>Date: 06/12/2009</div> <div>Project No. 06-1111-025</div> <div>Golder Associates</div> <div>Prepared By: MM</div> <div>Checked By: RO</div> </div> |       |       |                                 |



Date: 06/12/2009  
Project No. 06-1111-025

**Golder Associates**

Prepared By: MM  
Checked By: RO



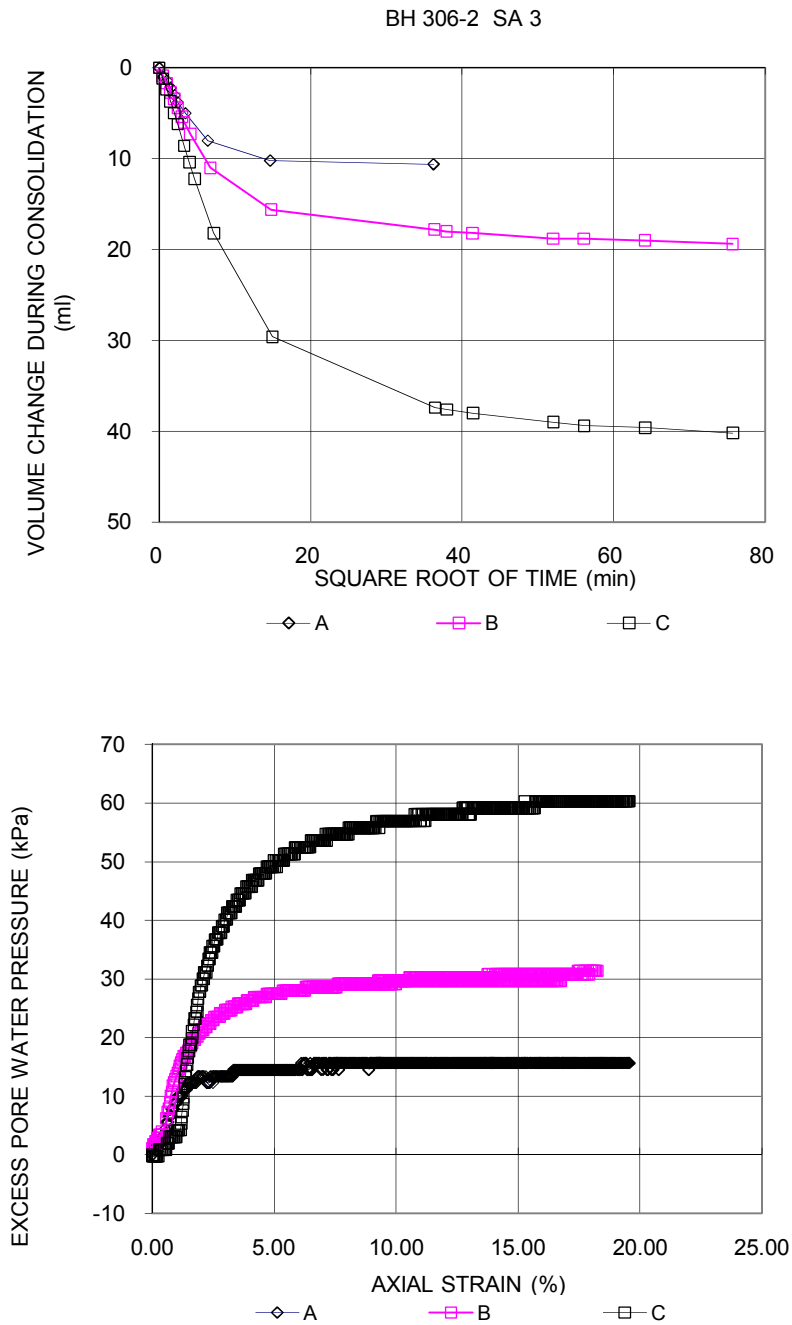
Date: 06/12/2009  
Project No. 06-1111-025

**Golder Associates**

Prepared By: MM  
Checked By: RO

**CONSOLIDATED UNDRAINED TRIAXIAL  
WITH PORE PRESSURE MEASUREMENTS**

**FIGURE C.S306-6  
Sheet 4 of 4**



Date: 06/12/2009  
Project No. 06-1111-025

**Golder Associates**

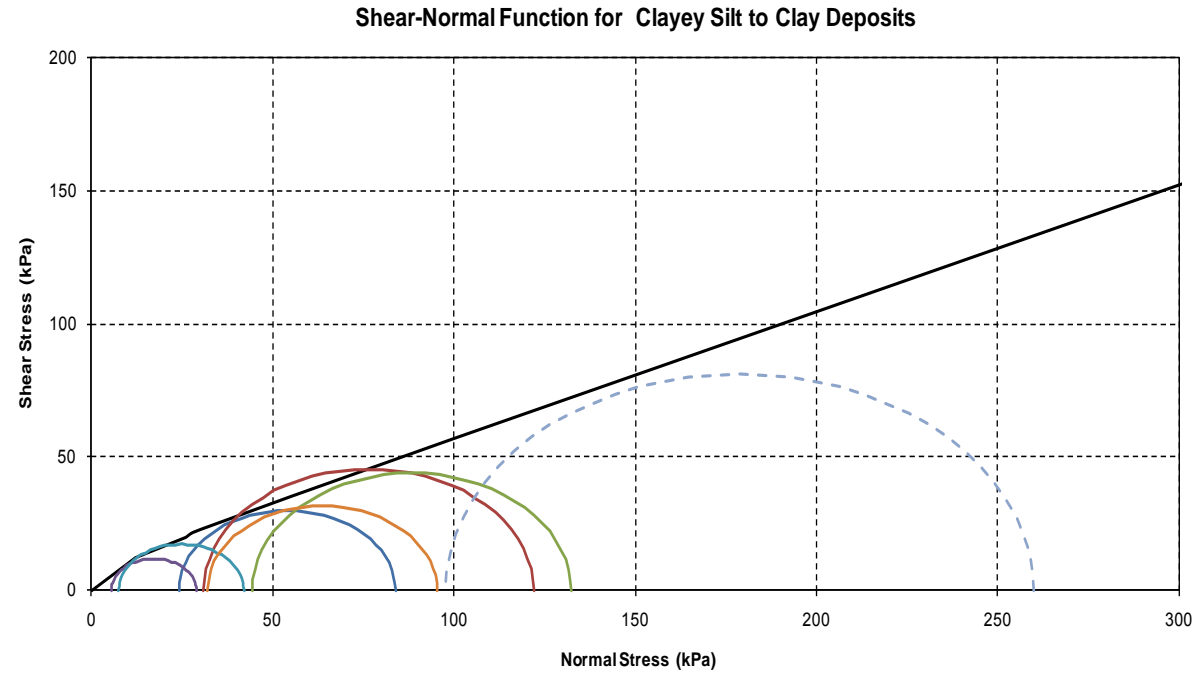
Prepared By: MM  
Checked By: RO



TABLE C1 – SUMMARY OF FOUNDATION ENGINEERING PARAMETERS  
HIGHWAY 69 FOUR-LANING – PHASE 3

| Swamp Crossing   | Stratigraphic Unit          | Top Elevation<br>(m) | Thickness<br>(m) | $\gamma'$<br>(kN/m <sup>3</sup> ) | $\phi'$<br>(°)  | $c'$<br>(kPa)  | $s_u$<br>(kPa) | $\sigma_p'$<br>(kPa) | $e_o$      | $C_c$     | $C_r$       | $E'$<br>(MPa) | $C_{\alpha(\epsilon)}$ |     | $c_h$<br>(cm <sup>2</sup> /s) |
|--|-----------------------------|----------------------|------------------|-----------------------------------|-----------------|----------------|----------------|----------------------|------------|-----------|-------------|---------------|------------------------|-----|-------------------------------|
|  |                             |                      |                  |                                   |                 |                |                |                      |            |           |             |               | N/C                    | O/C |                               |
| Swamp 306 SBL<br>Highway 69 SBL - STA 15+350 to 15+800 | Sand Blanket                | 191.2 – 188.9        | 1.5 – 3.0        | 18.5                              | 32              | 0              | --             | --                   | --         | --        | --          | 30            | --                     | --  | --                            |
|  | Peat / Topsoil              | 190.2 – 189.0        | 0.1 – 0.9        | 12                                | 27              | 1              | --             | --                   | --         | --        | --          | --            | --                     | --  | --                            |
|  | Organic Clayey Silt to Clay | 189.4 – 188.5        | 0.8 – 2.3        | 15.5                              | 26              | 0              | --             | --                   | --         | --        | --          | --            | --                     | --  | --                            |
|  | Sandy Silt to Silt          | 190.6 – 187.8        | 0.4 – 1.9        | 18                                | 27              | 0              | --             | --                   | --         | --        | --          | 3             | --                     | --  | --                            |
|  | Clayey Silt to Clay         | 192.1 – 179.1        | 0.9 – 13.2       | 16                                | 26 <sup>1</sup> | 4 <sup>1</sup> | 6 – 30         | 27 – 136             | 0.75 – 2.9 | 0.2 – 1.5 | 0.02 – 0.09 | --            | 2                      | 0.4 | 5.62 x 10 <sup>-3</sup>       |
|  | Silt to Sand                | 185.9 – 172.0        | 0.3 – 4.9        | 18                                | 27              | 0              | --             | --                   | --         | --        | --          | 3             | --                     | --  | --                            |

Note: <sup>1</sup> Clayey silt to clay deposits use a fully defined shear-normal function based on results of triaxial tests (approximately equivalent to  $c' = 4$  kPa and  $\phi' = 26^\circ$  over the stress range of  $0 \text{ kPa} \leq \sigma_n' \leq 200 \text{ kPa}$ . See Inset below.



\\mis1-s-filesrv1\data\active\2006\1111\06-1111-025 mrc hwy 69-522 to 64 french river\reporting\wick drain embankments\final\tables\06-1111-025-1 tblc1 summary of foundation engineering parameters.docx

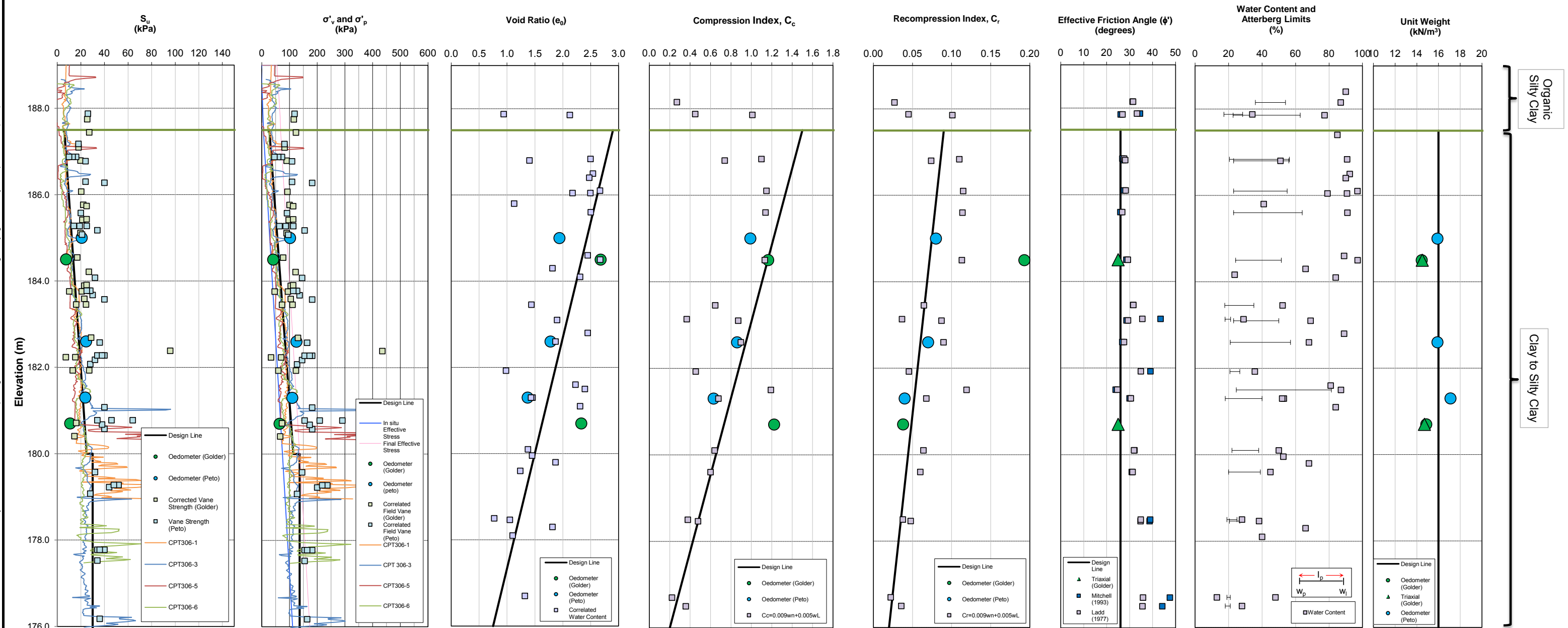
Prepared By: TZ

Reviewed By: JPD/JMAC

\\ms1-s-files\1\data\active\2006\11106-1111-025 MRC Hwy 69-522 to 64 French River\Reporting\Wick Drain Embankments\Final\Figures\Figure C1.xls\Swamp 306 Plots (Final)

SUMMARY PLOT OF ENGINEERING PARAMETERS FOR COHESIVE DEPOSITS  
Swamp 306 SBL - Highway 69 (SBL) - STA 15+360 to 15+750

FIGURE C1



NOTES:

Average original ground surface at the critical section is at about Elevation 189 m.  
Minimum sand blanket thickness below the original ground surface is about 1.5 m, with base extending to no lower than Elevation 186 m.

Golder Associates

Date: April 2012  
Project No: 06-1111-025-1

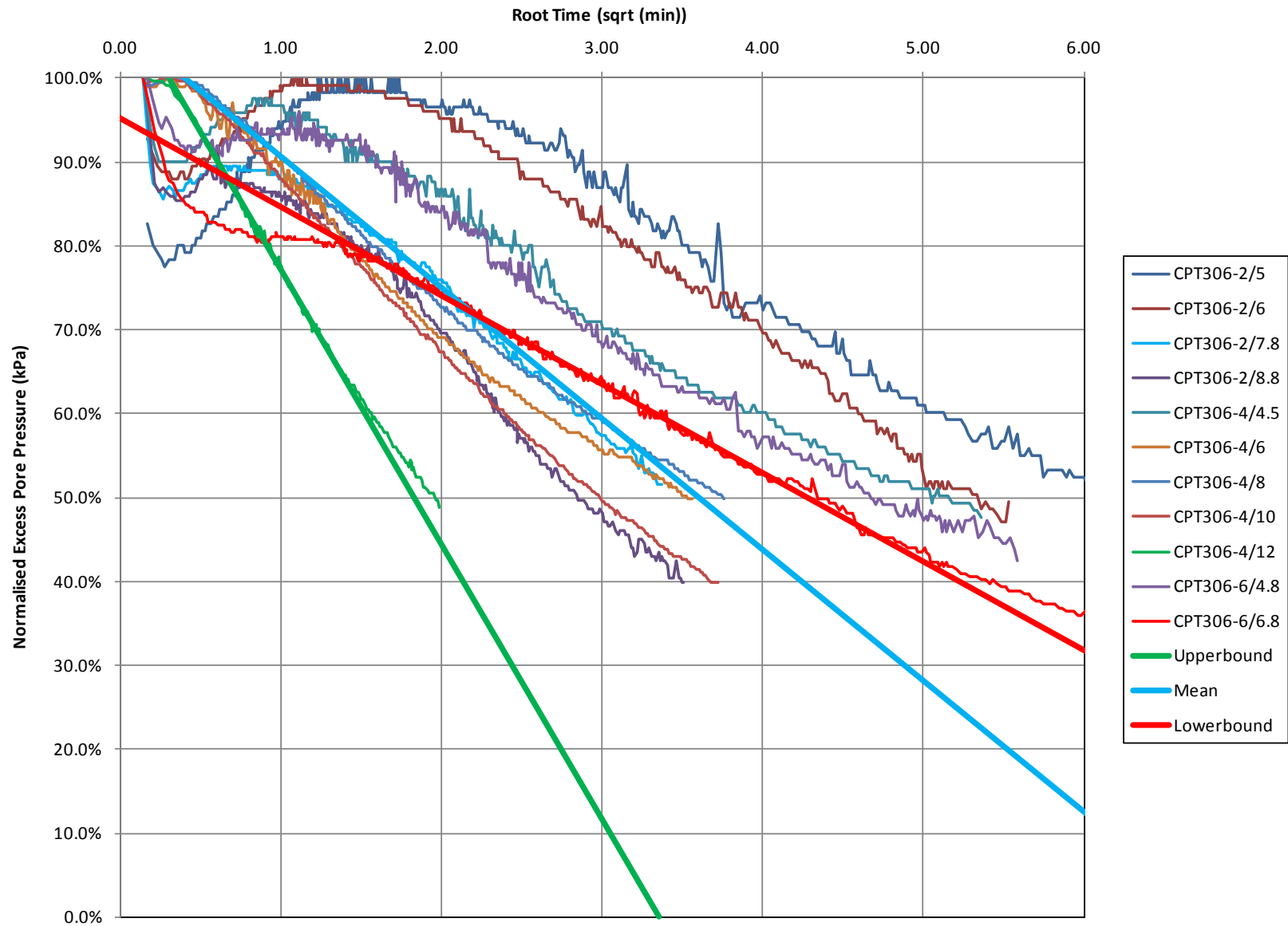
DB: TZ / MWK  
CHK: JPD





# CPT Pore Pressure Dissipation Tests Swamp 306 SBL

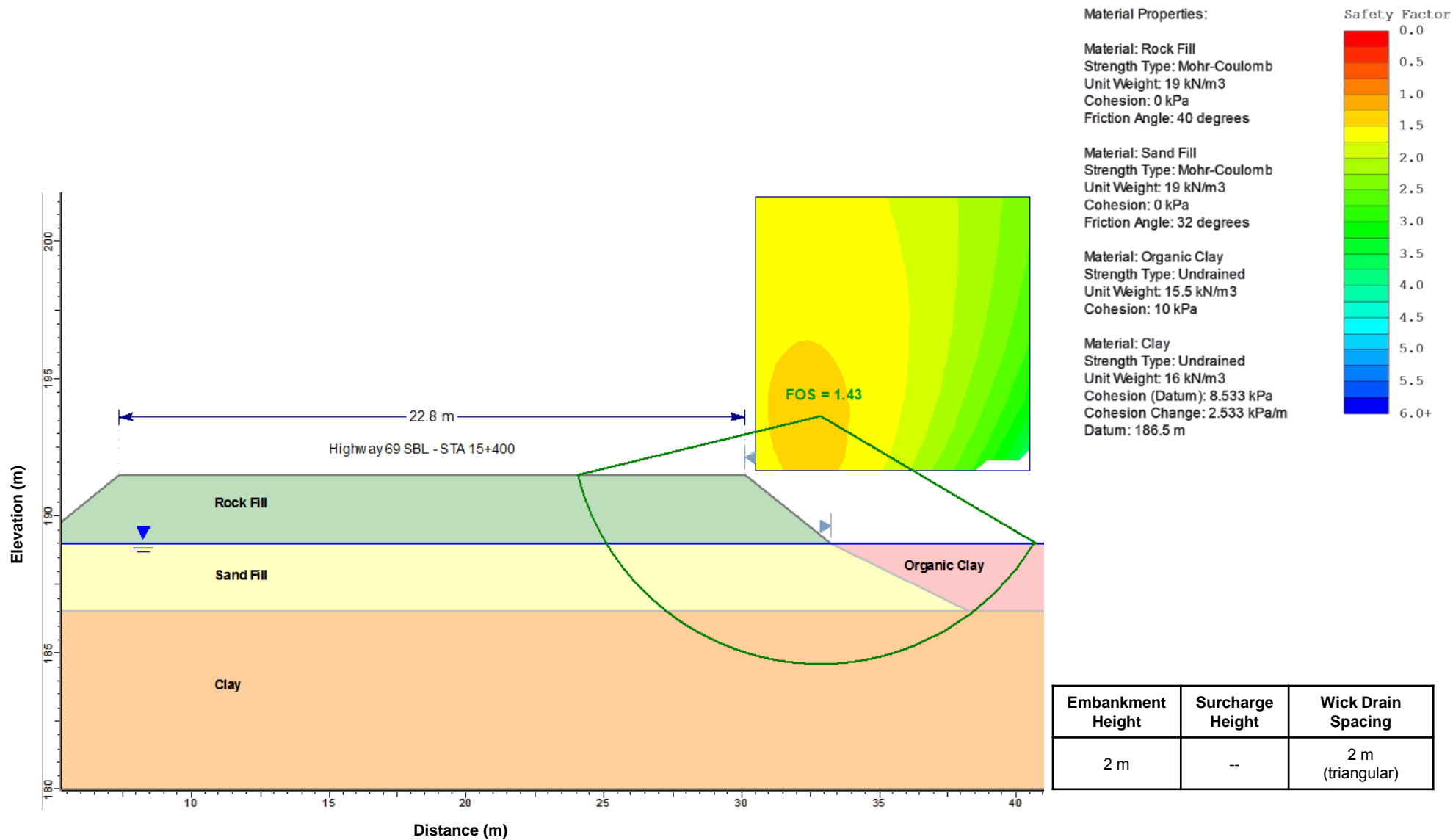
Figure C2





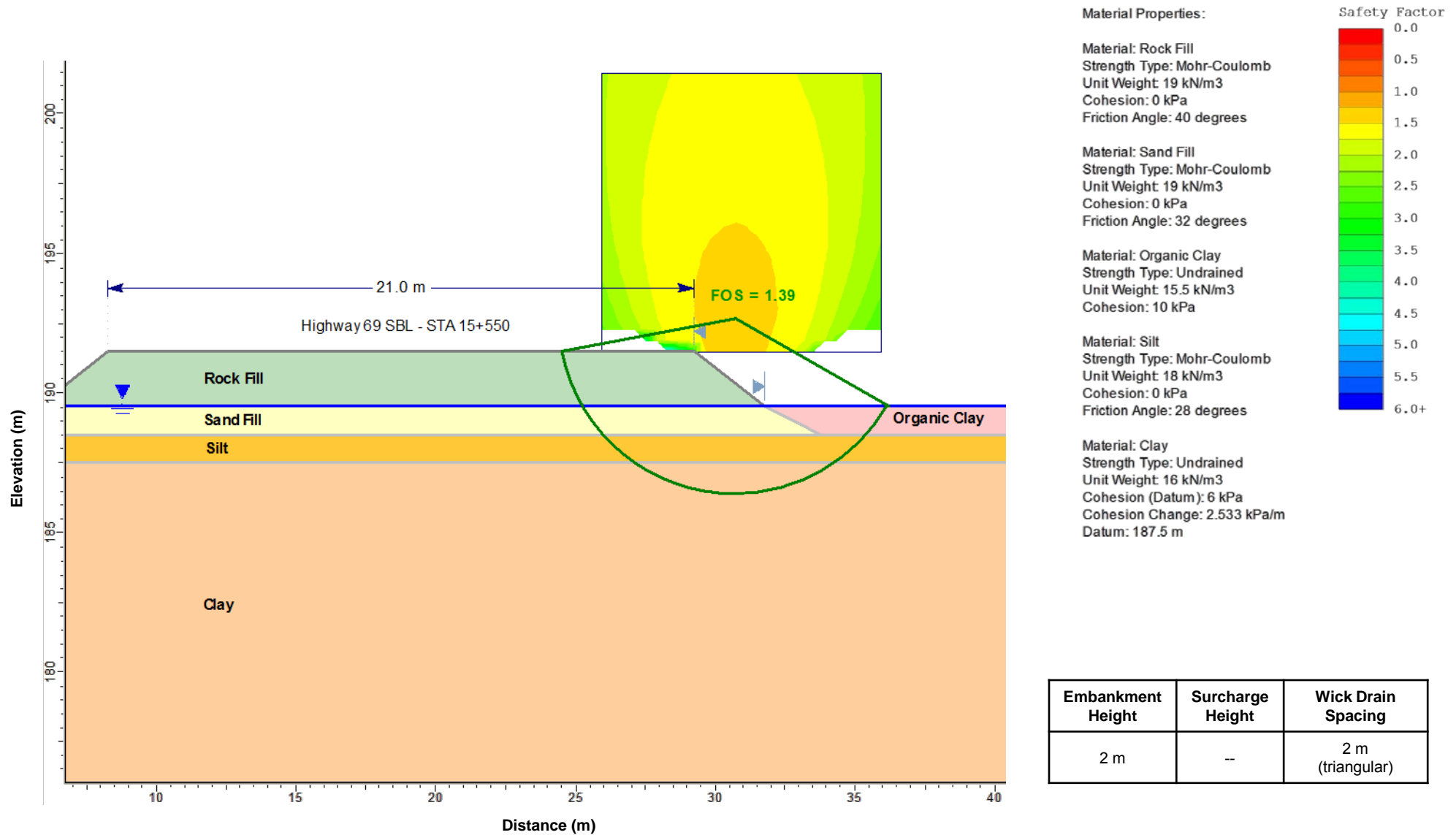
# Slope Stability – Total Stress Analysis – STA 15+400 (Swamp 306 SBL)

Figure C3-1



# Slope Stability – Total Stress Analysis – STA 15+550 (Swamp 306 SBL)

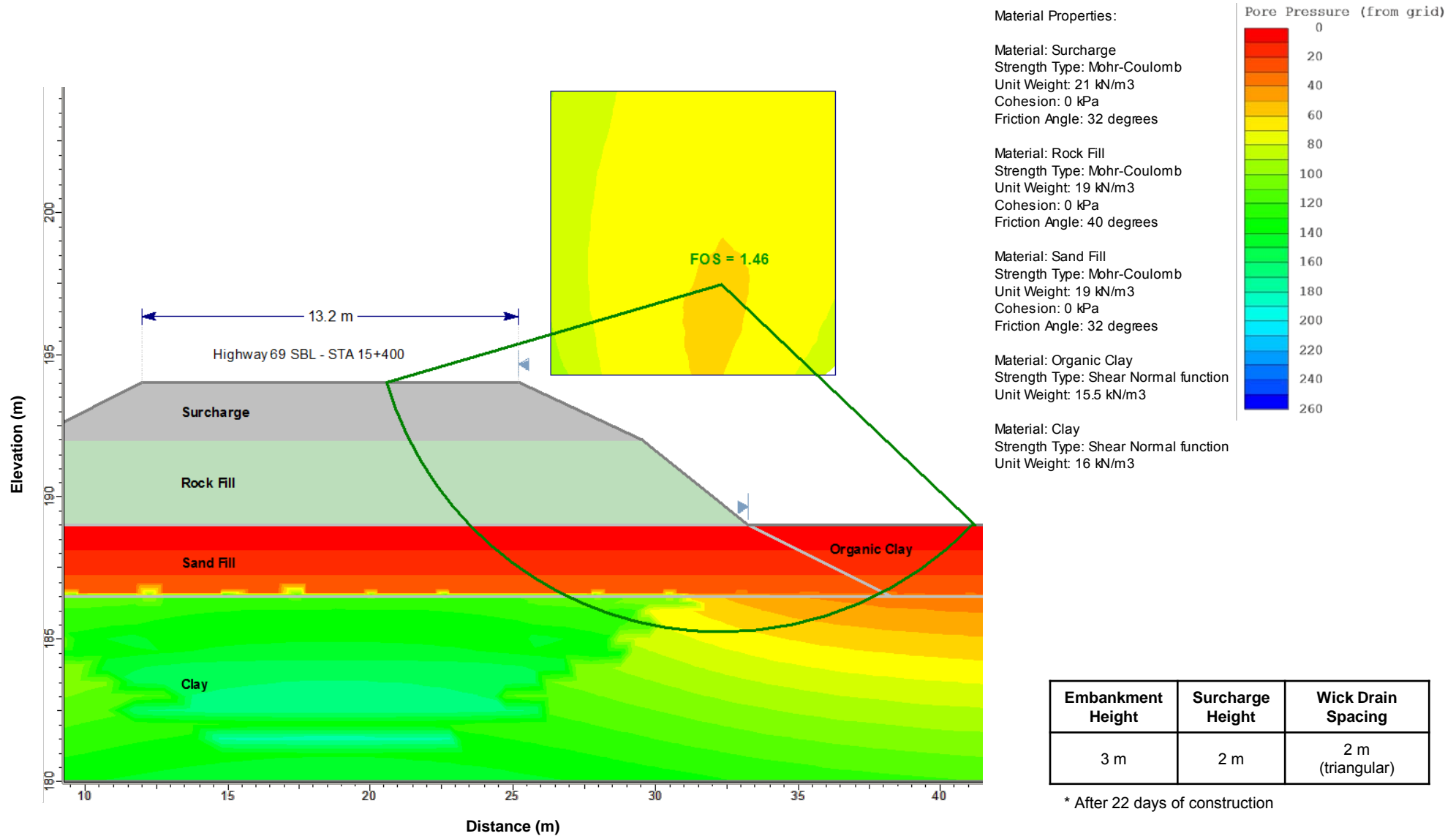
Figure C3-2





# Slope Stability – Effective Stress Analysis – STA 15+400 (Swamp 306 SBL)

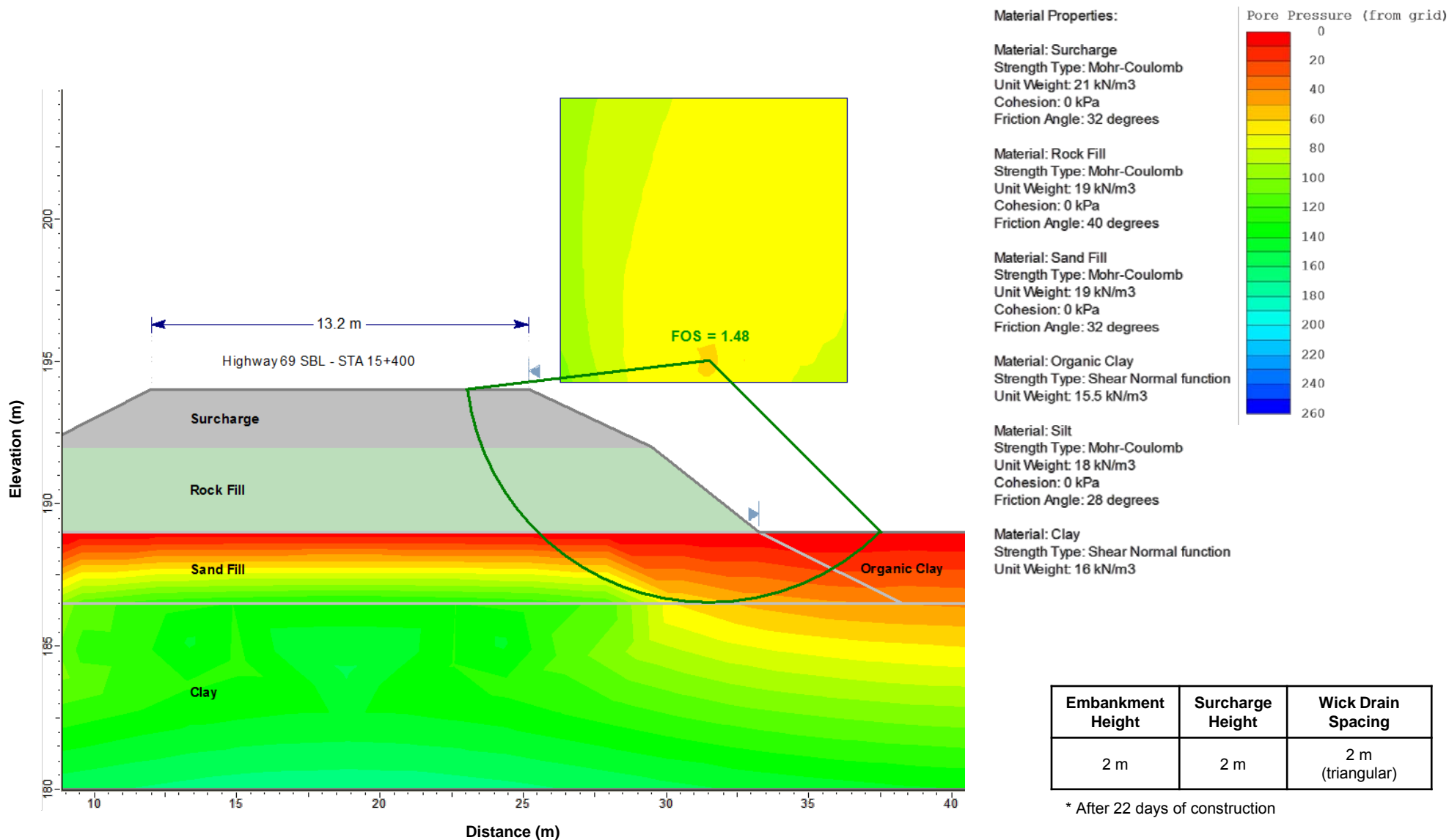
Figure C4-1





# Slope Stability – Effective Stress Analysis – STA 15+550 (Swamp 306 SBL)

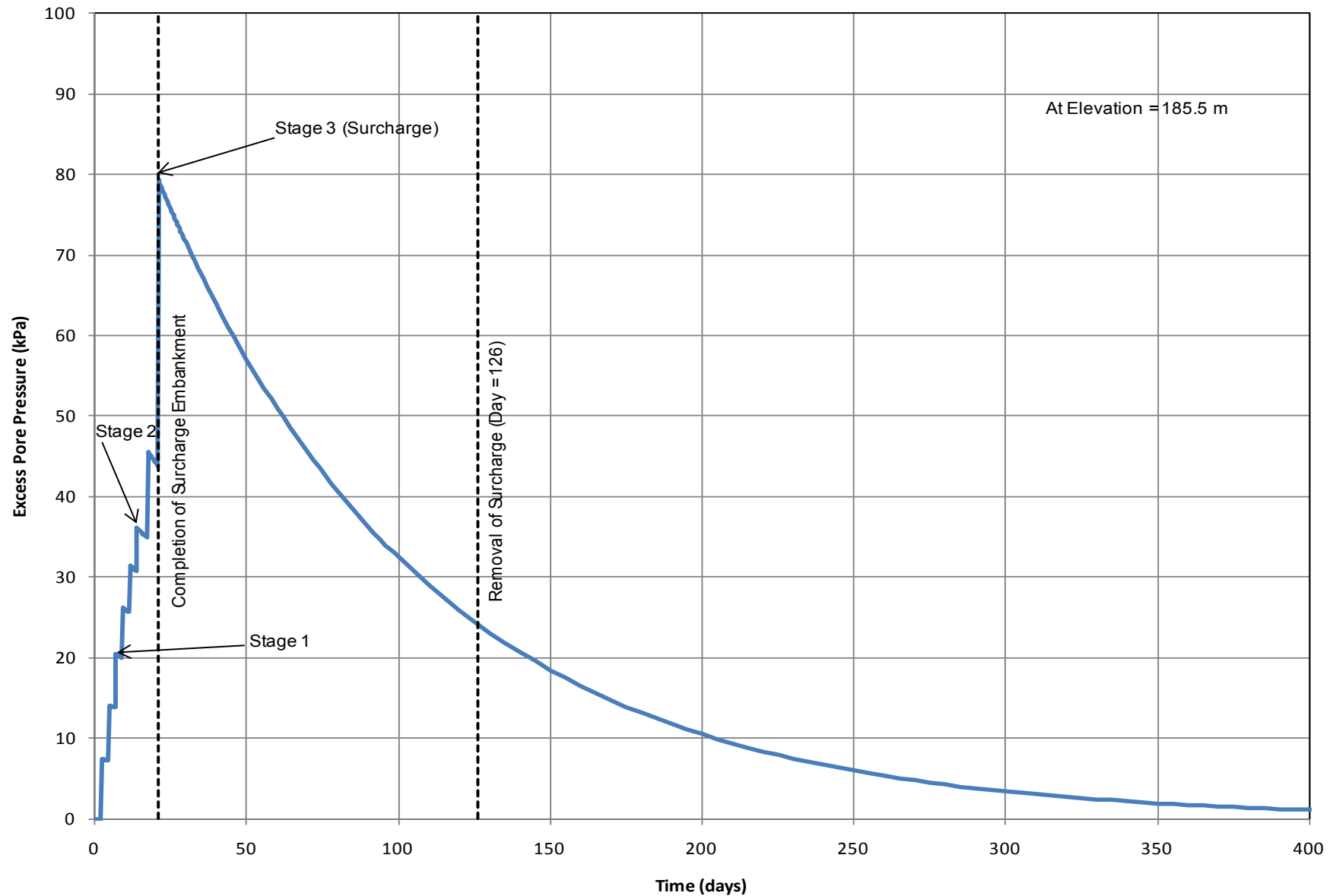
Figure C4-2





## Excess Pore Pressure Response below Embankment Centreline – STA 15+400 (Swamp 306 SBL)

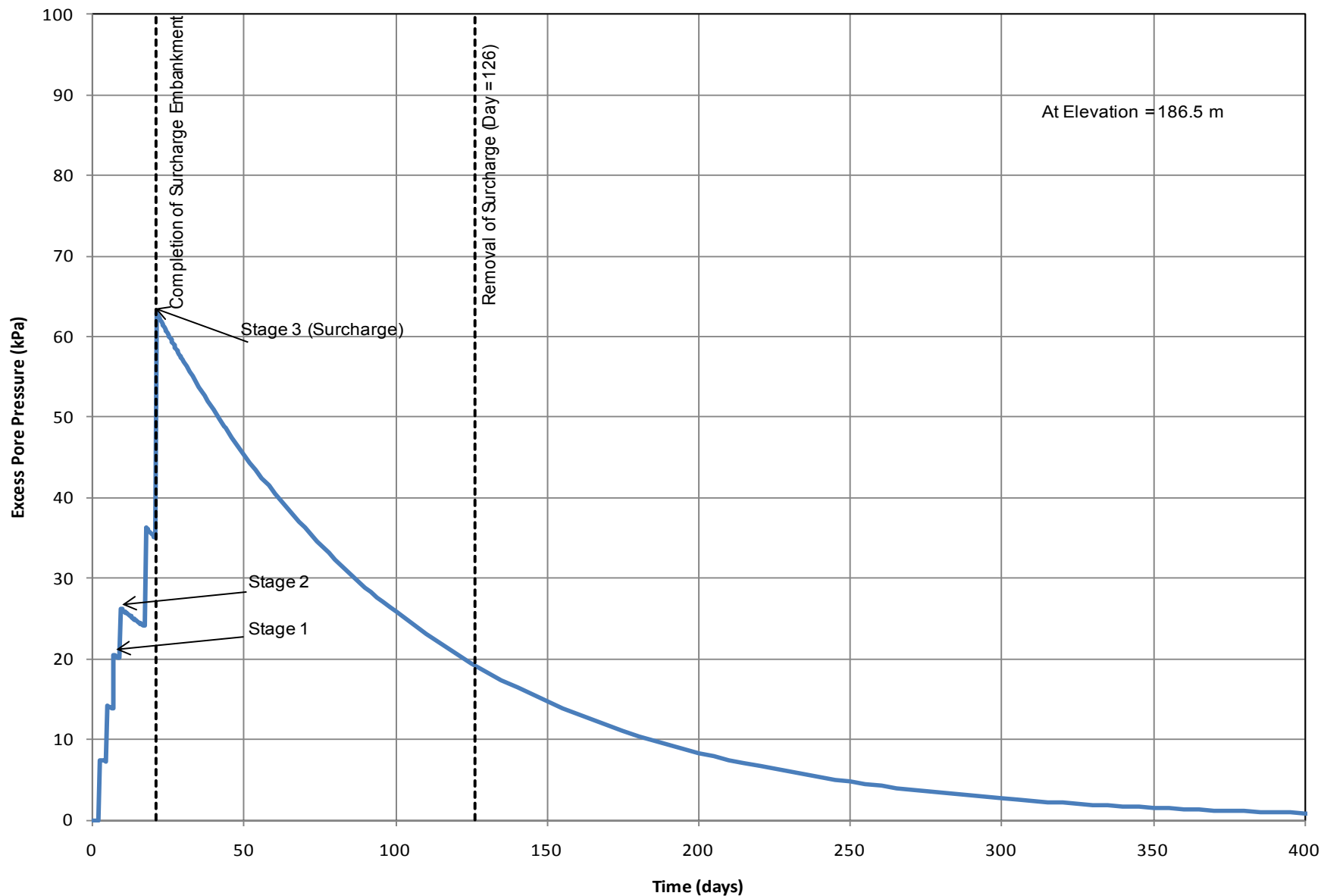
Figure C5-1





## Excess Pore Pressure Response below Embankment Centreline – STA 15+550 (Swamp 306 SBL)

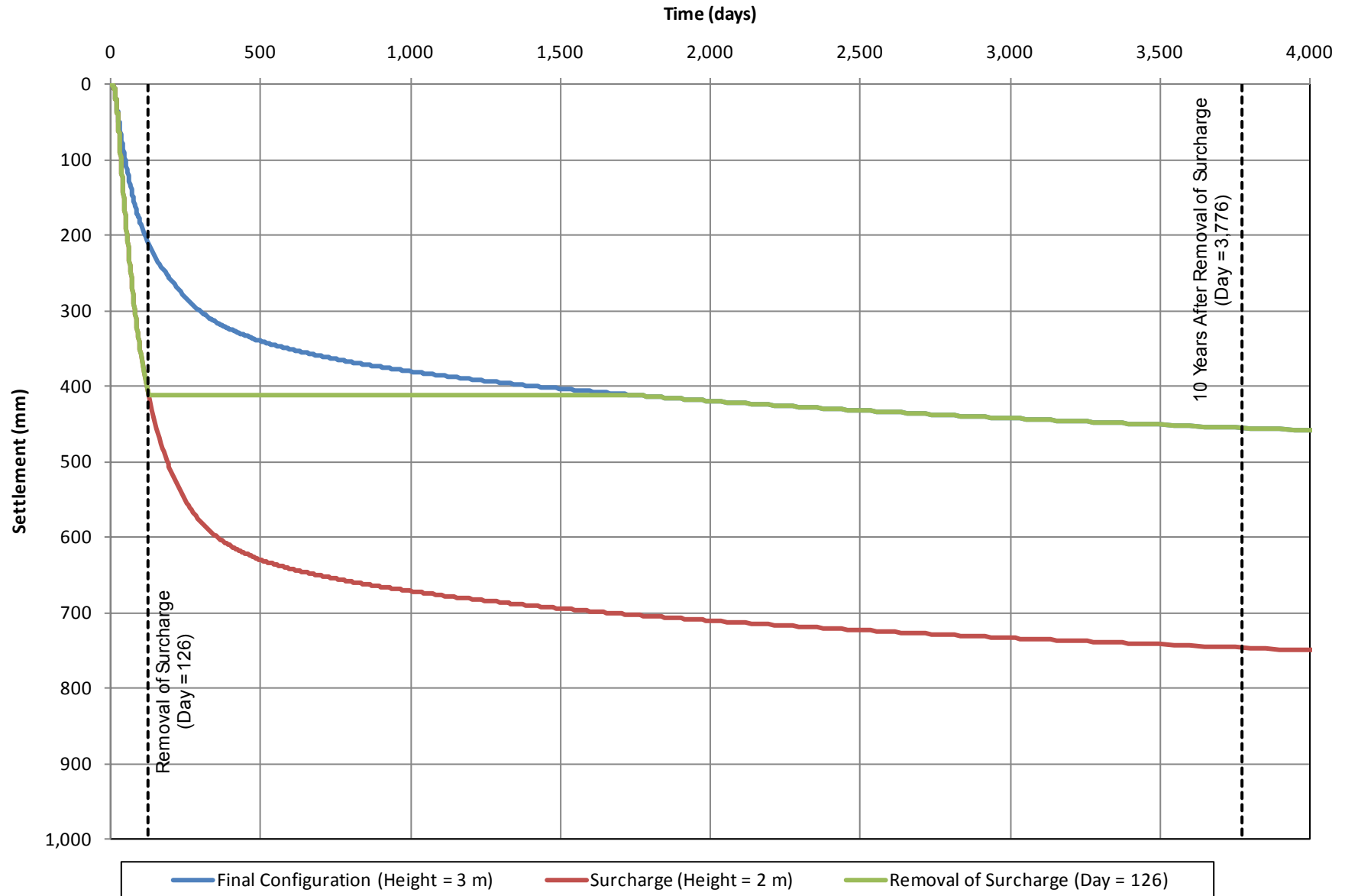
Figure C5-2





## Time – Rate Consolidation Settlement at Embankment Centreline – STA 15+400 (Swamp 306)

Figure C6-1

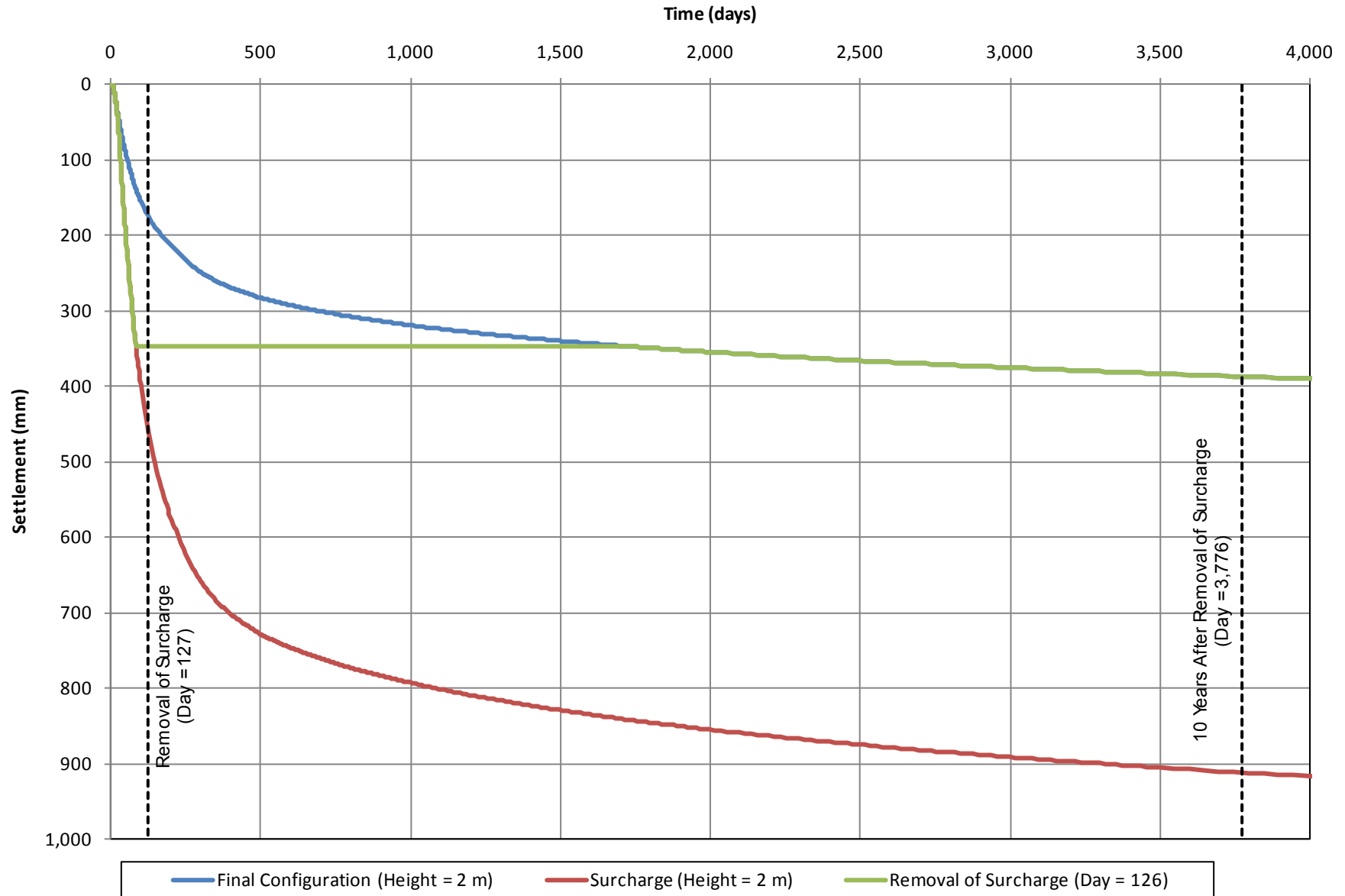






## Time – Rate Consolidation Settlement at Embankment Centreline – STA 15+550 (Swamp 306)

Figure C6-2





# **APPENDIX D**

**Highway 69 NBL – STA 14+425 to 14+500 (Swamp 307 SBL)**

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○<sup>3%</sup> STRAIN AT FAILURE

GT-A-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 1/27/12 SAC

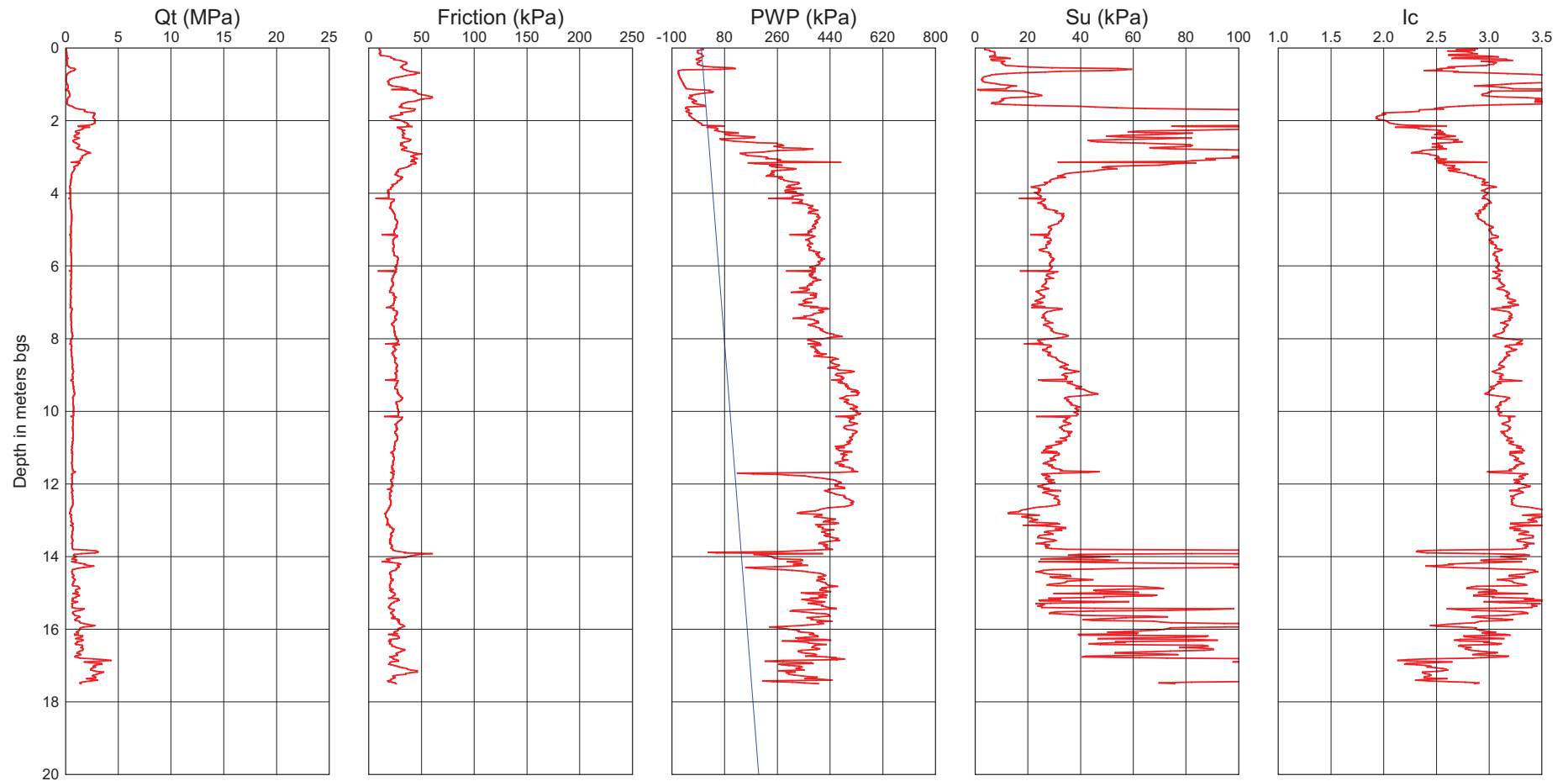
| PROJECT 06-1111-025 |   |            |         | <b>RECORD OF BOREHOLE No 307-1</b>                                     |            |                            |                 | 2 OF 2 <b>METRIC</b>                        |    |    |    |     |                                    |                                     |                                   |  |  |
|---------------------|---|------------|---------|--|------------|----------------------------|-----------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|--|--|
| G.W.P. 5203-06-00   |   |            |         | LOCATION N 5090527.6 ;E 220909.4                                       |            |                            |                 | ORIGINATED BY MR                            |    |    |    |     |                                    |                                     |                                   |  |  |
| DIST _____ HWY 69   |   |            |         | BOREHOLE TYPE 108 mm O.D. Solid Stem Augers and NW Casing, Wash Boring |            |                            |                 | COMPILED BY MWK                             |    |    |    |     |                                    |                                     |                                   |  |  |
| DATUM Geodetic      |   |            |         | DATE March 19, 2009  |            |                            |                 | CHECKED BY VA                               |    |    |    |     |                                    |                                     |                                   |  |  |
| SOIL PROFILE        |   |            | SAMPLES |  |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |    |     | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br><br>γ<br><br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br><br>GR SA SI CL |
| ELEV<br>DEPTH       | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE   | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |    |    |    |     |                                    |                                     |                                   |  |  |
|                     | --- CONTINUED FROM PREVIOUS PAGE ---  |            |         |  |            |                            |                 | 20  | 40 | 60 | 80 | 100 |                                    |                                     |                                   |  |  |
| 176.3               | SILT, trace to some clay, trace sand<br>Loose to compact<br>Grey<br>Wet   |            | 10      | SS   | 13         |                            | 177             |   |    |    |    |     |                                    |                                     |                                   |  |  |
| 16.5                | END OF BOREHOLE   |            |         |  |            |                            | 176             |   |    |    |    |     |                                    |                                     |                                   |  |  |
|                     | A Dynamic Cone Penetration Test was carried out between depths of 16.5 m and 18.8 m.  |            |         |  |            |                            | 175             |   |    |    |    |     |                                    |                                     |                                   |  |  |
| 174.0               | END OF DCPT   |            |         |  |            |                            | 174             |   |    |    |    |     |                                    |                                     |                                   |  |  |
| 18.8                | NOTES:<br><br>1. Water level in open borehole at ice surface (Elev. 192.8 m) upon completion of drilling.<br><br>2. An additional borehole was drilled 1 m east of Borehole 307-1 to obtain a Shelby tube sample between depths of 2.7 m and 3.2 m and to carry out insitu vane tests at depths of 3.5 m and 3.8 m. |            |         |  |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |  |  |

# Cone Penetration Test - CPT307-1

Test Date : March 11, 2009  
Location : Highway 69 - STA 15+460 o/s 23 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 192.80  
Water Table Depth : 0.00



Qt normalized for  
unequal end area effects

$Su = (Qt - \sigma_v) / Nk$   
Nk = 15.5  
Gamma = 15.5 kN/m<sup>3</sup>

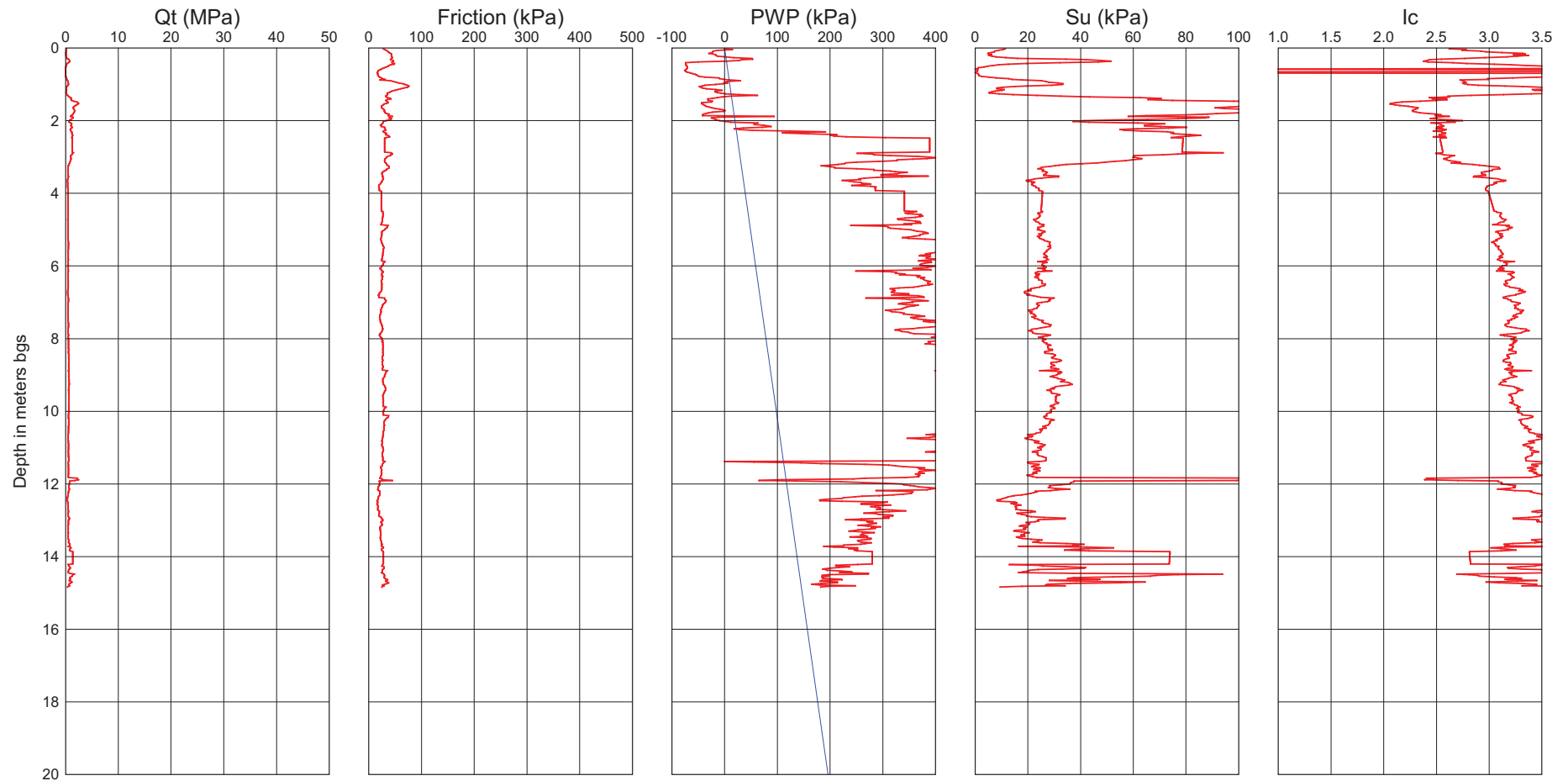
After Robertson and (Fear) Wride (1998)  
Ic < 1.31 - Gravelly sands  
1.31 < Ic < 2.05 - Clean to silty sand  
2.05 < Ic < 2.60 - Silty sand to sandy silt  
2.60 < Ic < 2.95 - Clayey silt to silty clay  
2.95 < Ic < 3.60 - Clays

# Cone Penetration Test - CPT307-2

Test Date : 11//2/3/  
Location : Highway 69 - STA 15+460 o/s 24 m Left

Operator : Golder Associates

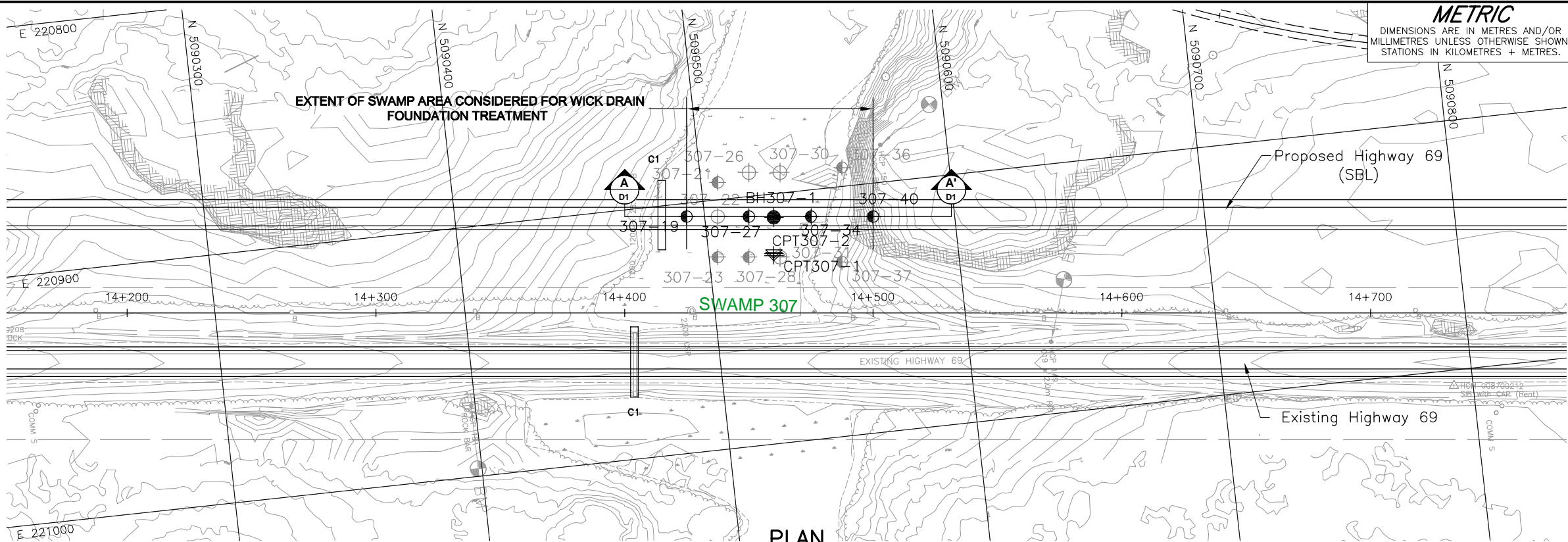
Ground Surf. Elev. : 192.80  
Water Table Depth : 0.00



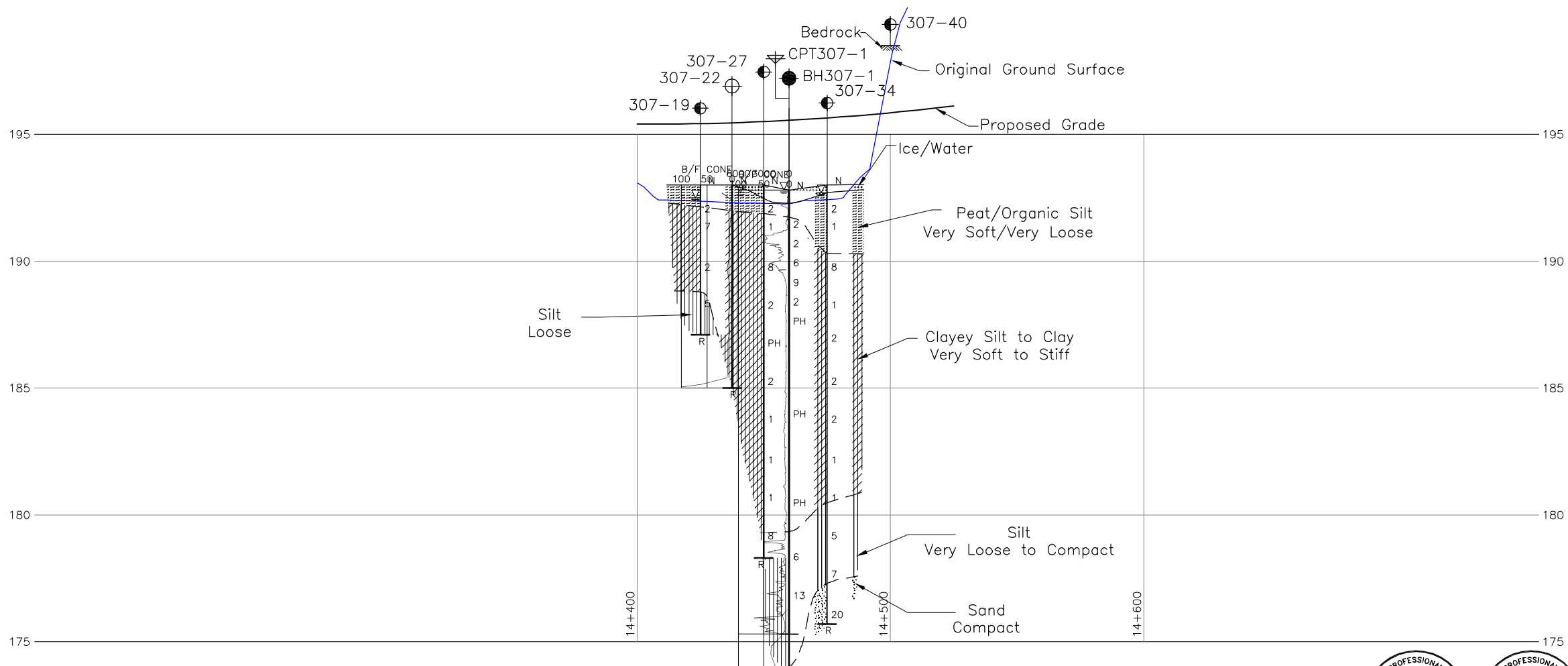
Qt normalized for  
unequal end area effects

$Su = (Qt - \sigma_v) / Nk$   
 $Nk = 15.5$   
 $\gamma = 15.5 \text{ kN/m}^3$

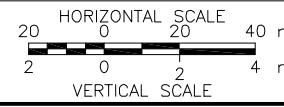
After Robertson and (Fear) Wride (1998)  
 $Ic < 1.31$  - Gravelly sands  
 $1.31 < Ic < 2.05$  - Clean to silty sand  
 $2.05 < Ic < 2.60$  - Silty sand to sandy silt  
 $2.60 < Ic < 2.95$  - Clayey silt to silty clay  
 $2.95 < Ic < 3.60$  - Clays



PLAN



A-A' CENTRELINE PROFILE



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

CONT No.  
GWP No. 5203-06-00

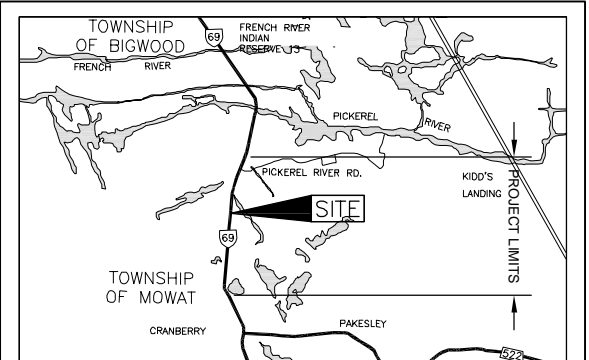


HIGHWAY 69 (SBL)  
STA 14+425 TO 14+500  
BOREHOLE LOCATION AND SOIL STRATA

SHEET



**Golder Associates Ltd.**  
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN

LEGEND

- Borehole – Current Investigation
- CPT – Current Investigation
- Borehole – Previous Investigation (Peto MacCallum Ltd.)
- Dynamic Cone Penetration Test – Previous Investigation (Peto MacCallum Ltd.)
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL observed during or upon completion of drilling
- R Refusal

| No.      | ELEVATION | CO-ORDINATES |          |
|----------|-----------|--------------|----------|
|          |           | NORTHING     | EASTING  |
| BH307-1  | 192.8     | 5090527.6    | 220909.4 |
| CPT307-1 | 192.8     | 5090525.9    | 220924.8 |
| CPT307-2 | 192.8     | 5090526.0    | 220923.8 |

NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

The boundaries between soil strata have been established only at borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

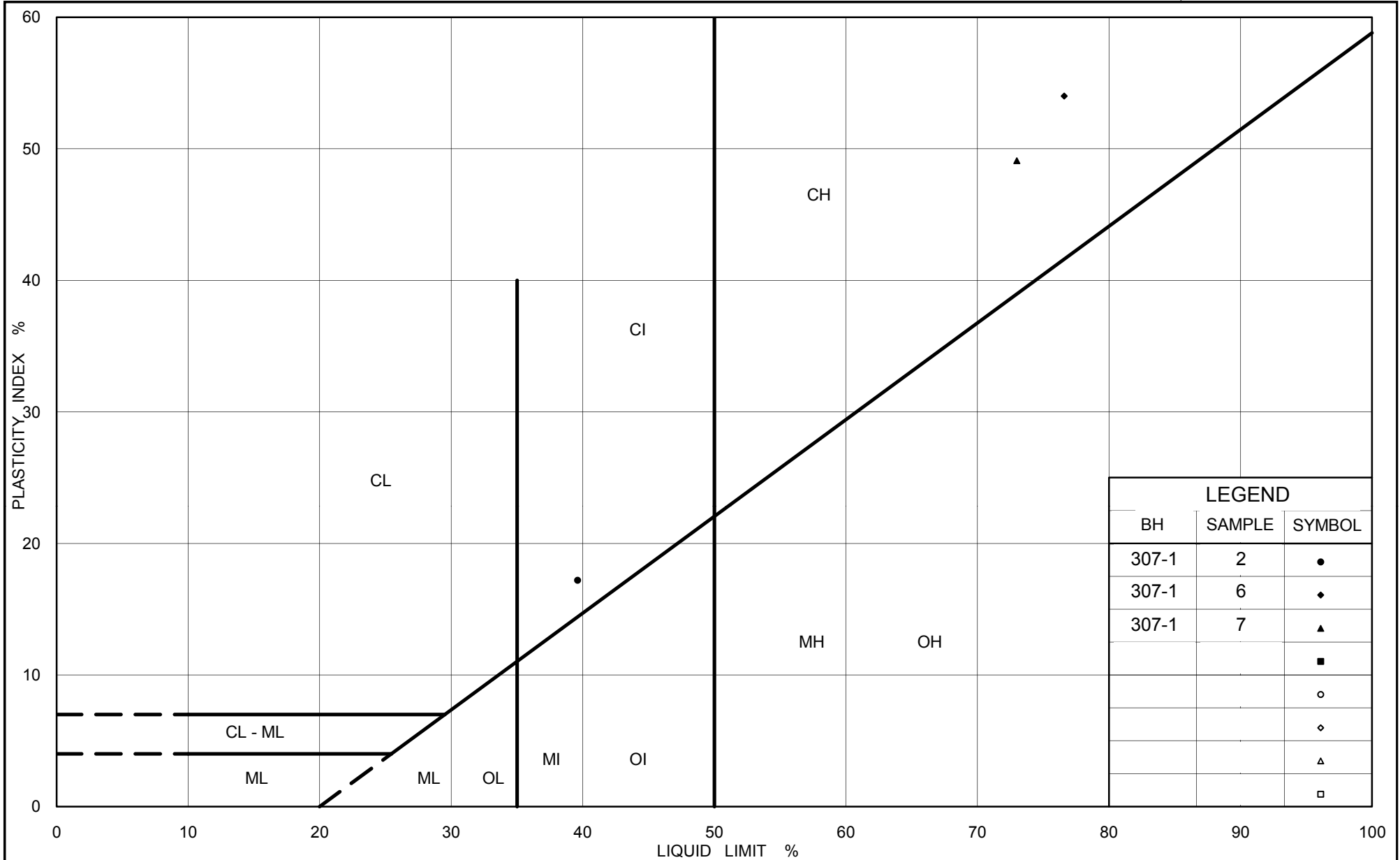
The complete foundation investigation and design report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS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

REFERENCE

Base plans and Profile provided in digital format by MRC, drawing file's no. PHASE 3 Plan 090211 - Golder.dwg, received February 11, 2009.  
1-6454\_ Phase3-ML PROFILE-Mar 26-09.dwg, received Sept. 30, 2009.



| NO.                 | DATE                    | BY              | REVISION |
|---------------------|-------------------------|-----------------|----------|
| Geocres No. 41H-106 |                         |                 |          |
| HWY. 69             | PROJECT NO. 06-1111-025 |                 | DIST.    |
| SUBM'D. MWK         | CHKD. MWK               | DATE: Feb. 2012 | SITE:    |
| DRAWN: RJ/JFC       | CHKD. VA                | APPD. JPD/JMAC  | DWG. D1  |



Ministry of Transportation

Ontario

**PLASTICITY CHART**  
 Clayey Silt to Clay  
 Highway 69 (SBL) STA 14+425 to 14+500

Figure No. D.S307-1

Project No. 06-1111-025

Checked By: TVA



**CONSOLIDATION TEST SUMMARY****Highway 69 (SBL) STA 14+425 to 14+500****FIGURE D.S307-2****Sheet 1 of 4****SAMPLE IDENTIFICATION**

|                 |             |                 |     |
|-----------------|-------------|-----------------|-----|
| Project Number  | 06-1111-025 | Sample Number   | 6   |
| Borehole Number | 307-1       | Sample Depth, m | 5.3 |

**TEST CONDITIONS**

|                  |            |                   |    |
|------------------|------------|-------------------|----|
| Test Type        | Standard   | Load Duration, hr | 24 |
| Oedometer Number | 3          |                   |    |
| Date Started     | 06/02/2009 |                   |    |
| Date Completed   | 06/27/2009 |                   |    |

**SAMPLE DIMENSIONS AND PROPERTIES - INITIAL**

|                         |        |                                    |       |
|-------------------------|--------|------------------------------------|-------|
| Sample Height, cm       | 2.54   | Unit Weight, kN/m <sup>3</sup>     | 14.92 |
| Sample Diameter, cm     | 6.35   | Dry Unit Weight, kN/m <sup>3</sup> | 8.35  |
| Area, cm <sup>2</sup>   | 31.62  | Specific Gravity, measured         | 2.71  |
| Volume, cm <sup>3</sup> | 80.28  | Solids Height, cm                  | 0.797 |
| Water Content, %        | 78.83  | Volume of Solids, cm <sup>3</sup>  | 25.21 |
| Wet Mass, g             | 122.18 | Volume of Voids, cm <sup>3</sup>   | 55.07 |
| Dry Mass, g             | 68.32  | Degree of Saturation, %            | 97.8  |

**TEST COMPUTATIONS**

| Pressure<br>kPa | Corr.<br>Height<br>cm | Void<br>Ratio | Average<br>Height<br>cm | t <sub>90</sub><br>sec | cv.<br>cm <sup>2</sup> /s | mv<br>m <sup>2</sup> /kN | k<br>cm/s |
|-----------------|-----------------------|---------------|-------------------------|------------------------|---------------------------|--------------------------|-----------|
| 0.00            | 2.539                 | 2.184         | 2.539                   |                        |                           |                          |           |
| 4.70            | 2.531                 | 2.174         | 2.535                   | 2                      | 6.81E-01                  | 7.12E-04                 | 4.75E-05  |
| 9.55            | 2.526                 | 2.168         | 2.528                   | 4                      | 3.39E-01                  | 4.06E-04                 | 1.35E-05  |
| 19.44           | 2.516                 | 2.155         | 2.521                   | 11                     | 1.22E-01                  | 3.98E-04                 | 4.78E-06  |
| 38.75           | 2.495                 | 2.129         | 2.505                   | 9                      | 1.48E-01                  | 4.20E-04                 | 6.09E-06  |
| 77.50           | 2.455                 | 2.079         | 2.475                   | 34                     | 3.82E-02                  | 4.06E-04                 | 1.52E-06  |
| 154.93          | 2.252                 | 1.824         | 2.353                   | 19                     | 6.18E-02                  | 1.03E-03                 | 6.26E-06  |
| 309.82          | 1.895                 | 1.376         | 2.073                   | 371                    | 2.46E-03                  | 9.09E-04                 | 2.19E-07  |
| 620.03          | 1.677                 | 1.103         | 1.786                   | 315                    | 2.15E-03                  | 2.77E-04                 | 5.82E-08  |
| 1239.80         | 1.508                 | 0.891         | 1.592                   | 240                    | 2.24E-03                  | 1.08E-04                 | 2.36E-08  |
| 2478.18         | 1.375                 | 0.724         | 1.441                   | 93                     | 4.73E-03                  | 4.23E-05                 | 1.96E-08  |
| 1239.80         | 1.383                 | 0.734         | 1.379                   |                        |                           |                          |           |
| 309.82          | 1.430                 | 0.794         | 1.406                   |                        |                           |                          |           |
| 77.50           | 1.487                 | 0.865         | 1.458                   |                        |                           |                          |           |
| 19.44           | 1.533                 | 0.923         | 1.510                   |                        |                           |                          |           |
| 4.70            | 1.561                 | 0.958         | 1.547                   |                        |                           |                          |           |

Note:

k calculated using cv based on t<sub>90</sub> values.**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

|                         |       |                                    |       |
|-------------------------|-------|------------------------------------|-------|
| Sample Height, cm       | 1.56  | Unit Weight, kN/m <sup>3</sup>     | 18.80 |
| Sample Diameter, cm     | 6.35  | Dry Unit Weight, kN/m <sup>3</sup> | 13.57 |
| Area, cm <sup>2</sup>   | 31.62 | Specific Gravity, measured         | 2.71  |
| Volume, cm <sup>3</sup> | 49.37 | Solids Height, cm                  | 0.797 |
| Water Content, %        | 38.57 | Volume of Solids, cm <sup>3</sup>  | 25.21 |
| Wet Mass, g             | 94.67 | Volume of Voids, cm <sup>3</sup>   | 24.16 |
| Dry Mass, g             | 68.32 |                                    |       |

Prepared By: LH

**Golder Associates**

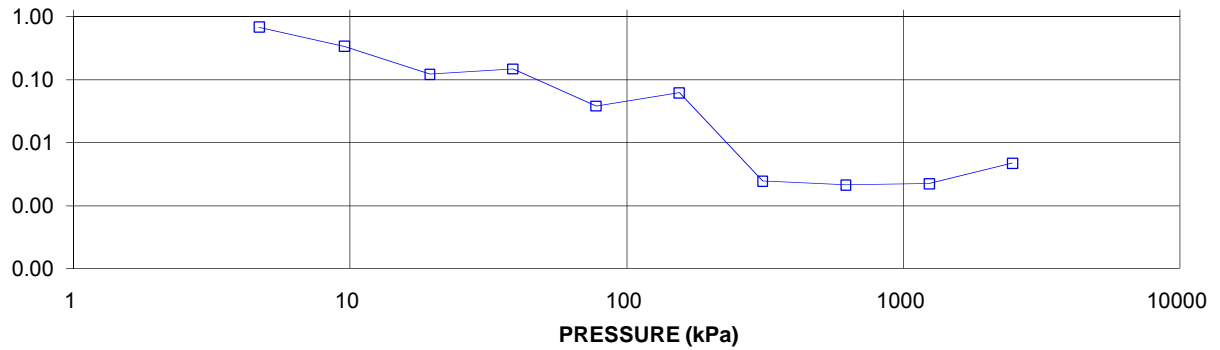
Checked By: MM

**CONSOLIDATION TEST SUMMARY**  
**Highway 69 (SBL) STA 14+425 to 14+500**

**FIGURE D.S307-2**  
**Sheet 2 of 4**

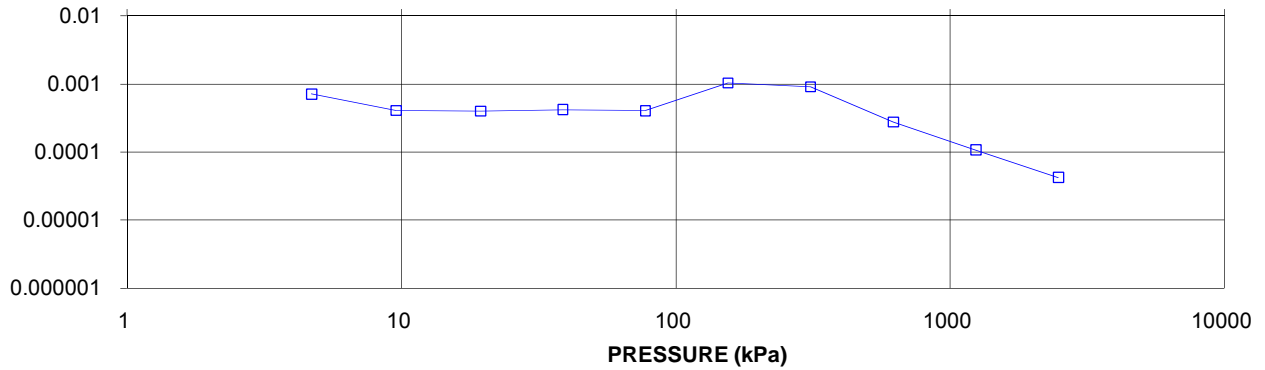
COEFFICIENT OF CONSOLIDATION,  
 $\text{cm}^2/\text{s}$

**CONSOLIDATION TEST**  
**CV  $\text{cm}^2/\text{s}$  VS PRESSURE (kPa)**  
**BH 307-1 SA 6**



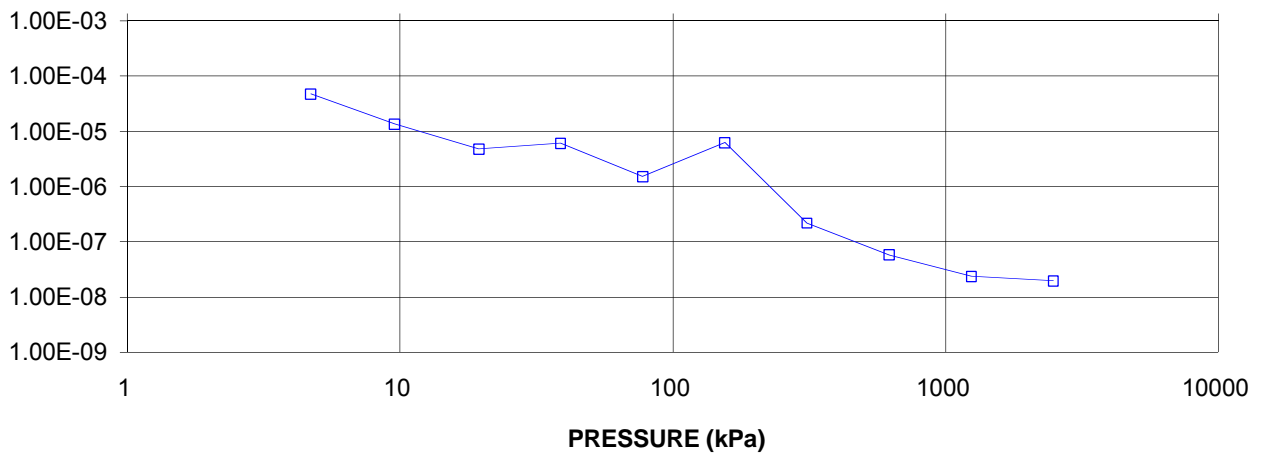
VOLUME COMPRESSIBILITY,  $\text{m}^2/\text{kN}$

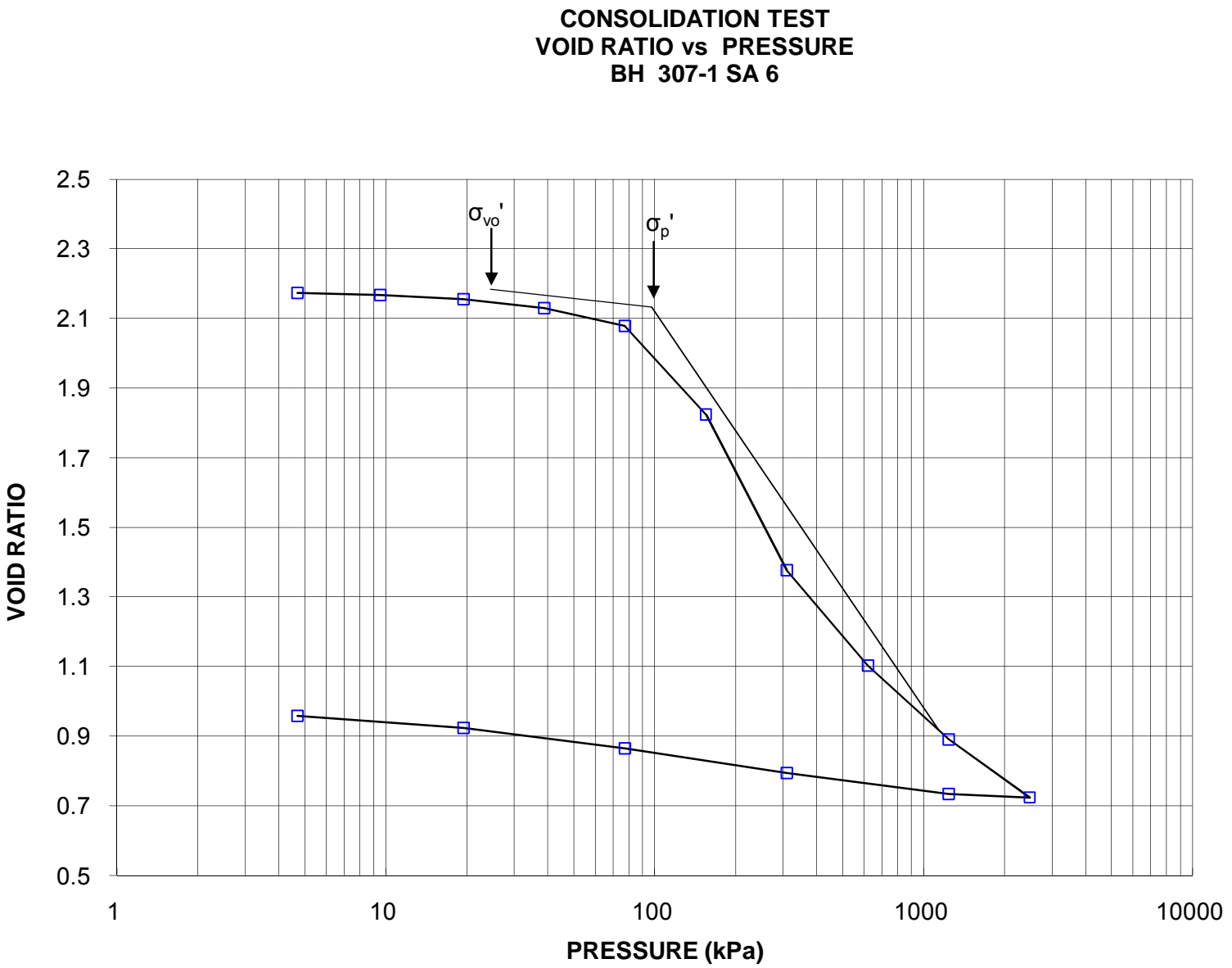
**CONSOLIDATION TEST**  
**MV  $\text{m}^2/\text{kN}$  vs PRESSURE (kPa)**  
**BH 307-1 SA 6**

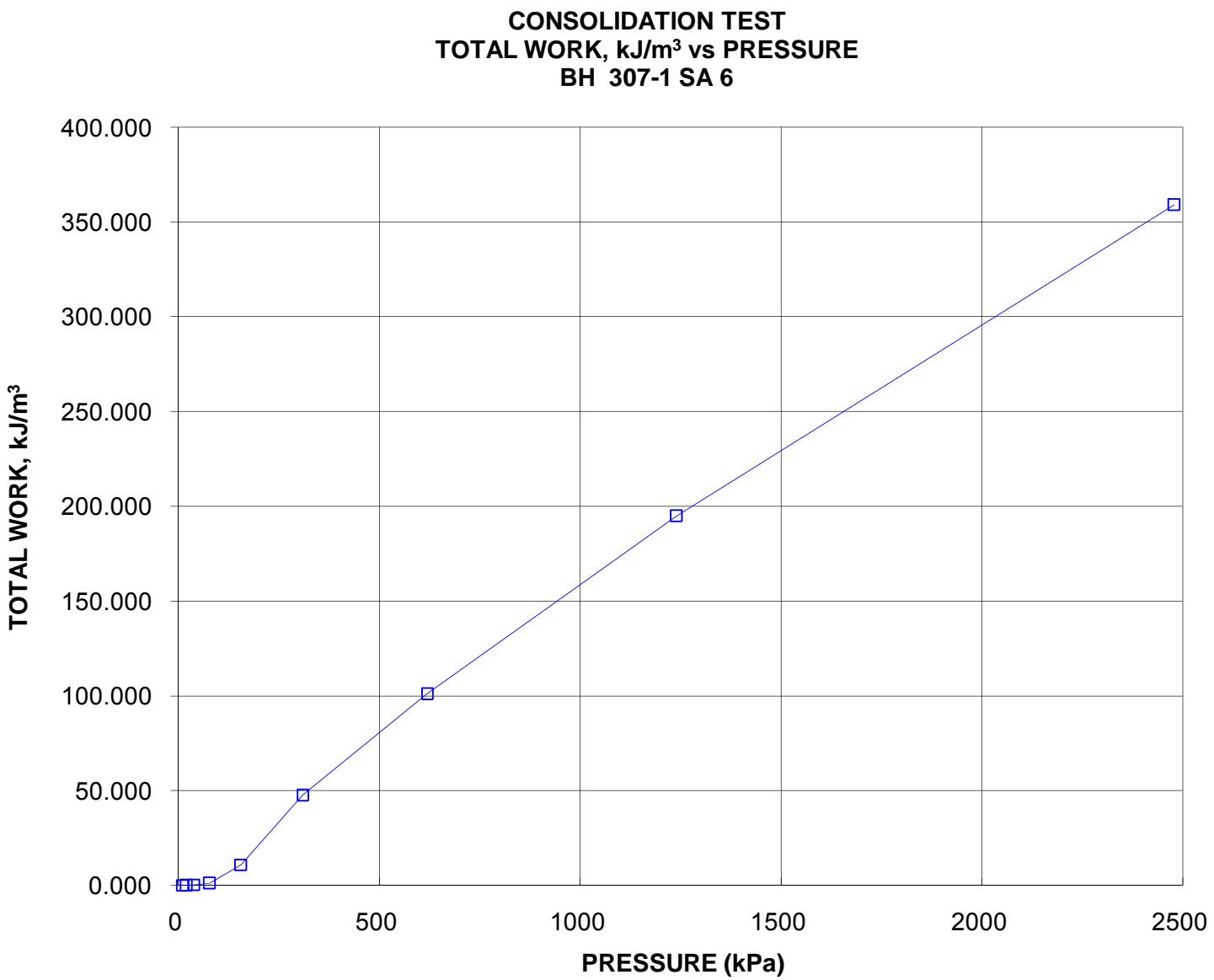


HYDRAULIC CONDUCTIVITY,  $\text{cm}/\text{s}$

**CONSOLIDATION TEST**  
**HYDRAULIC CONDUCTIVITY vs PRESSURE**  
**BH 307-1 SA 6**







**CONSOLIDATION TEST SUMMARY****Highway 69 (SBL) STA 14+425 to 14+500****FIGURE D.S307-3****Sheet 1 of 4****SAMPLE IDENTIFICATION**

|                 |             |                 |     |
|-----------------|-------------|-----------------|-----|
| Project Number  | 06-1111-025 | Sample Number   | 7   |
| Borehole Number | 307-1       | Sample Depth, m | 8.9 |

**TEST CONDITIONS**

|                  |            |                   |    |
|------------------|------------|-------------------|----|
| Test Type        | Standard   | Load Duration, hr | 24 |
| Oedometer Number | 6          |                   |    |
| Date Started     | 06/17/2009 |                   |    |
| Date Completed   | 07/07/2009 |                   |    |

**SAMPLE DIMENSIONS AND PROPERTIES - INITIAL**

|                         |       |                                    |       |
|-------------------------|-------|------------------------------------|-------|
| Sample Height, cm       | 1.90  | Unit Weight, kN/m <sup>3</sup>     | 15.21 |
| Sample Diameter, cm     | 6.34  | Dry Unit Weight, kN/m <sup>3</sup> | 9.24  |
| Area, cm <sup>2</sup>   | 31.57 | Specific Gravity, measured         | 2.76  |
| Volume, cm <sup>3</sup> | 59.86 | Solids Height, cm                  | 0.647 |
| Water Content, %        | 64.60 | Volume of Solids, cm <sup>3</sup>  | 20.43 |
| Wet Mass, g             | 92.82 | Volume of Voids, cm <sup>3</sup>   | 39.42 |
| Dry Mass, g             | 56.39 | Degree of Saturation, %            | 92.4  |

**TEST COMPUTATIONS**

| Pressure<br>kPa | Corr.<br>Height<br>cm | Void<br>Ratio | Average<br>Height<br>cm | t <sub>90</sub><br>sec | cv.<br>cm <sup>2</sup> /s | mv<br>m <sup>2</sup> /kN | k<br>cm/s |
|-----------------|-----------------------|---------------|-------------------------|------------------------|---------------------------|--------------------------|-----------|
| 0.00            | 1.896                 | 1.930         | 1.896                   |                        |                           |                          |           |
| 4.74            | 1.891                 | 1.922         | 1.894                   | 1                      | 7.60E-01                  | 5.45E-04                 | 4.06E-05  |
| 9.53            | 1.886                 | 1.915         | 1.889                   | 8                      | 9.45E-02                  | 5.18E-04                 | 4.79E-06  |
| 19.31           | 1.877                 | 1.900         | 1.882                   | 7                      | 1.07E-01                  | 5.02E-04                 | 5.27E-06  |
| 38.80           | 1.860                 | 1.874         | 1.869                   | 8                      | 9.25E-02                  | 4.55E-04                 | 4.12E-06  |
| 77.62           | 1.802                 | 1.784         | 1.831                   | 5                      | 1.42E-01                  | 7.98E-04                 | 1.11E-05  |
| 155.17          | 1.622                 | 1.507         | 1.712                   | 7                      | 8.88E-02                  | 1.22E-03                 | 1.06E-05  |
| 310.23          | 1.413                 | 1.183         | 1.518                   | 19                     | 2.57E-02                  | 7.13E-04                 | 1.80E-06  |
| 620.78          | 1.266                 | 0.955         | 1.339                   | 49                     | 7.76E-03                  | 2.50E-04                 | 1.90E-07  |
| 1241.11         | 1.153                 | 0.781         | 1.209                   | 32                     | 9.69E-03                  | 9.57E-05                 | 9.09E-08  |
| 2481.69         | 1.063                 | 0.642         | 1.108                   | 25                     | 1.04E-02                  | 3.83E-05                 | 3.90E-08  |
| 1241.11         | 1.077                 | 0.664         | 1.070                   |                        |                           |                          |           |
| 310.23          | 1.103                 | 0.704         | 1.090                   |                        |                           |                          |           |
| 77.62           | 1.140                 | 0.762         | 1.122                   |                        |                           |                          |           |
| 19.31           | 1.178                 | 0.820         | 1.159                   |                        |                           |                          |           |
| 4.84            | 1.202                 | 0.857         | 1.190                   |                        |                           |                          |           |

Note:

k calculated using cv based on t<sub>90</sub> values.**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

|                         |       |                                    |       |
|-------------------------|-------|------------------------------------|-------|
| Sample Height, cm       | 1.20  | Unit Weight, kN/m <sup>3</sup>     | 19.61 |
| Sample Diameter, cm     | 6.34  | Dry Unit Weight, kN/m <sup>3</sup> | 14.58 |
| Area, cm <sup>2</sup>   | 31.57 | Specific Gravity, measured         | 2.76  |
| Volume, cm <sup>3</sup> | 37.93 | Solids Height, cm                  | 0.647 |
| Water Content, %        | 34.49 | Volume of Solids, cm <sup>3</sup>  | 20.43 |
| Wet Mass, g             | 75.84 | Volume of Voids, cm <sup>3</sup>   | 17.50 |
| Dry Mass, g             | 56.39 |                                    |       |

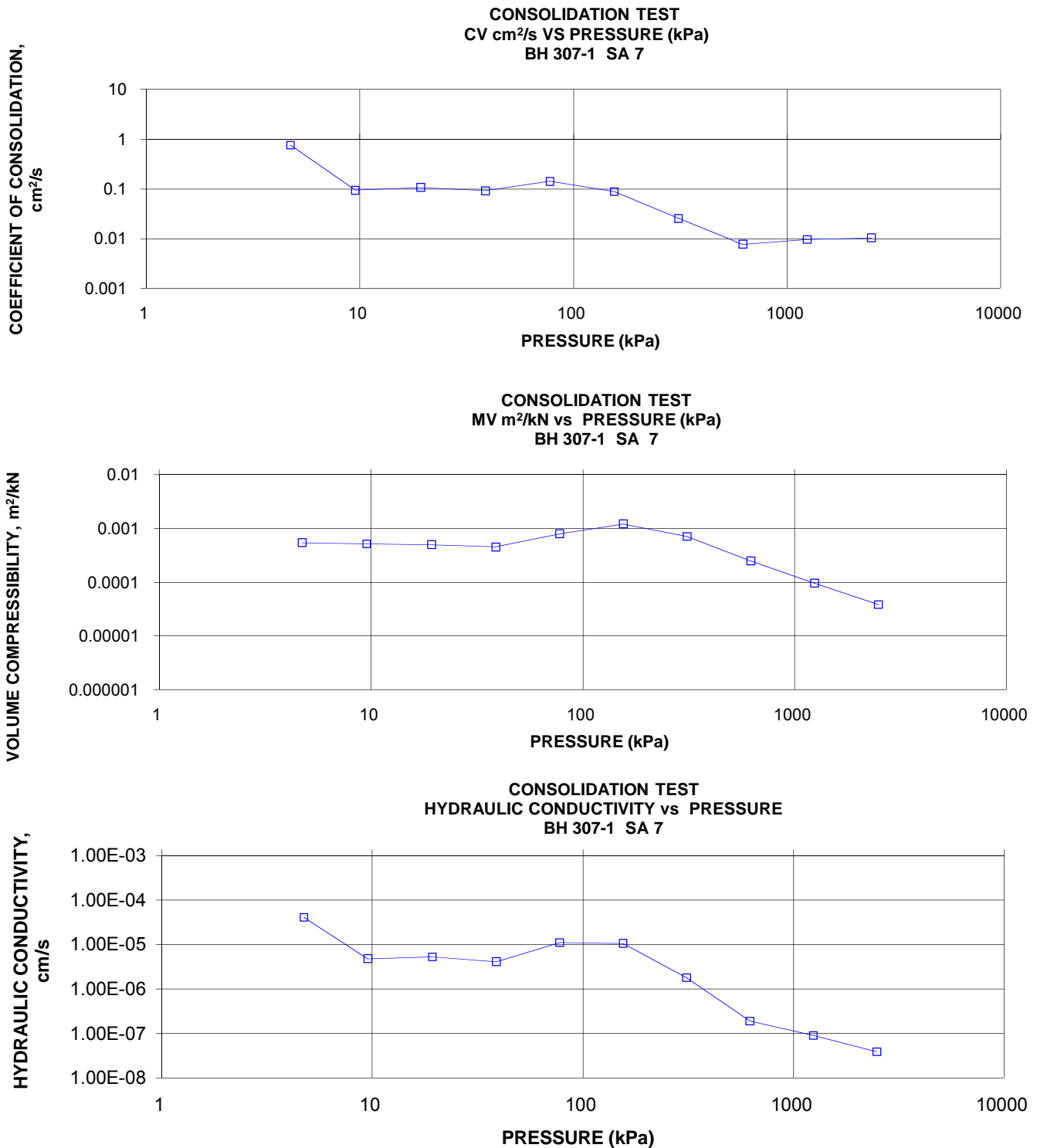
Prepared By: LH

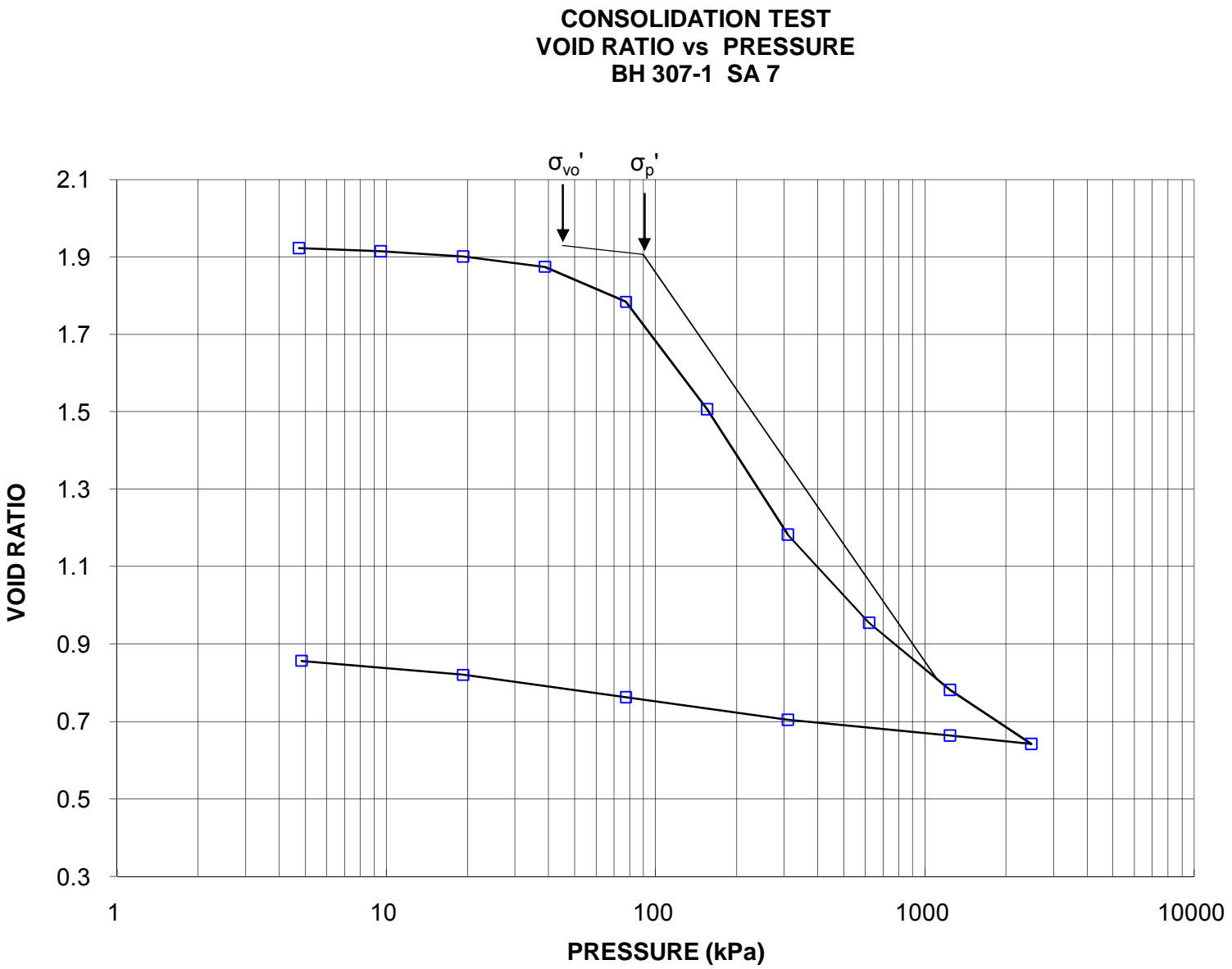
**Golder Associates**

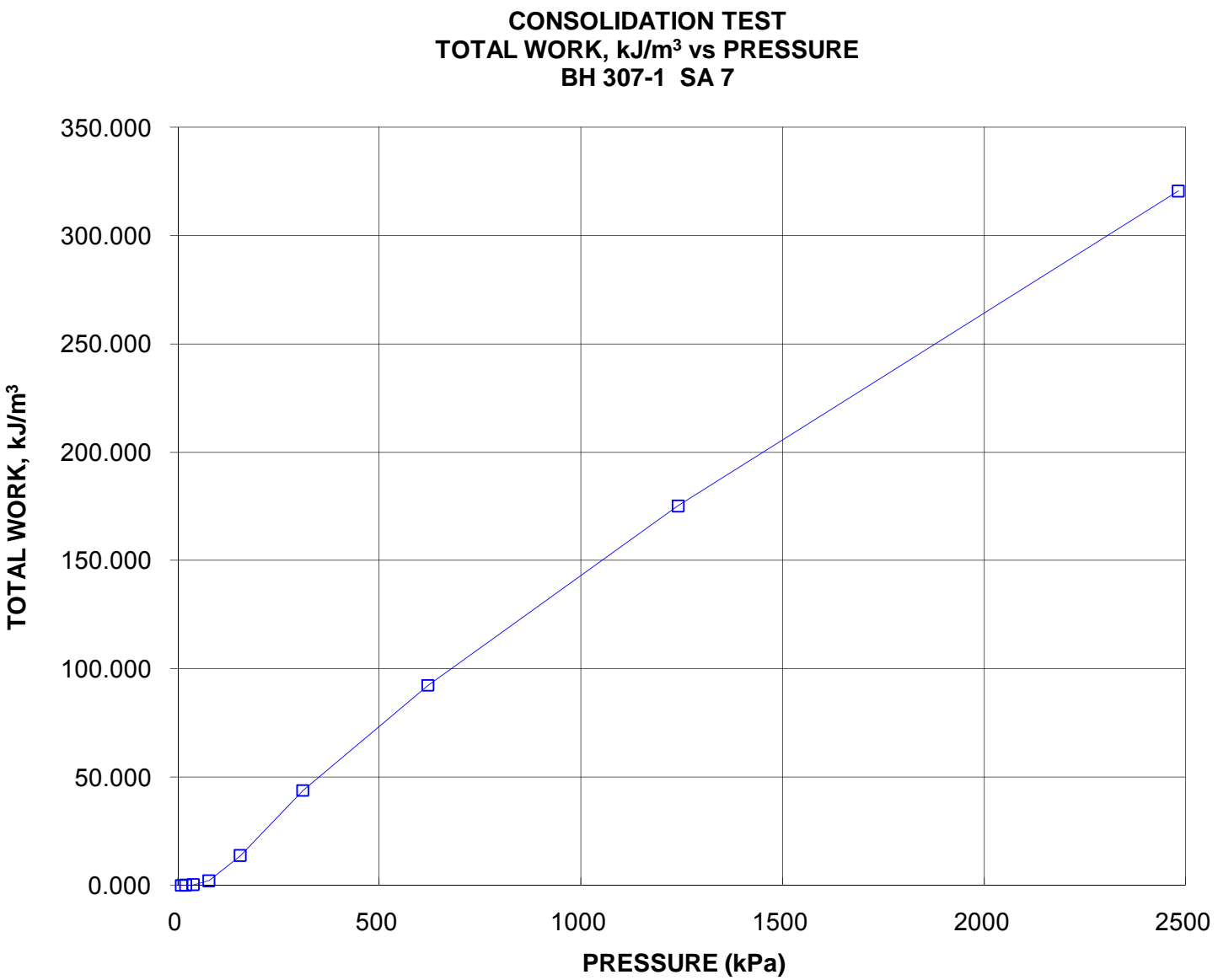
Checked By: MM

**CONSOLIDATION TEST SUMMARY**  
**Highway 69 (SBL) STA 14+425 to 14+500**

**FIGURE D.S307-3**  
**Sheet 2 of 4**







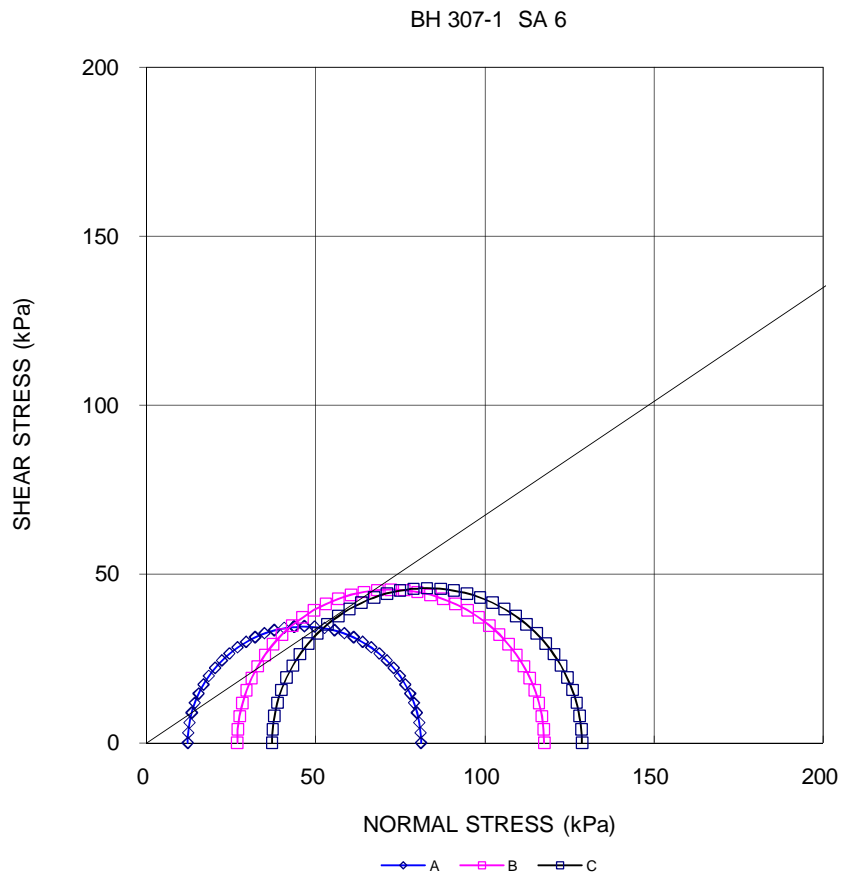


| CONSOLIDATED UNDRAINED TRIAXIAL<br>WITH PORE PRESSURE MEASUREMENTS  |       |       | FIGURE D.S307-4<br>Sheet 1 of 4 |
|---|-------|-------|---------------------------------|
| TEST STAGE  | A     | B     | C                               |
| BOREHOLE NUMBER   | 307-1 | 307-1 | 307-1                           |
| SAMPLE  | 6     | 6     | 6                               |
| SPECIMEN DIAMETER, cm   | 5.05  | 5.01  | 5.03                            |
| SPECIMEN HEIGHT, cm   | 10.16 | 10.17 | 10.15                           |
| WATER CONTENT BEFORE CONSOLIDATION, %   | 76.5  | 77.6  | 76.7                            |
| CELL PRESSURE, $\sigma_3$ , kPa   | 450.0 | 560.0 | 595.0                           |
| BACK PRESSURE, kPa  | 415.0 | 485.0 | 485.0                           |
| PORE PRESSURE PARAMETER "B"   | 0.98  | 0.97  | 0.96                            |
| CONSOLIDATION PRESSURE, $\sigma_c$ , kPa  | 35.0  | 75.0  | 110.0                           |
| VOLUMETRIC STRAIN DURING CONSOLIDATION, %   | 1.6   | 2.5   | 11.9                            |
| WATER CONTENT AFTER CONSOLIDATION, %  | 74.7  | 74.7  | 63.3                            |
| AVERAGE RATE OF STRAIN, %/hr  | 0.5   | 0.5   | 0.5                             |
| TIME TO FAILURE, DAYS   | 2     | 2     | 2                               |
| WATER CONTENT AFTER TEST, %   | 75.8  | 76.2  | 69.4                            |
| MAX. DEVIATOR STRESS, $(\sigma_1 - \sigma_3)$ , kPa   | 69.0  | 90.8  | 91.6                            |
| AXIAL STRAIN AT $(\sigma_1 - \sigma_3)$ MAXIMUM, %  | 1.2   | 1.3   | 4.1                             |
| MAX EFFECTIVE PRINCIPAL STRESS<br>RATIO, $(\sigma_1 / \sigma_3)$ MAXIMUM  | 6.7   | 5.9   | 4.1                             |
| DEVIATOR STRESS AT $(\sigma_1 / \sigma_3)$ MAXIMUM, kPa   | 69.0  | 81.8  | 80.1                            |
| AXIAL STRAIN AT $(\sigma_1 / \sigma_3)$ MAXIMUM, %  | 1.2   | 3.1   | 10.4                            |
| PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 - \sigma_3)$ MAXIMUM   | 0.33  | 0.53  | 0.80                            |
| PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 / \sigma_3)$ MAXIMUM   | 0.33  | 0.71  | 1.05                            |
| NATURAL WATER CONTENT, %  | 73.2  | 75.3  | 73.8                            |
| DRY DENSITY, Mg/m <sup>3</sup>  | 0.90  | 0.88  | 0.89                            |
| FILTER DRAINS USED, y/n   | y     | y     | y                               |
| TEST NOTES:   |       |       |                                 |
| CHANGED RATE OF STRAIN, %/hr  | -     | -     | -                               |
| AXIAL STRAIN WHERE RATE OF STRAIN WAS CHANGED, %  | -     | -     | -                               |
| FAILURE PLANE NUMBER  | 1.0   | 1.0   | -                               |
| ANGLE OF FAILURE, DEGREES   | 55.0  | 60.0  | bulged                          |
| <div> <div>Date: 06/17/2009</div> <div>Project No. 06-1111-025</div> <div>Golder Associates</div> <div>Prepared By: MM</div> <div>Checked By: RO</div> </div> |       |       |                                 |

**CONSOLIDATED UNDRAINED TRIAXIAL  
WITH PORE PRESSURE MEASUREMENTS**

**FIGURE D.S307-4**

**Sheet 2 of 4**



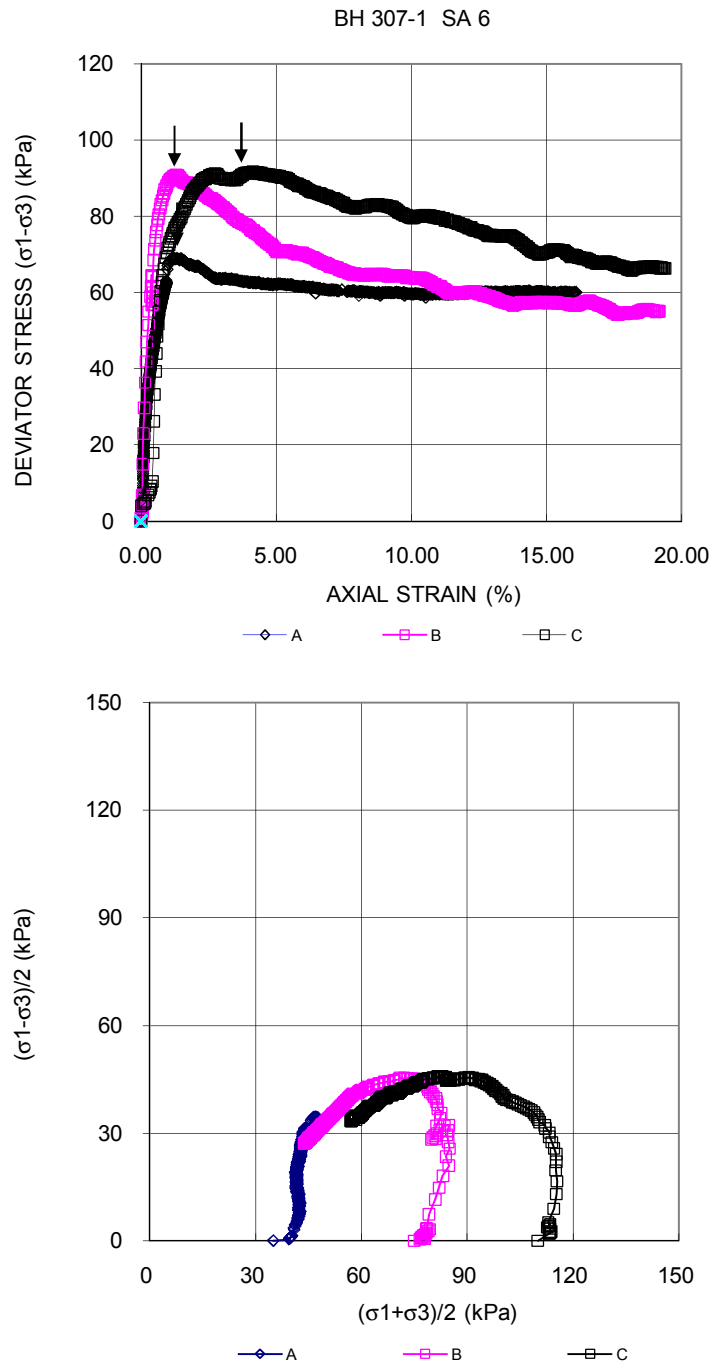
Date: 06/17/2009  
Project No. 06-1111-025

**Golder Associates**

Prepared By: MM  
Checked By: RO

**CONSOLIDATED UNDRAINED TRIAXIAL  
WITH PORE PRESSURE MEASUREMENTS**

**FIGURE D.S307-4**  
**Sheet 3 of 4**



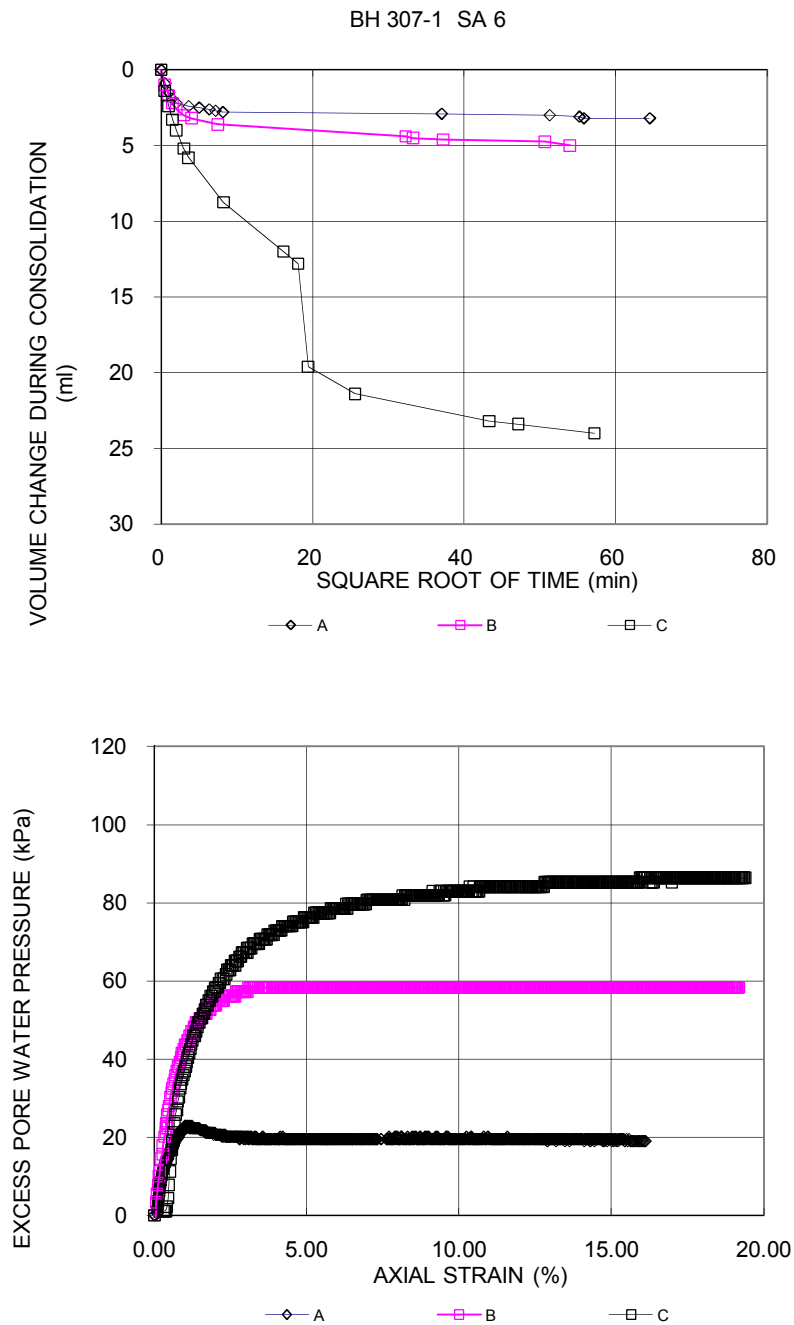
Date: 06/17/2009  
Project No. 06-1111-025

**Golder Associates**

Prepared By: MM  
Checked By: RO

**CONSOLIDATED UNDRAINED TRIAXIAL  
WITH PORE PRESSURE MEASUREMENTS**

**FIGURE D.S307-4**  
**Sheet 4 of 4**

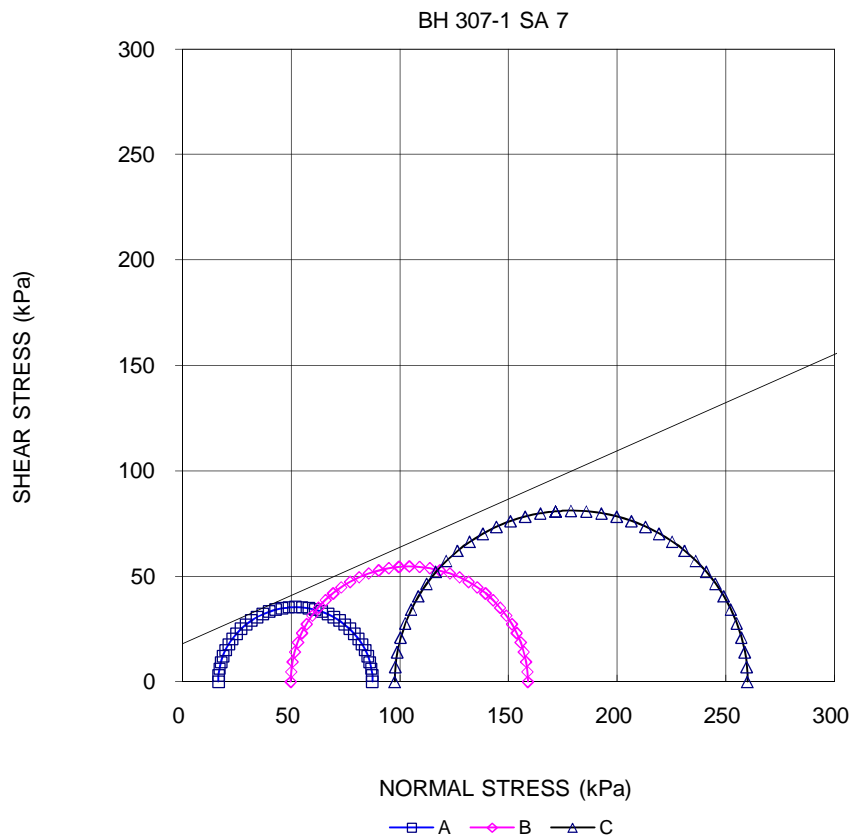


Date: 06/17/2009  
Project No. 06-1111-025

**Golder Associates**

Prepared By: MM  
Checked By: RO

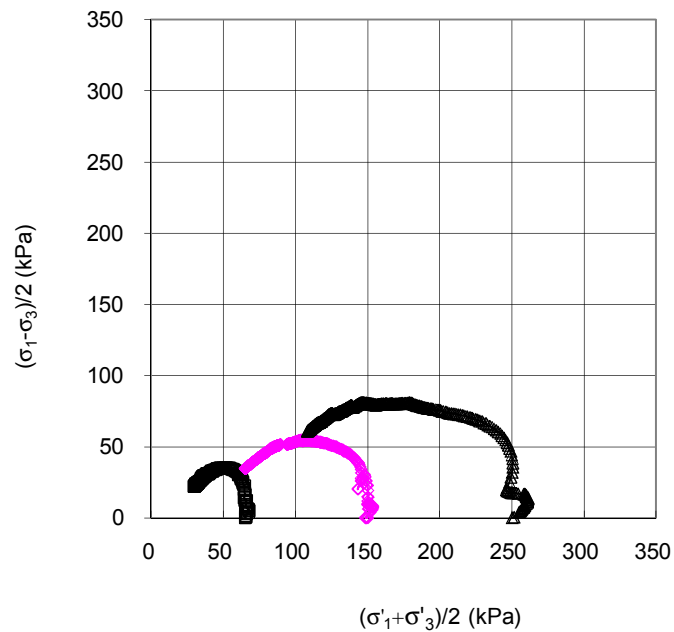
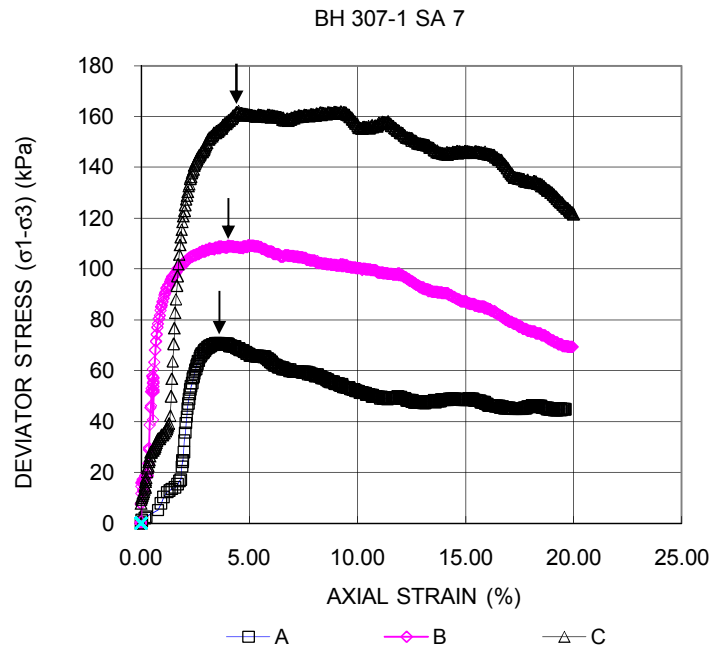
| CONSOLIDATED UNDRAINED TRIAXIAL<br>WITH PORE PRESSURE MEASUREMENTS  |                 |                 | FIGURE D.S307-5<br>Sheet 1 of 4 |
|---|-----------------|-----------------|---------------------------------|
| TEST STAGE  | A               | B               | C                               |
| BOREHOLE NUMBER   | 307-1           | 307-1           | 307-1                           |
| SAMPLE  | 7               | 7               | 7                               |
| SPECIMEN DIAMETER, cm   | 5.00            | 5.02            | 5.03                            |
| SPECIMEN HEIGHT, cm   | 10.15           | 10.10           | 10.05                           |
| WATER CONTENT BEFORE CONSOLIDATION, %   | 75.5            | 81.1            | 71.5                            |
| CELL PRESSURE, $\sigma_3$ , kPa   | 550.0           | 565.0           | 385.0                           |
| BACK PRESSURE, kPa  | 485.0           | 415.0           | 135.0                           |
| PORE PRESSURE PARAMETER "B"   | 0.92            | 0.96            | 0.96                            |
| CONSOLIDATION PRESSURE, $\sigma_c$ , kPa  | 65.0            | 150.0           | 250.0                           |
| VOLUMETRIC STRAIN DURING CONSOLIDATION, %   | 2.5             | 12.8            | 28.6                            |
| WATER CONTENT AFTER CONSOLIDATION, %  | 72.7            | 66.5            | 40.5                            |
| AVERAGE RATE OF STRAIN, %/hr  | 0.5             | 0.5             | 0.5                             |
| TIME TO FAILURE, DAYS   | 2               | 2               | 2                               |
| WATER CONTENT AFTER TEST, %   | 71.5            | 63.7            | 49.9                            |
| MAX. DEVIATOR STRESS, $(\sigma_1 - \sigma_3)$ , kPa   | 70.8            | 109.2           | 162.3                           |
| AXIAL STRAIN AT $(\sigma_1 - \sigma_3)$ MAXIMUM, %  | 3.4             | 5.0             | 4.5                             |
| MAX EFFECTIVE PRINCIPAL STRESS<br>RATIO, $(\sigma_1 / \sigma_3)$ MAXIMUM  | 10.2            | 3.9             | 3.9                             |
| DEVIATOR STRESS AT $(\sigma_1 / \sigma_3)$ MAXIMUM, kPa   | 59.4            | 98.2            | 145.8                           |
| AXIAL STRAIN AT $(\sigma_1 / \sigma_3)$ MAXIMUM, %  | 7.6             | 11.9            | 15.7                            |
| PORE PRESSURE PARAMETER, Af, at $(\sigma_1 - \sigma_3)$ MAXIMUM   | 0.68            | 0.92            | 0.94                            |
| PORE PRESSURE PARAMETER, Af, at $(\sigma_1 / \sigma_3)$ MAXIMUM   | 0.99            | 1.18            | 1.36                            |
| NATURAL WATER CONTENT, %  | 71.4            | 76.2            | 70.2                            |
| DRY DENSITY, Mg/m <sup>3</sup>  | 0.91            | 0.88            | 0.93                            |
| FILTER DRAINS USED, y/n   | y               | y               | y                               |
| TEST NOTES:   |                 |                 |                                 |
| CHANGED RATE OF STRAIN, %/hr  | -               | -               | -                               |
| AXIAL STRAIN WHERE RATE OF STRAIN WAS CHANGED, %  | -               | -               | -                               |
| FAILURE PLANE NUMBER  | 1.0             | 1.0             | 1.0                             |
| ANGLE OF FAILURE, DEGREES   | 70 <sup>0</sup> | 65 <sup>0</sup> | 70 <sup>0</sup>                 |
| <div> <div>Date: 07/13/2009</div> <div>Project No. 06-1111-025</div> </div> <div> <b>Golder Associates</b> </div> <div> <div>Prepared By: LH</div> <div>Checked By: MM</div> </div> |                 |                 |                                 |



Date: 07/13/2009  
Project No. 06-1111-025

**Golder Associates**

Prepared By: LH  
Checked By: MM



Date: 07/13/2009  
Project No. 06-1111-025

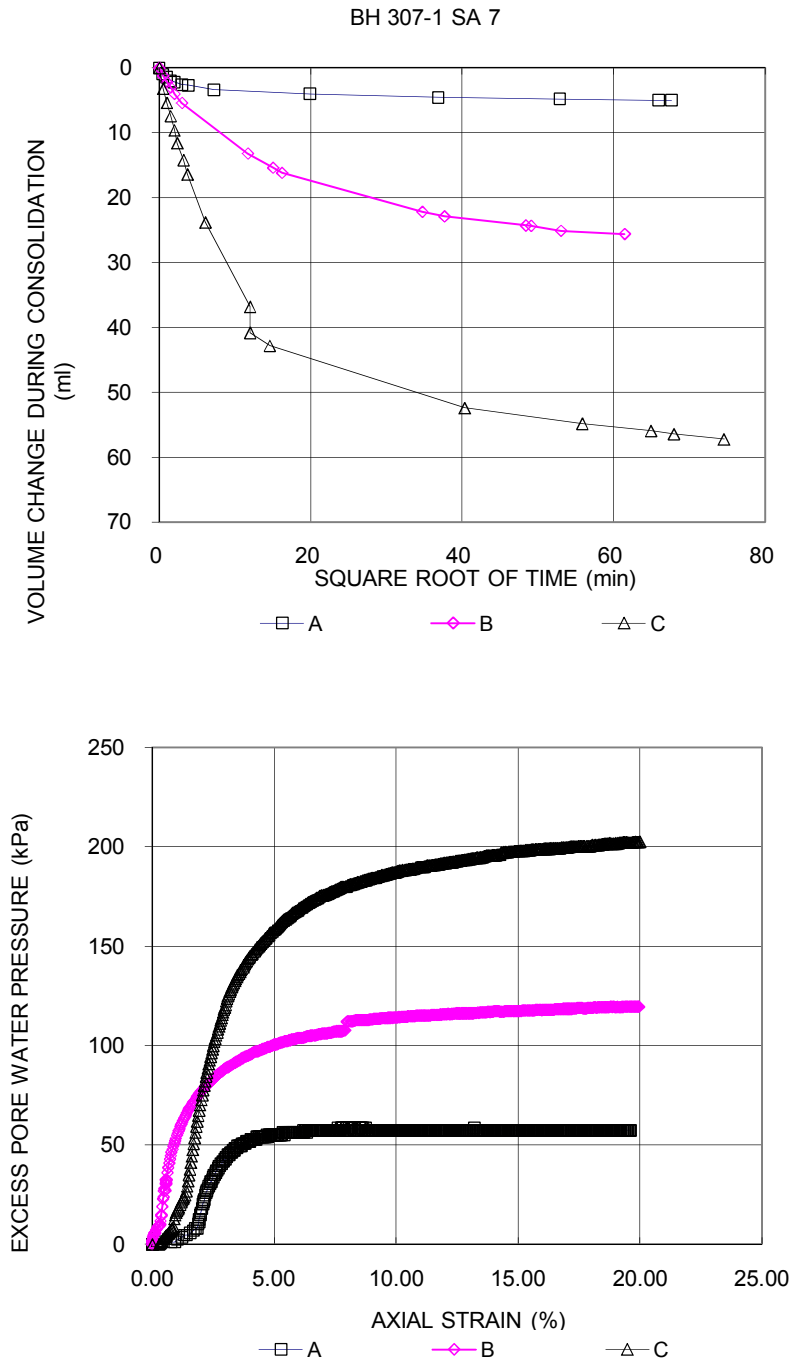
**Golder Associates**

Prepared By: LH  
Checked By: MM

**CONSOLIDATED UNDRAINED TRIAXIAL  
WITH PORE PRESSURE MEASUREMENTS**

**FIGURE D.S307-5**

**Sheet 4 of 4**



Date: 07/13/2009  
Project No. 06-1111-025

**Golder Associates**

Prepared By: LH  
Checked By: MM

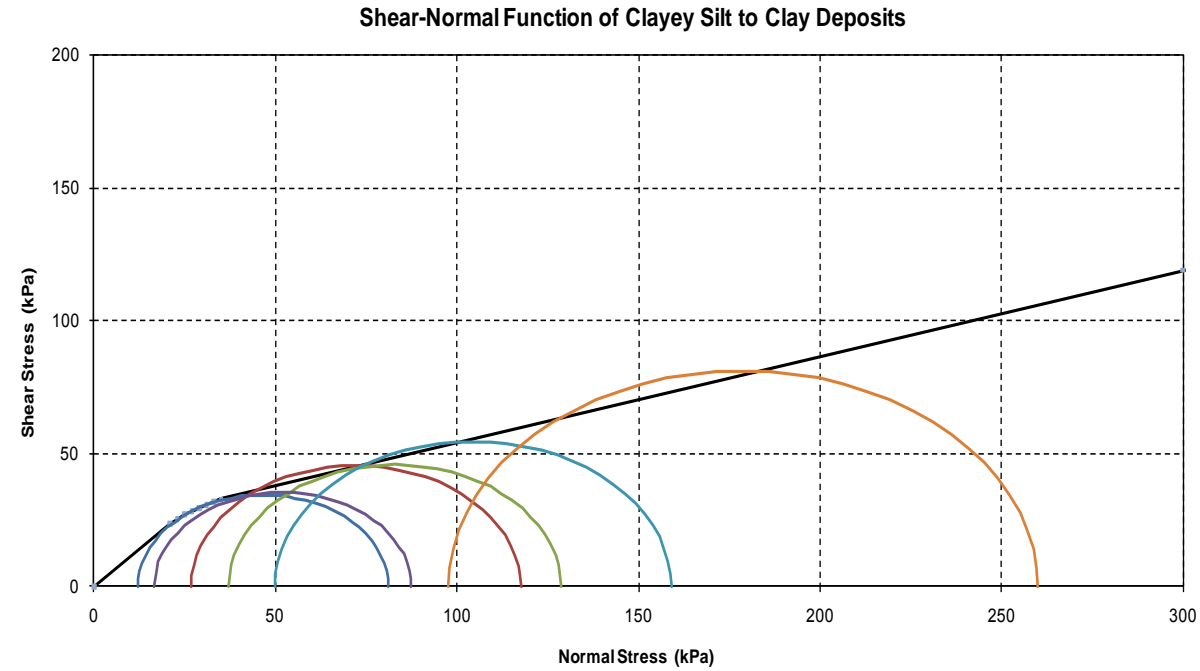




TABLE D1 – SUMMARY OF FOUNDATION ENGINEERING PARAMETERS  
HIGHWAY 69 FOUR-LANING – PHASE 3

| Swamp Crossing   | Stratigraphic Unit  | Top Elevation<br>(m) | Thickness<br>(m) | $\gamma'$<br>(kN/m <sup>3</sup> ) | $\phi'$<br>(°)  | $c'$<br>(kPa)  | $s_u$<br>(kPa) | $\sigma_p'$<br>(kPa) | $e_o$      | $C_c$     | $C_r$       | $E'$<br>(MPa) | $C_{\alpha(\epsilon)}$ |     | $c_h$<br>(cm <sup>2</sup> /s) |
|--|---------------------|----------------------|------------------|-----------------------------------|-----------------|----------------|----------------|----------------------|------------|-----------|-------------|---------------|------------------------|-----|-------------------------------|
|  |                     |                      |                  |                                   |                 |                |                |                      |            |           |             |               | N/C                    | O/C |                               |
| Swamp 307 SBL<br>Highway 69 SBL - STA 14+425 to 14+500 | Sand Blanket        | 193.4 - 193          | 2 – 2.7          | 18.5                              | 32              | 0              | --             | --                   | --         | --        | --          | 30            | --                     | --  | --                            |
|  | Peat / Root Mat     | 193.4 – 191.9        | 0.1 – 2.4        | 12                                | 27              | 1              | --             | --                   | --         | --        | --          | --            | --                     | --  | --                            |
|  | Silt (Upper)        | 193.3 – 191.0        | 1.5 – 4.4        | 18                                | 28              | 0              | --             | --                   | --         | --        | --          | --            | --                     | --  | --                            |
|  | Clayey Silt to Clay | 192.0 – 182.3        | 1.9 – 9.6        | 15.5                              | 25 <sup>1</sup> | 5 <sup>1</sup> | 25 – 45        | 114 – 182            | 0.7 – 2.25 | 0.2 – 1.2 | 0.02 – 0.09 | --            | 2                      | 0.4 | 5.28 x 10 <sup>-3</sup>       |
|  | Silt (Lower)        | 188.8 – 179.0        | 0.9 – 3.5        | 18                                | 28              | 0              | --             | --                   | --         | --        | --          | 3             | --                     | --  | --                            |
|  | Sand with Gravel    | ~ 177.1              | ~ 1.4            | 18.5                              | 30              | 0              | --             | --                   | --         | --        | --          | --            | --                     | --  | --                            |

Note: <sup>1</sup> Clayey silt to clay deposits use a fully defined shear-normal function based on results of triaxial tests (approximately equivalent to  $c' = 5$  kPa and  $\phi' = 25^\circ$  over the stress range of  $0 \text{ kPa} \leq \sigma_n' \leq 200 \text{ kPa}$ . See Inset.



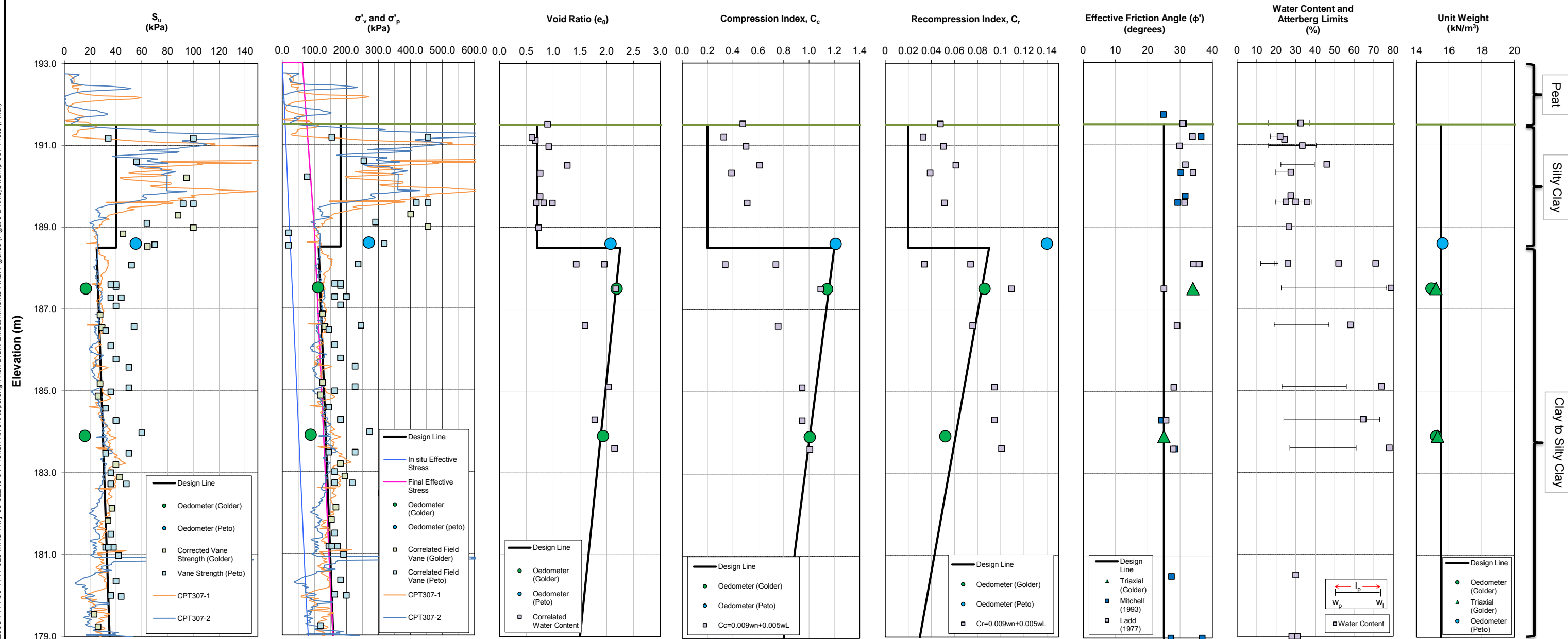
\\mis1-s-filesrv1\data\active\2006\1111\06-1111-025 mrc hwy 69-522 to 64 french river\reporting\wick drain embankments\final\tables\06-1111-025-1 tbld1 summary of foundation engineering parameters.docx

Prepared By: TZ

Reviewed By: JPD/JMAC

SUMMARY PLOT OF ENGINEERING PARAMETERS FOR COHESIVE DEPOSITS  
Swamp 307 SBL - Highway 69 (SBL) - STA 14+425 to 14+490

FIGURE D1



NOTES:

Average original ground surface at the critical section is at Elevation 193 m.  
Minimum sand blanket thickness below original ground surface = 2 m, with base extending to no lower than Elevation 190.3 m.

Date: April 2012  
Project No: 06-1111-025-1

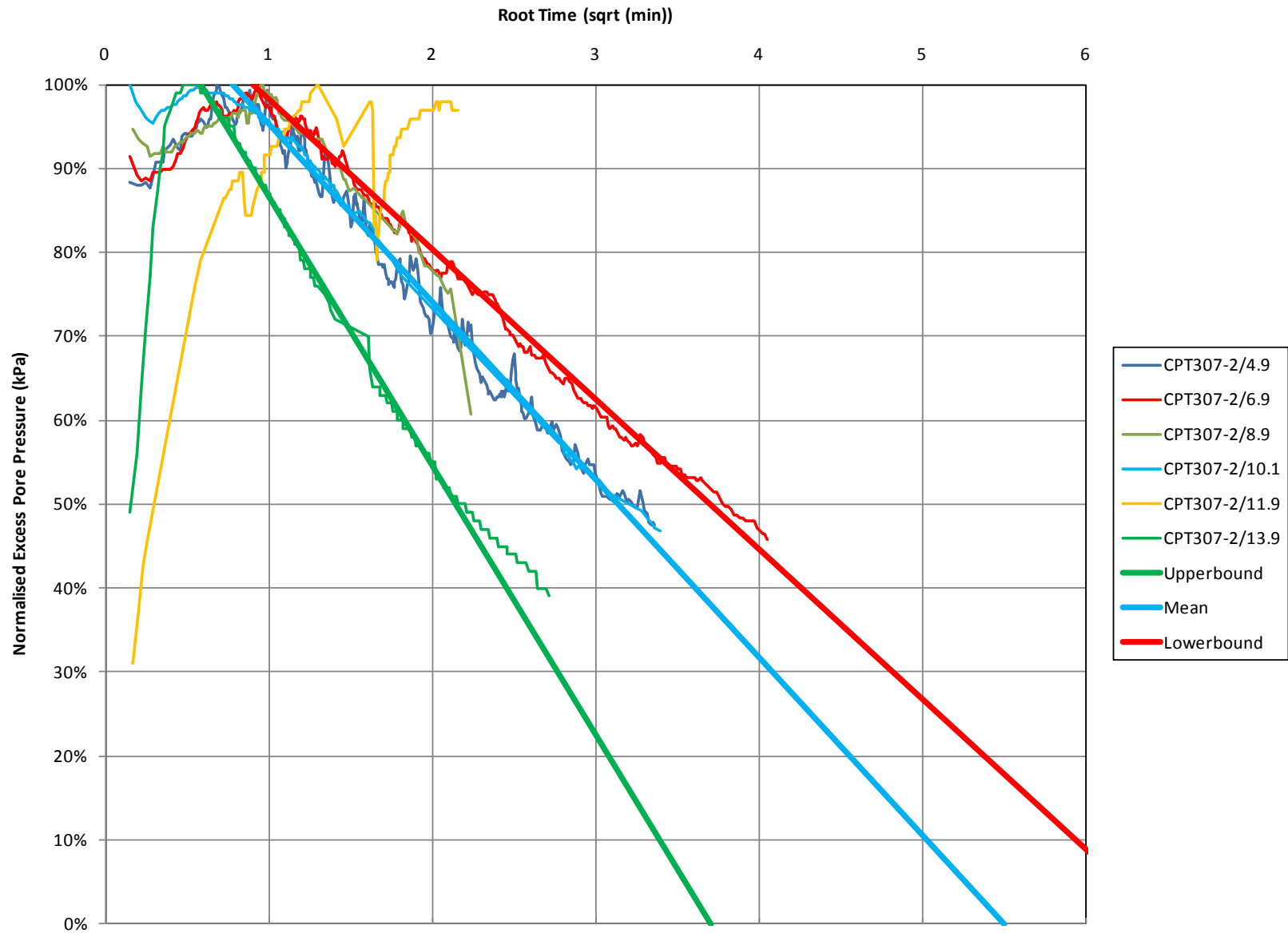
DB: TZ / MWK  
CHK: JPD



Golder Associates

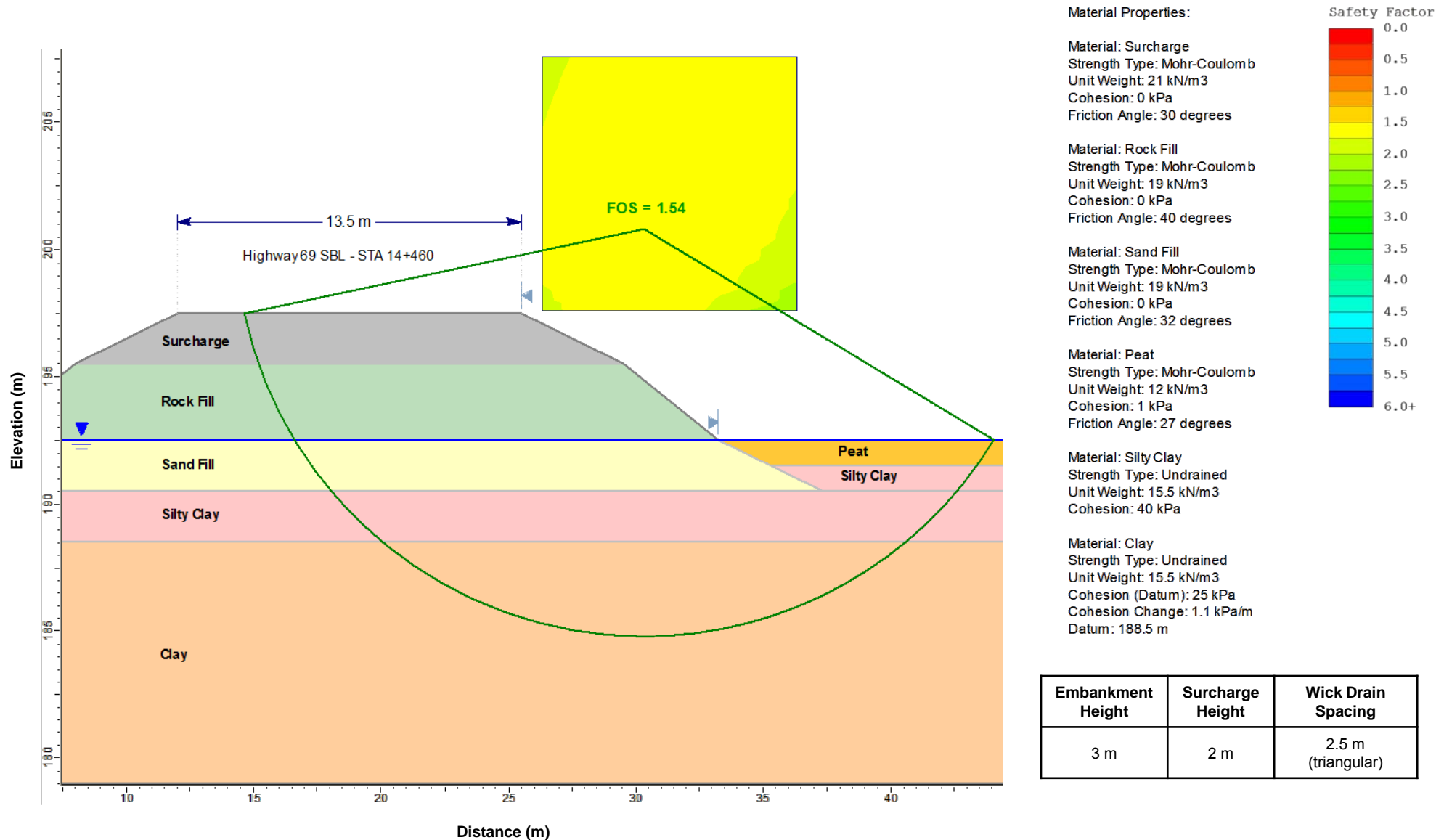
# CPT Pore Pressure Dissipation Tests Swamp 307 SBL

Figure D2



# Slope Stability – Total Stress Analysis – STA 14+460 (Swamp 307 SBL)

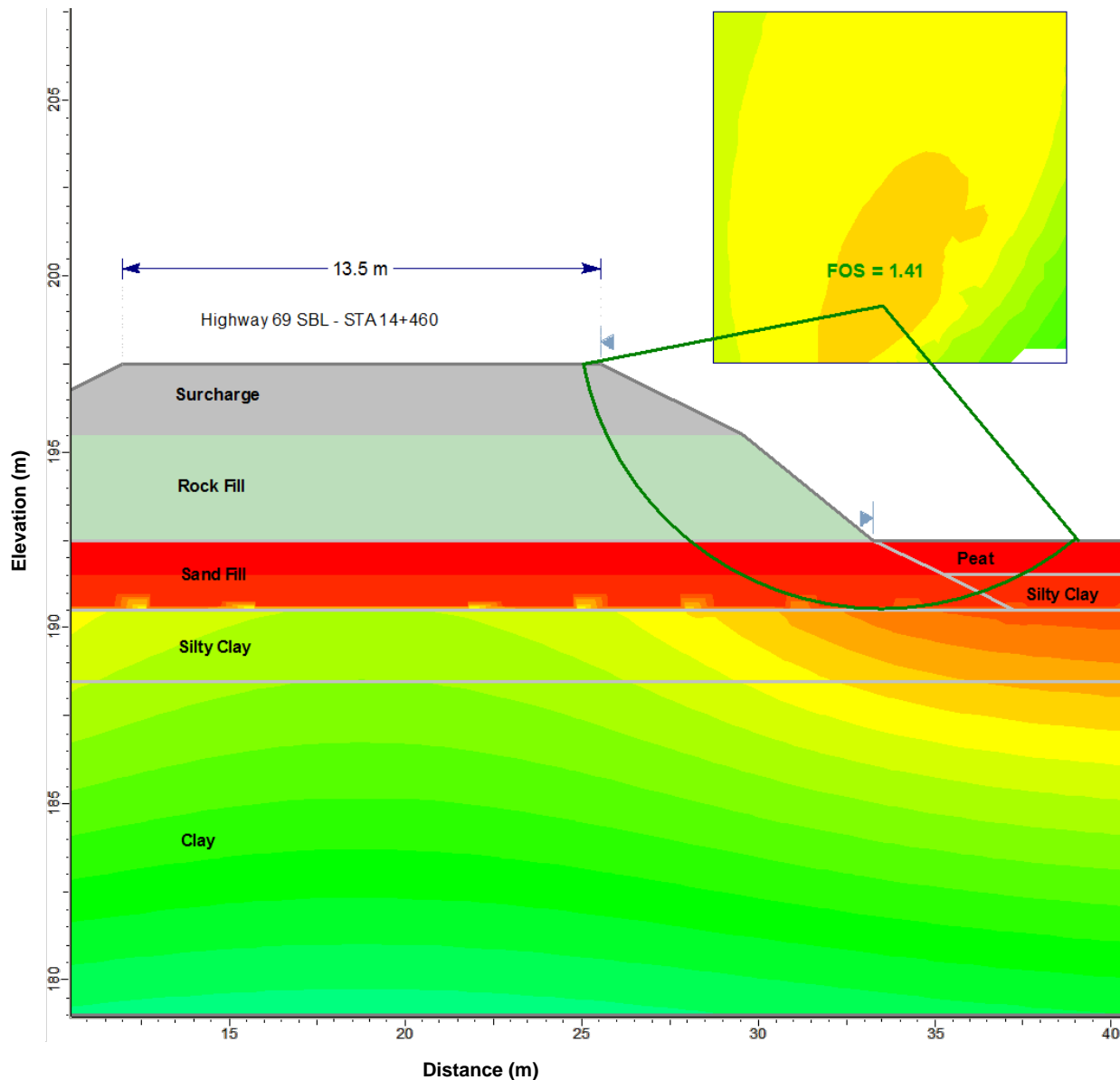
Figure D3





# Slope Stability – Effective Stress Analysis – STA 14+460 (Swamp 307 SBL)

Figure D4



## Material Properties:

Material: Surchage  
Strength Type: Mohr-Coulomb  
Unit Weight: 21 kN/m<sup>3</sup>  
Cohesion: 0 kPa  
Friction Angle: 30 degrees

Material: Rock Fill  
Strength Type: Mohr-Coulomb  
Unit Weight: 19 kN/m<sup>3</sup>  
Cohesion: 0 kPa  
Friction Angle: 40 degrees

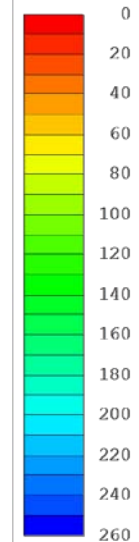
Material: Sand Fill  
Strength Type: Mohr-Coulomb  
Unit Weight: 19 kN/m<sup>3</sup>  
Cohesion: 0 kPa  
Friction Angle: 32 degrees

Material: Peat  
Strength Type: Mohr-Coulomb  
Unit Weight: 12 kN/m<sup>3</sup>  
Cohesion: 1 kPa  
Friction Angle: 27 degrees

Material: Silty Clay  
Strength Type: Shear Normal function  
Unit Weight: 15.5 kN/m<sup>3</sup>

Material: Clay  
Strength Type: Shear Normal function  
Unit Weight: 15.5 kN/m<sup>3</sup>

## Pore Pressure (from grid)



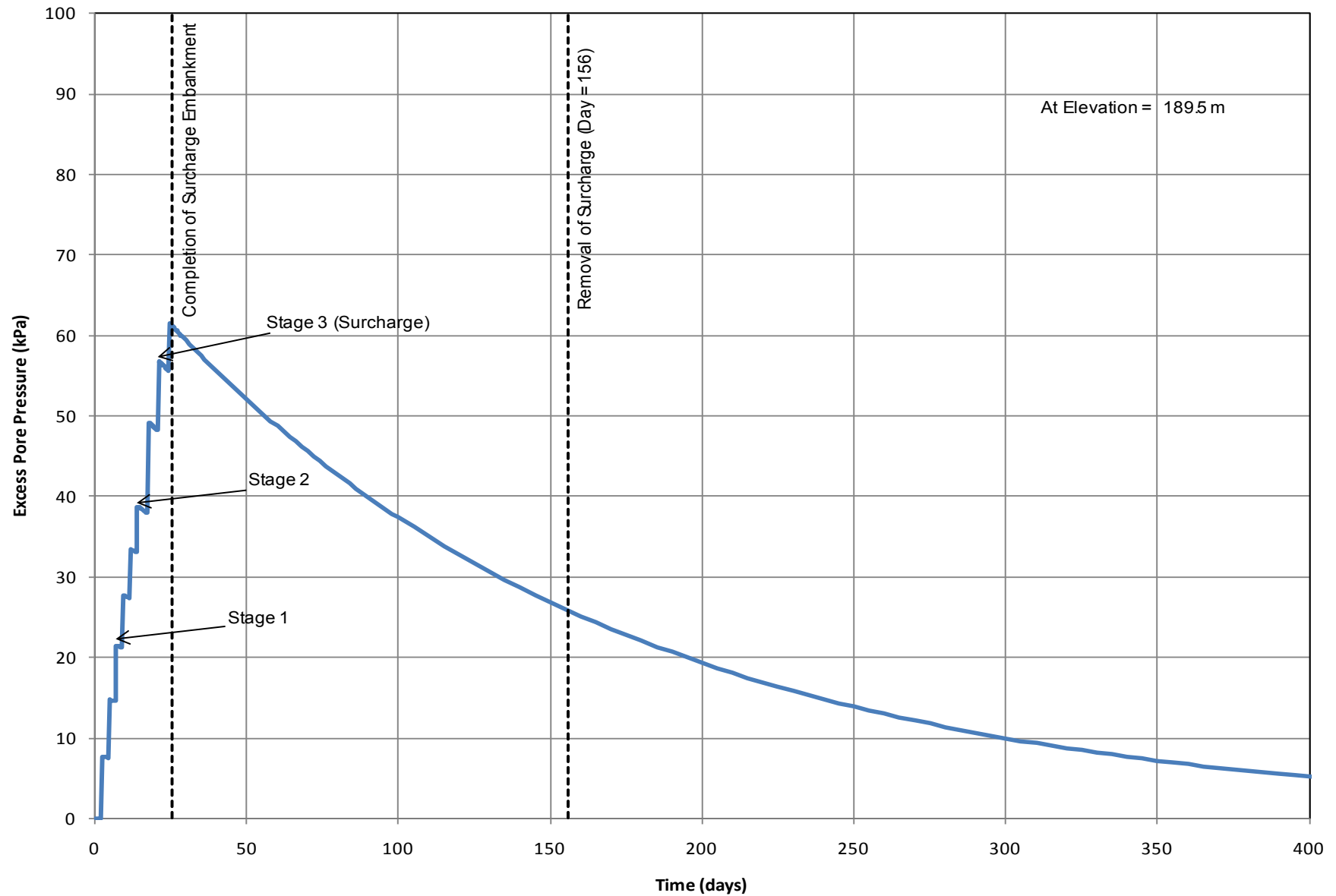
| Embankment Height | Surcharge Height | Wick Drain Spacing |
|-------------------|------------------|--------------------|
| 3 m               | 2 m              | 2.5 m (triangular) |

\* After 22 days of construction



## Excess Pore Pressure Response below Embankment Centreline – STA 14+460 (Swamp 307 SBL)

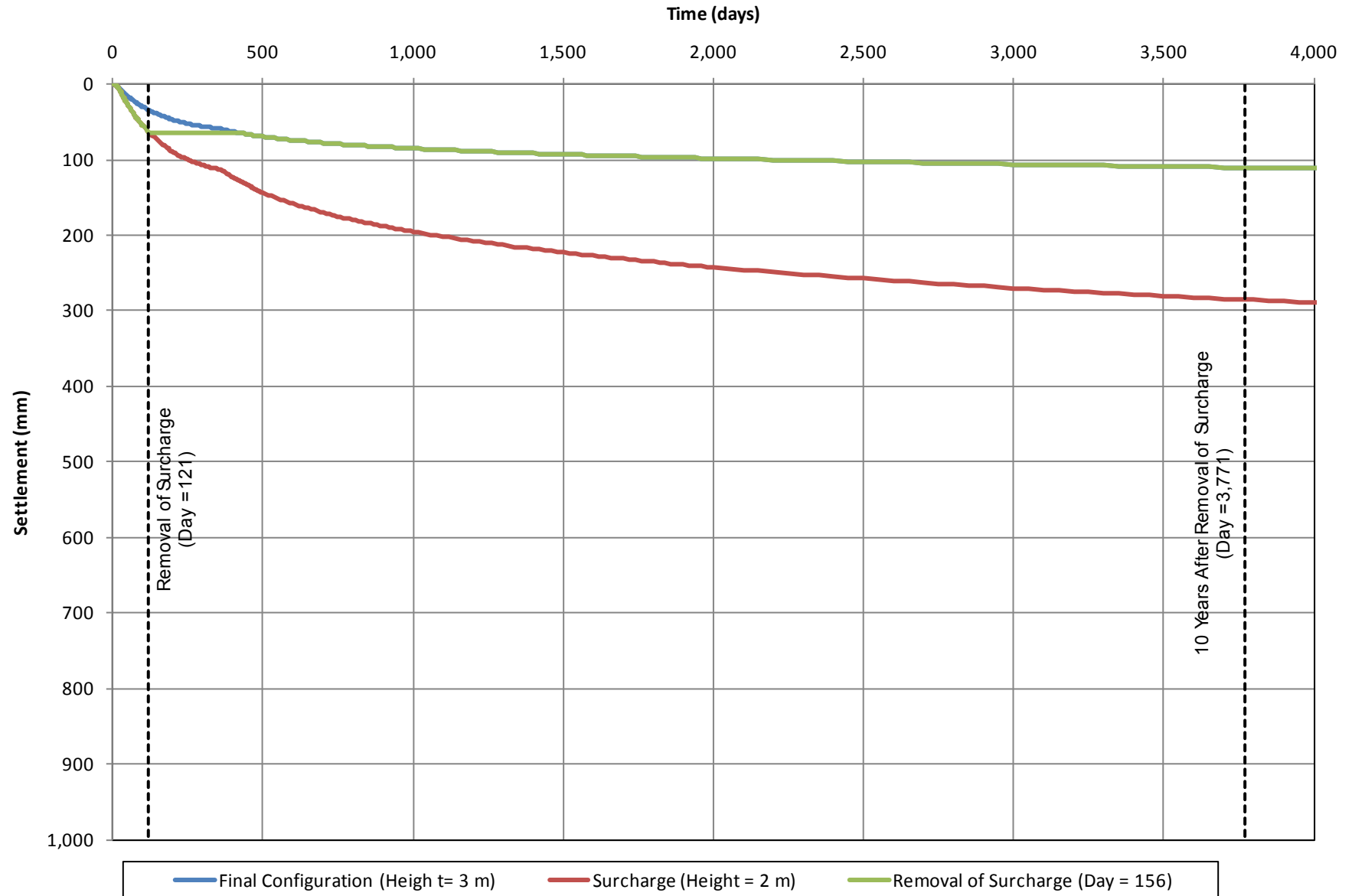
Figure D5





## Time – Rate Consolidation Settlement at Embankment Centreline – STA 14+460 (Swamp 307)

Figure D6









# APPENDIX E

Highway 69 SBL – STA 13+160 to 13+450 (Swamp 310 SBL)



| PROJECT 06-1111-025 |  |  | RECORD OF BOREHOLE No 310-1                                    |      |            | 1 OF 1 METRIC  |                 |   |   |  |  |             |  |  |                                       |   |  |                                    |             |  |  |
|---------------------|--|--|--|------|------------|--|-----------------|---|---|--|--|-------------|--|--|---------------------------------------|---|--|------------------------------------|-------------|--|--|
| G.W.P. 5203-06-00   |  |  | LOCATION N 5089349.4 ; E 220782.8                              |      |            | ORIGINATED BY MWK  |                 |   |   |  |  |             |  |  |                                       |   |  |                                    |             |  |  |
| DIST _____ HWY 69   |  |  | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers |      |            | COMPILED BY MWK  |                 |   |   |  |  |             |  |  |                                       |   |  |                                    |             |  |  |
| DATUM Geodetic      |  |  | DATE March 17, 2009  |      |            | CHECKED BY VA  |                 |   |   |  |  |             |  |  |                                       |   |  |                                    |             |  |  |
| SOIL PROFILE        |  |  | SAMPLES  |      |            | DYNAMIC CONE PENETRATION RESISTANCE PLOT   |                 |   | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT |  |  | UNIT WEIGHT |  |  | REMARKS & GRAIN SIZE DISTRIBUTION (%) |   |  |                                    |             |  |  |
| ELEV<br>DEPTH       | DESCRIPTION  | STRAT PLOT   | NUMBER   | TYPE | "N" VALUES | GROUND WATER<br>CONDITIONS   | ELEVATION SCALE | SHEAR STRENGTH kPa<br>○ UNCONFINED + FIELD VANE<br>● QUICK TRIAXIAL × REMOULDED |   |  |  |             | WATER CONTENT (%)<br>W <sub>p</sub> — W — W <sub>L</sub> |  |                                       | γ |  |                                    | GR SA SI CL |  |  |
| 194.6<br>0.0        | GROUND SURFACE<br>PEAT (Fibrous)<br>Very soft<br>Dark brown<br>Wet   |  |  |      |            |  | 194             |   |   |  |  |             |  |  |                                       |   |  | 820.2<br>106<br>97.3<br>73<br>59.5 | OC = 90.3%  |  |  |
|                     |  |  | 1  | AS   | WH         |  | 193             |   |   |  |  |             |  |  |                                       |   |  |                                    |             |  |  |
| 192.5<br>2.1        | CLAY, trace silt, containing organics<br>Very soft<br>Grey<br>Wet  |  |  |      |            |  | 192             |   |   |  |  |             |  |  |                                       |   |  |                                    |             |  |  |
|                     |  |  | 2  | SS   | WH         |  | 191             |   |   |  |  |             |  |  |                                       |   |  |                                    |             |  |  |
|                     |  |  | 3  | TO   | PH         |  | 190             |   |   |  |  |             |  |  |                                       |   |  |                                    |             |  |  |
|                     |  |  |  |      |            |  | 189             |   |   |  |  |             |  |  |                                       |   |  |                                    |             |  |  |
|                     |  |  |  |      |            |  |                 |   |   |  |  |             |  |  |                                       |   |  |                                    |             |  |  |
| 187.3<br>7.3        | END OF BOREHOLE<br>AUGER REFUSAL<br><br>NOTES:<br><br>1. Water level in open borehole at ground surface (Elev. 194.6 m) upon completion of drilling.<br><br>2. An additional borehole was drilled adjacent to Borehole 310-1 to obtain a Shelby tube sample between depths of 5.2 m and 5.8 m. |  |  |      |            |  |                 |   |   |  |  |             |  |  |                                       |   |  |                                    |             |  |  |

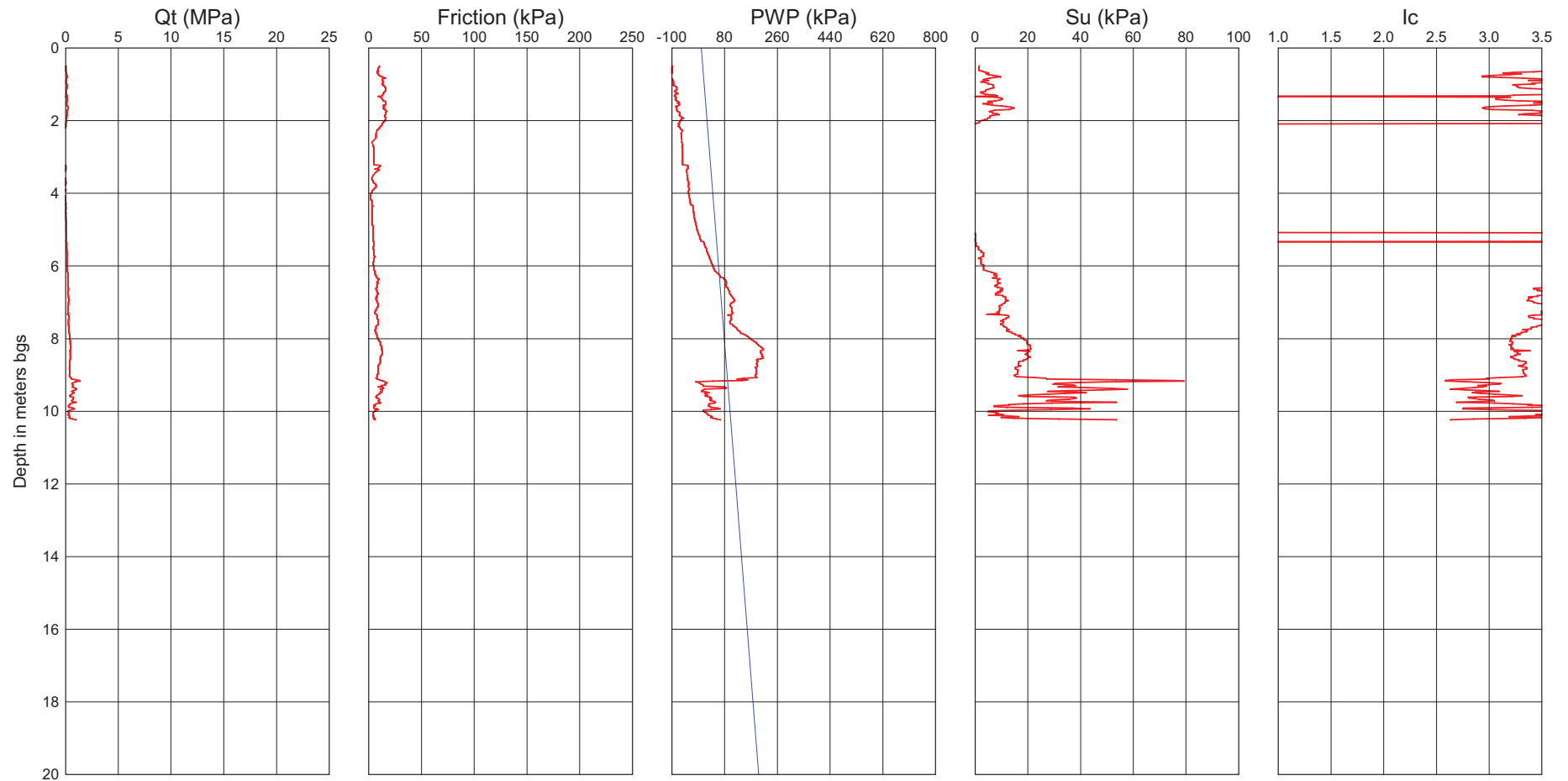
| PROJECT 06-1111-025 |   |  | <b>RECORD OF BOREHOLE No 310-2</b>                             |      |            | 1 OF 1 <b>METRIC</b>  |                 |   |   |  |      |             |                                 |   |                                       |            |             |  |
|---------------------|---|--|--|------|------------|---|-----------------|---|---|--|------|-------------|---------------------------------|---|---------------------------------------|------------|-------------|--|
| G.W.P. 5203-06-00   |   |  | LOCATION N 5089449.9 ; E 220792.8                              |      |            | ORIGINATED BY MWK   |                 |   |   |  |      |             |                                 |   |                                       |            |             |  |
| DIST _____ HWY 69   |   |  | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers |      |            | COMPILED BY MWK   |                 |   |   |  |      |             |                                 |   |                                       |            |             |  |
| DATUM Geodetic      |   |  | DATE March 17, 2009  |      |            | CHECKED BY VA   |                 |   |   |  |      |             |                                 |   |                                       |            |             |  |
| SOIL PROFILE        |   |  | SAMPLES  |      |            | DYNAMIC CONE PENETRATION RESISTANCE PLOT  |                 |   | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT |  |      | UNIT WEIGHT |                                 |   | REMARKS & GRAIN SIZE DISTRIBUTION (%) |            |             |  |
| ELEV<br>DEPTH       | DESCRIPTION   | STRAT PLOT   | NUMBER   | TYPE | "N" VALUES | GROUND WATER CONDITIONS   | ELEVATION SCALE | SHEAR STRENGTH kPa  |   |  |      |             | WATER CONTENT (%)               |   |                                       |            |             |  |
| 194.6<br>0.0        | GROUND SURFACE<br>PEAT (Fibrous)<br>Very soft<br>Black<br>Wet   |  |  |      |            |  | 20 40 60 80 100 | ○ UNCONFINED + FIELD VANE<br>● QUICK TRIAXIAL × REMOULDED |   |  |      |             | W <sub>p</sub> W W <sub>L</sub> | γ |                                       |            | GR SA SI CL |  |
| 191.6<br>3.1        | PEAT (Amorphous)<br>Very soft<br>Brown<br>Wet   |  | 1  | SS   | WH         |   | 194             |   |   |  |      |             | 573.4                           |   |                                       | OC = 42.4% |             |  |
|                     |   |  |  |      |            |   | 193             |   |   |  |      |             |                                 |   |                                       |            |             |  |
|                     |   |  |  |      |            |   | 192             |   |   |  |      |             |                                 |   |                                       |            |             |  |
|                     |   |  | 2  | SS   | WH         |   | 191             |   |   |  |      |             |                                 |   |                                       |            |             |  |
|                     |   |  | 3  | SS   | WH         |   | 190             |   |   |  |      |             |                                 |   |                                       |            |             |  |
| 189.7<br>4.9        | CLAY, trace silt<br>Very soft<br>Grey<br>Wet  |  | 4  | TO   | PH         |   | 189             | 2 +   |   |  |      |             | 89.7                            |   |                                       |            |             |  |
|                     |   |  | 5  | TO   | PH         |   | 188             |   |   |  |      |             | 68.8                            |   |                                       |            |             |  |
|                     |   | 6  | TO   | PH   | 187        |   |                 |   |   |  | 78.8 |             |                                 |   |                                       |            |             |  |
| 186.1<br>8.5        | CLAYEY SILT<br>Firm<br>Grey<br>Wet  |  |  |      | 186        | 2 +   |                 |   |   |  |      |             |                                 |   |                                       |            |             |  |
|                     |   | 7  | TO   | PH   | 185        |   |                 |   |   |  | ○    |             |                                 |   |                                       |            |             |  |
| 184.7<br>9.9        | END OF BOREHOLE<br>AUGER REFUSAL<br><br>NOTE:<br>1. Water level in open borehole at ground surface (Elev. 194.6 m) upon completion of drilling. |  |  |      |            |   |                 |   |   |  |      |             |                                 |   |                                       |            |             |  |

# Cone Penetration Test - CPT310-1

Test Date : March 16, 2009  
Location : Highway 69 - STA 13+377 o/s 39 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 194.60  
Water Table Depth : 0.00



Qt normalized for  
unequal end area effects

$Su = (Qt - \sigma_v) / Nk$   
 $Nk = 15.5$   
 $\gamma = 16 \text{ kN/m}^3$

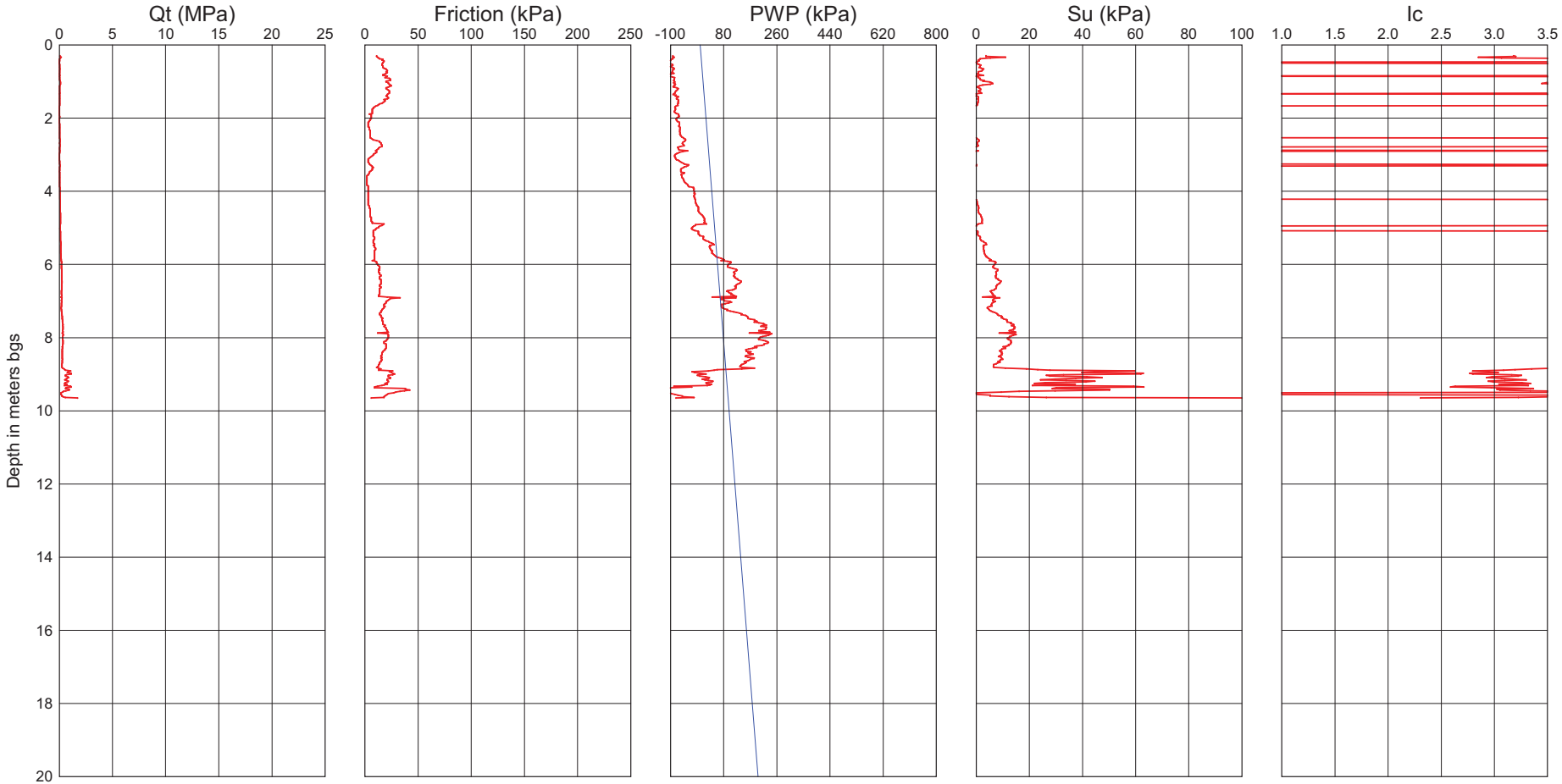
After Robertson and (Fear) Wride (1998)  
 $Ic < 1.31$  - Gravelly sands  
 $1.31 < Ic < 2.05$  - Clean to silty sand  
 $2.05 < Ic < 2.60$  - Silty sand to sandy silt  
 $2.60 < Ic < 2.95$  - Clayey silt to silty clay  
 $2.95 < Ic < 3.60$  - Clays

# Cone Penetration Test - CPT310-2

Test Date : March 16, 2009  
Location : Highway 69 - STA 13+377 o/s 38 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 194.60  
Water Table Depth : 0.00



Qt normalized for  
unequal end area effects

$S_u = (Q_t - \sigma_v) / N_k$   
 $N_k = 15.5$   
 $\gamma = 16 \text{ kN/m}^3$

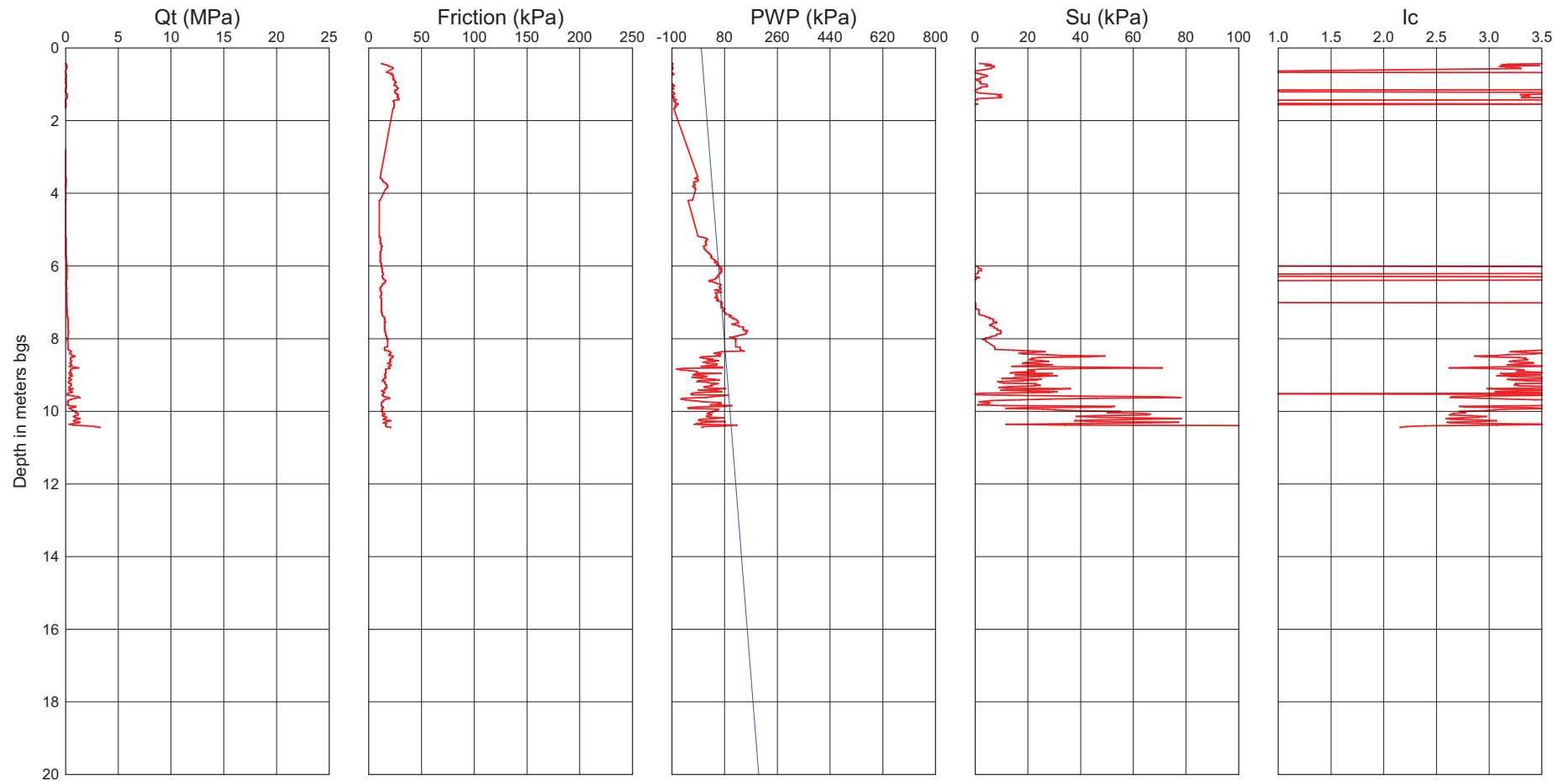
After Robertson and (Fear) Wride (1998)  
 $I_c < 1.31$  - Gravelly sands  
 $1.31 < I_c < 2.05$  - Clean to silty sand  
 $2.05 < I_c < 2.60$  - Silty sand to sandy silt  
 $2.60 < I_c < 2.95$  - Clayey silt to silty clay  
 $2.95 < I_c < 3.60$  - Clays

# Cone Penetration Test - CPT310-3

Test Date : March 16, 2009  
Location : Highway 69 - STA 13+275 o/s 39 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 194.60  
Water Table Depth : 0.00



Qt normalized for  
unequal end area effects

$Su = (Qt - \sigma_v) / Nk$   
 $Nk = 15.5$   
 $\gamma = 16 \text{ kN/m}^3$

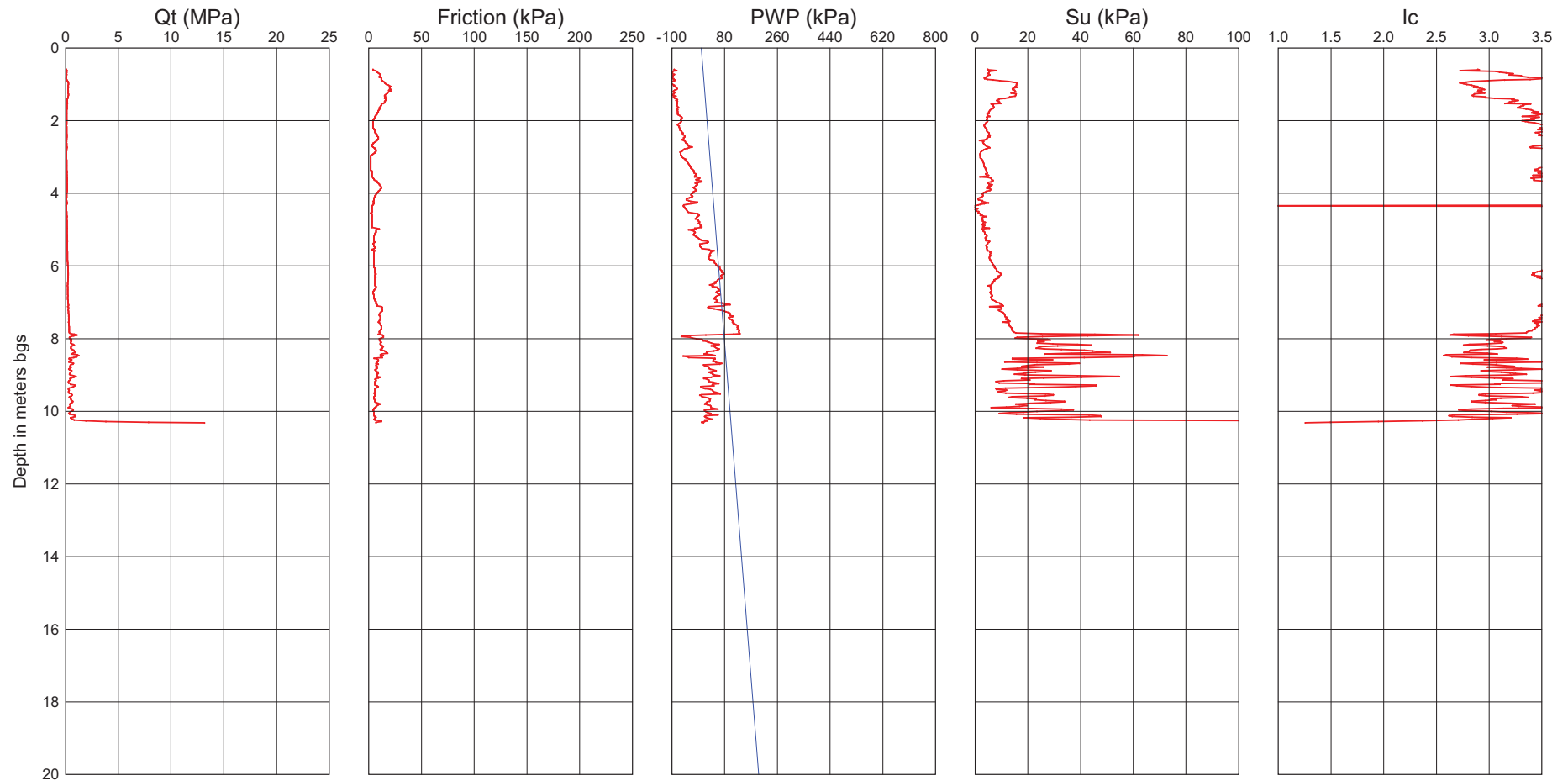
After Robertson and (Fear) Wride (1998)  
Ic < 1.31 - Gravelly sands  
1.31 < Ic < 2.05 - Clean to silty sand  
2.05 < Ic < 2.60 - Silty sand to sandy silt  
2.60 < Ic < 2.95 - Clayey silt to silty clay  
2.95 < Ic < 3.60 - Clays

# Cone Penetration Test - CPT310-4

Test Date : March 16, 2009  
Location : Highway 69 - STA 13+275 o/s 38 m Left

Operator : Golder Associates Ltd.

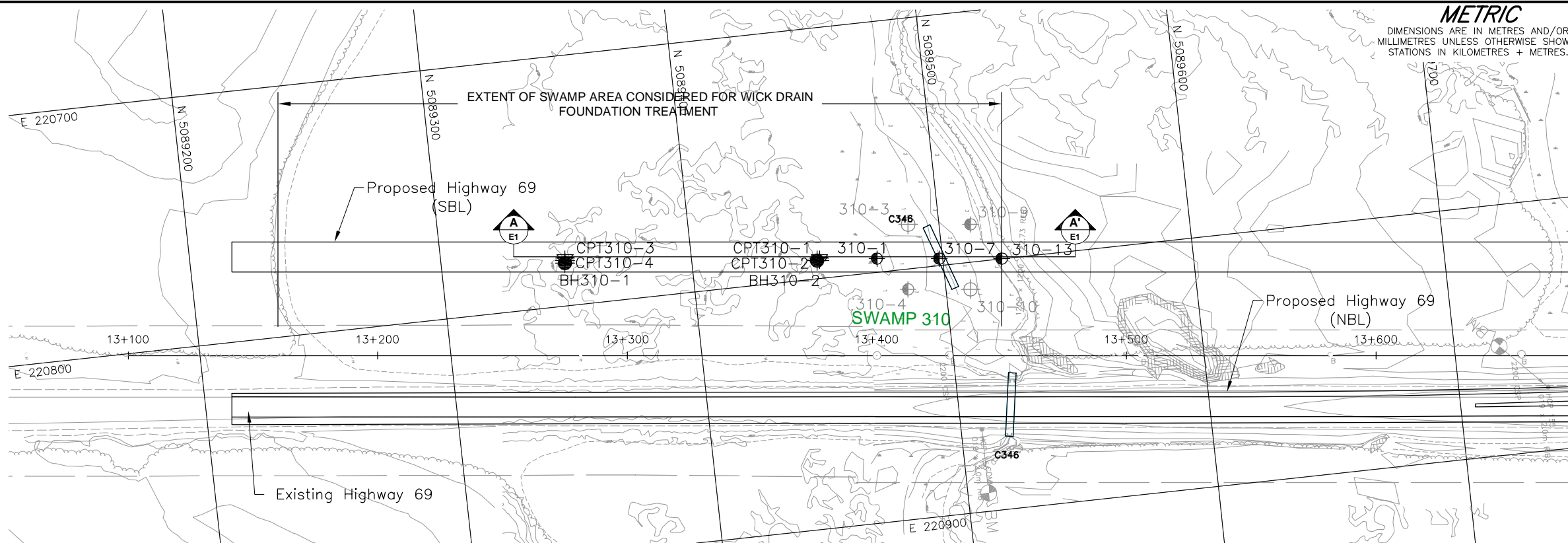
Ground Surf. Elev. : 194.60  
Water Table Depth : 0.00



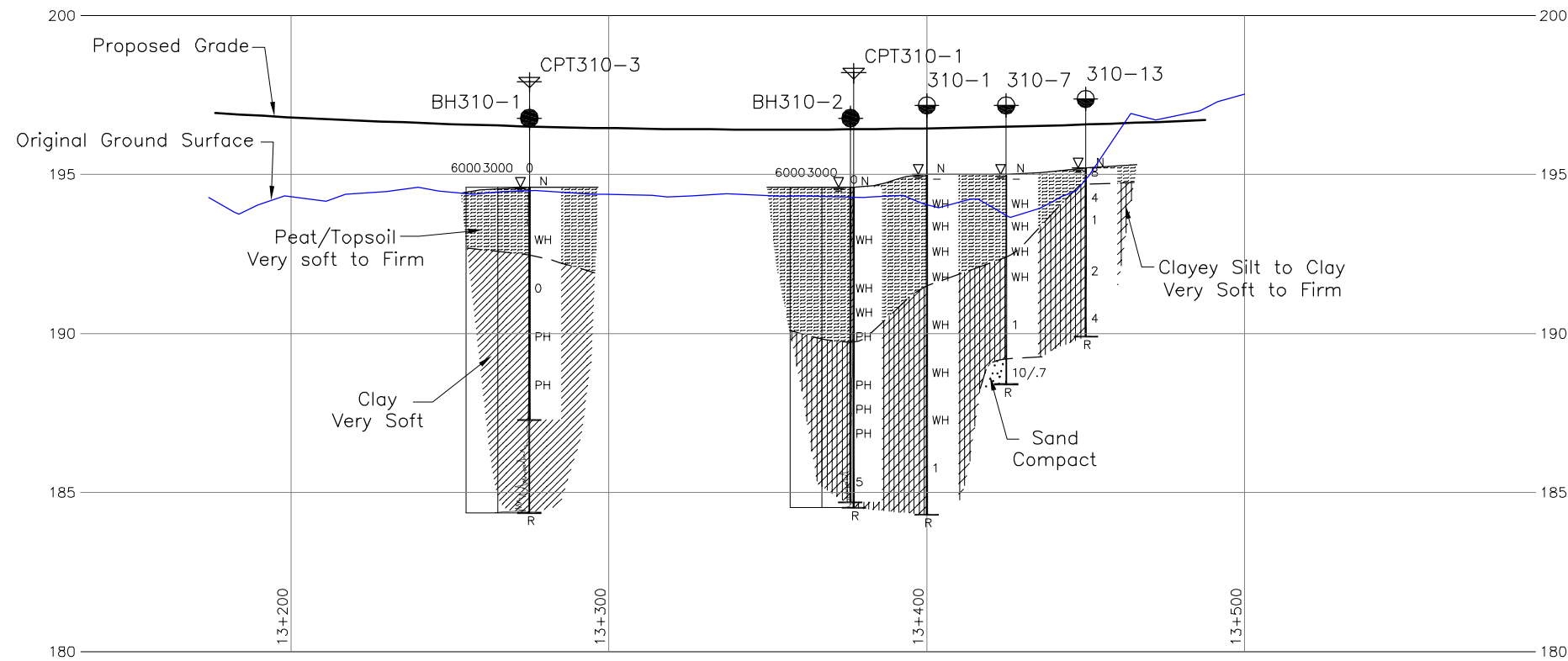
Qt normalized for  
unequal end area effects

$Su = (Qt - \sigma_v) / Nk$   
 $Nk = 15.5$   
 $\gamma = 16 \text{ kN/m}^3$

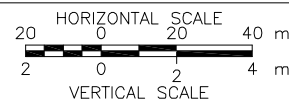
After Robertson and (Fear) Wride (1998)  
Ic < 1.31 - Gravelly sands  
1.31 < Ic < 2.05 - Clean to silty sand  
2.05 < Ic < 2.60 - Silty sand to sandy silt  
2.60 < Ic < 2.95 - Clayey silt to silty clay  
2.95 < Ic < 3.60 - Clays



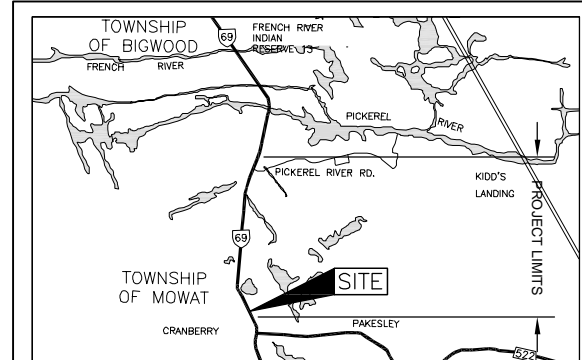
PLAN

A-A'  
E1

CENTRELINE PROFILE

CONT No.  
GWP No. 5203-06-00HIGHWAY 69 (SBL)  
STA 13+160 TO 13+450  
BOREHOLE LOCATION AND SOIL STRATA

SHEET

Golder Associates Ltd.  
MISSISSAUGA, ONTARIO, CANADA

KEY PLAN



LEGEND

- Borehole - Current Investigation
- CPT - Current Investigation
- Borehole - Previous Investigation (Peto MacCallum Ltd.)
- Dynamic Cone Penetration Test - Previous Investigation (Peto MacCallum Ltd.)
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL observed during or upon completion of drilling
- R Refusal

| No.      | ELEVATION | CO-ORDINATES |          |
|----------|-----------|--------------|----------|
|          |           | NORTHING     | EASTING  |
| BH310-1  | 194.6     | 5089349.4    | 220782.8 |
| BH310-2  | 194.6     | 5089449.9    | 220792.8 |
| CPT310-1 | 194.6     | 5089451.0    | 220791.9 |
| CPT310-2 | 194.6     | 5089450.9    | 220792.9 |
| CPT310-3 | 194.6     | 5089349.6    | 220780.9 |
| CPT310-4 | 194.6     | 5089349.5    | 220781.9 |

NOTES

This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

The boundaries between soil strata have been established only at borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

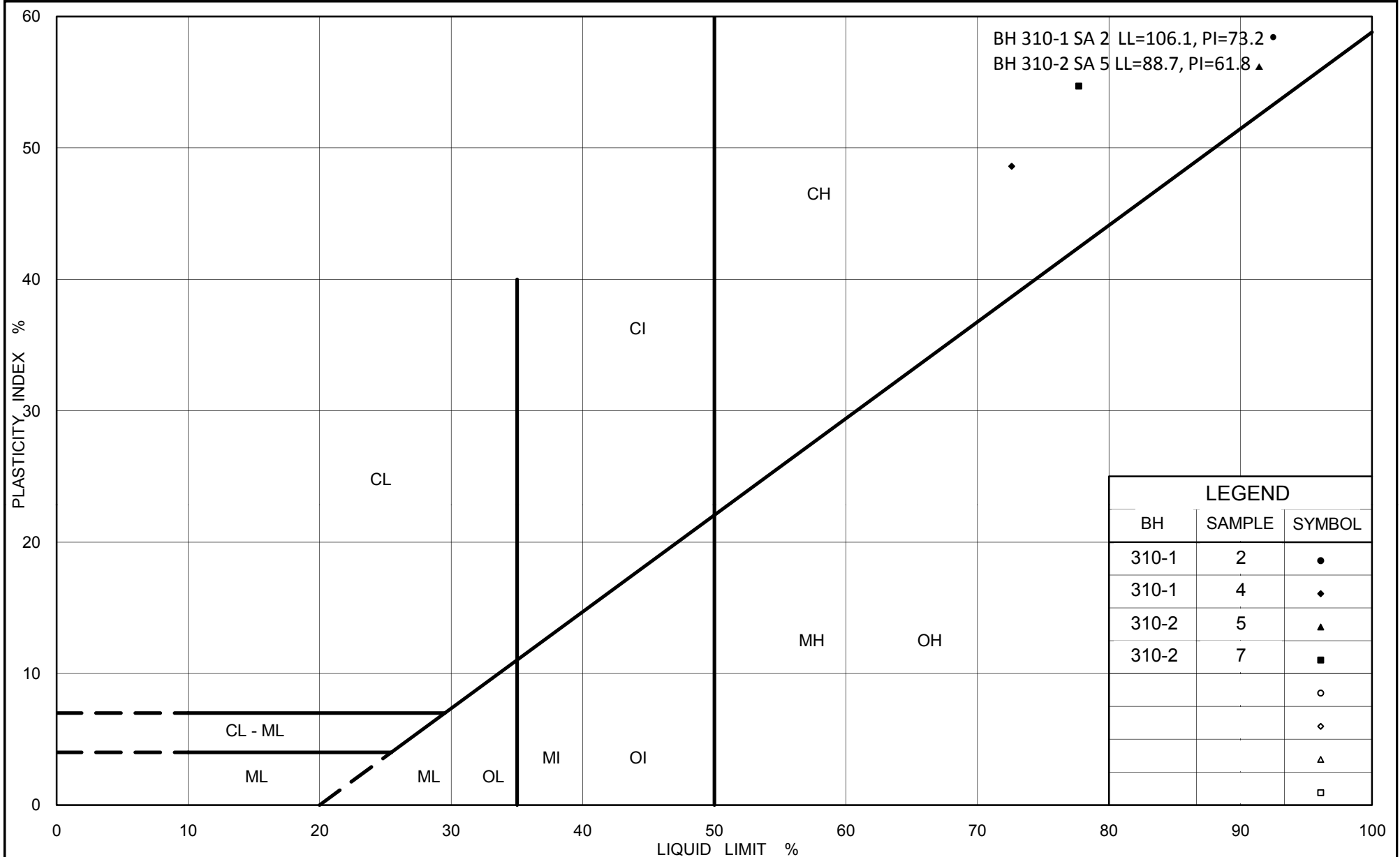
The complete foundation investigation and design report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS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

REFERENCE

Base plans provided in digital format by MRC, drawing file no. PHASE 3 Plan 090211 - Golder.dwg, received February 11, 2009 and drawing file no. 6454 Phase 3 Mainline Plan 091110.dwg, received November 10, 2009.



| NO.         | DATE      | BY              | REVISION                      |
|-------------|-----------|-----------------|-------------------------------|
| HWY. 69     |           |                 | PROJECT NO. 06-1111-025 DIST. |
| SUBM'D. MWK | CHKD. MWK | DATE: Feb. 2012 | SITE:                         |
| DRAWN: RJ   | CHKD. VA  | APPD. JPD/JMAC  | DWG. E1                       |



Ministry of Transportation

Ontario

# PLASTICITY CHART Clay

Highway 69 (SBL) STA 13+160 to 13+450

Figure No. E.S310-1

Project No. 06-1111-025

Checked By: TVA





# **APPENDIX F**

## **Investigation by Others**

## RECORD OF BOREHOLE No 302-19

1 of 1

METRIC

|        |            |          |  |               |        |
|--------|------------|----------|--|---------------|--------|
| G.W.P. | 5203-06-00 | LOCATION | Hwy 69 (New), Sta. 17+700, o/s 19.0m Lt. CL Med. | ORIGINATED BY | V.M.M. |
|--------|------------|----------|--|---------------|--------|

DIST 54 HWY 69 BOREHOLE TYPE Power Augering COMPILED BY N.S.B.

DATUM Geodetic DATE February 22, 2007 CHECKED BY G.D.

[illegible]

**METRIC**









| SOIL PROFILE                               |   |            |        |        |            | SAMPLES                      |                 |  |   |  |   |  |
|--|---|------------|--------|--------|------------|------------------------------|-----------------|--|---|--|---|--|
| ELEV<br>DEPTH                              | DESCRIPTION                                   | STRAT PLOT | NUMBER | TYPE   | "N" VALUES | GROUND WATER<br>* CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT  | PLASTIC LIMIT<br><br>NATURAL MOISTURE CONTENT<br><br>LIQUID LIMIT | UNIT WEIGHT<br><br>$\gamma$<br><br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE DISTRIBUTION (%) |  |
| 188.9<br>0.0<br>0.2                        | Top of Ice<br>Ice                             |            | 1      | AS     | -          |                              | 188             | <br>SHEAR STRENGTH kPa<br>○ UNCONFINED + FIELD VANE<br>● QUICK TRIAXIAL x LAB VANE | <br>WATER CONTENT (%)   |  | GR SA SI CL                                 |  |
|  | Peat, coarse fibrous<br>Dark brown            |            |        |        |            |                              |                 |  |   |  |   |  |
| 187.8<br>1.1                               | Clayey silt, organics<br>Firm Dark grey Moist |            | 2      | SS     | 3          |                              |                 |  |   |  |   |  |
|  | Mottled Wet grey/brown                        |            | 3      | SS     | 4          |                              |                 |  |   |  |   |  |
| 186.2<br>2.7                               | Silty sand                                    |            |        |        |            |                              | 186             |  |   |  |   |  |
| 185.6<br>3.3                               | Loose Grey Wet                                | 4          | SS     | 4/15cm |            |                              |                 |  |   |  |   |  |
|  | End of borehole                               |            |        |        |            |                              |                 |  |   |  |   |  |
|  | Refusal on probable bedrock                   |            |        |        |            |                              |                 |  |   |  |   |  |
| * Borehole dry upon completion of drilling |   |            |        |        |            |                              |                 |  |   |  |   |  |

# RECORD OF BOREHOLE No 302-21

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+725, o/s 44.5m Lt. CL Med. ORIGINATED BY T.X.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 01, 2007 CHECKED BY G.D.

| SOIL PROFILE  |   |   | SAMPLES |      |            | GROUND WATER<br>CONDITIONS  | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |              |    |     |  |  | PLASTIC<br>LIMIT<br><br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br><br>w | LIQUID<br>LIMIT<br><br>w <sub>L</sub> | UNIT<br>WEIGHT<br><br>γ<br><br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |   |    |    |    |    |    |
|---------------|---|---|---------|------|------------|---|-----------------|---|----|--------------|----|-----|--|--|--|---|---------------------------------------|--|---|---|----|----|----|----|----|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT  | NUMBER  | TYPE | "N" VALUES |   |                 | SHEAR STRENGTH kPa                          |    |              |    |     |  |  |  |   |                                       |  | WATER CONTENT (%)                                 |   |    | GR | SA | SI | CL |
|               |   |   |         |      |            |   |                 | ○ UNCONFINED                                |    | + FIELD VANE |    |     |  |  |  |   |                                       |  |   |   |    |    |    |    |    |
| 189.0         | Ground Surface  |   |         |      |            |   |                 | 20  | 40 | 60           | 80 | 100 |  |  |  |   |                                       |  |   |   |    |    |    |    |    |
| 0.0           | Peat, coarse fibrous<br>Dark brown  |  | 1       | SS   | 1          |   |                 |   |    |              |    |     |  |  |  |   |                                       | 1609   |   |   |    |    |    |    |    |
| 188.5         | Silt<br>with sand, trace clay   |  |         |      |            |   |                 |   |    |              |    |     |  |  |  |   |                                       |  |   |   |    |    |    |    |    |
| 0.5           | Loose Grey Wet  |  | 2       | SS   | 8          |  | 188             |   |    |              |    |     |  |  |  |   |                                       |  |   | 0 | 24 | 67 | 9  |    |    |
|               | trace gravel  |  |         |      |            |   |                 |   |    |              |    |     |  |  |  |   |                                       |  |   |   |    |    |    |    |    |
| 187.0         | Compact   |  | 3       | SS   | 17         |   | 187             |   |    |              |    |     |  |  |  |   |                                       |  |   |   |    |    |    |    |    |
| 2.0           | End of borehole<br>Refusal on probable bedrock  |   |         |      |            |   |                 |   |    |              |    |     |  |  |  |   |                                       |  |   |   |    |    |    |    |    |
|               | * 2007 03 01  |   |         |      |            |   |                 |   |    |              |    |     |  |  |  |   |                                       |  |   |   |    |    |    |    |    |
|               |  Water level observed<br>during drilling |   |         |      |            |   |                 |   |    |              |    |     |  |  |  |   |                                       |  |   |   |    |    |    |    |    |
|               |  Water level measured<br>after drilling |   |         |      |            |   |                 |   |    |              |    |     |  |  |  |   |                                       |  |   |   |    |    |    |    |    |

**METRIC**

ON\_MOT VER3 SWAMP 302-MAR 13.GPJ ON\_MOT.GDT 12/14/2007 10:59:57 AM

**RECORD OF BOREHOLE No 302-23**

2 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+725, o/s 43.3m Rt. CL Med. ORIGINATED BY T.X.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 01, 2007 CHECKED BY G.D.

| SOIL PROFILE  |  |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                  |   |   |            | PLASTIC<br>LIMIT<br><br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br><br>w | LIQUID<br>LIMIT<br><br>w <sub>L</sub> | UNIT<br>WEIGHT<br><br>γ<br><br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br><br>GR SA SI CL |                   |  |  |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|------------------|---|---|------------|--|---|---------------------------------------|--|--|-------------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION  | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |                  |   |   |            |  |   |                                       |  |  | WATER CONTENT (%) |  |  |
|               |  |            |         |      |            |                            |                 | ○ UNCONFINED                                | ● QUICK TRIAXIAL | + | × | FIELD VANE |  |   |                                       |  |  | LAB VANE          |  |  |
| 173.0         |  |            |         |      |            |                            |                 |   |                  |   |   |            |  |   |                                       |  |  |                   |  |  |
| 172.0         |  |            |         |      |            |                            |                 |   |                  |   |   |            |  |   |                                       |  |  |                   |  |  |
| 16.0          | End of dynamic cone<br>penetration test<br><br>Refusal on probable bedrock<br><br>Samples 6 to 9 : ' N '-<br>values affected by<br>hydraulic disturbance<br><br><br>*     2007   03   01<br><br>▽     Water level observed<br>during drilling<br><br>C.F.H.S.A. - Denotes<br>Continuous Flight<br>Hollow Stem Augers |            |         |      |            |                            |                 |   |                  |   |   |            |  |   |                                       |  |  |                   |  |  |

**RECORD OF BOREHOLE No 302-24**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+750, o/s 18.8m Lt. CL Med. ORIGINATED BY T.X.  
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
DATUM Geodetic DATE March 01, 2007 CHECKED BY G.D.

| SOIL PROFILE  |  |            |        | SAMPLES |            |                    | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |  |                   |   |  | PLASTIC<br>LIMIT<br>W <sub>P</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br><br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |                  |  |  |
|---------------|--|------------|--------|---------|------------|--------------------|----------------------------|-----------------|---|--|-------------------|---|--|------------------------------------|-------------------------------------|-----------------------------------|--|---|------------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION  | STRAT PLOT | NUMBER | TYPE    | "N" VALUES | SHEAR STRENGTH kPa |                            |                 |   |  | WATER CONTENT (%) |   |  |                                    |                                     |                                   |  |   |                  |  |  |
|               |  |            |        |         |            | ○ UNCONFINED       |                            |                 | + FIELD VANE                                |  |                   | — |  |                                    |                                     |                                   |  |   |                  |  |  |
|               |  |            |        |         |            | ● QUICK TRIAXIAL   |                            |                 | × LAB VANE                                  |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
| 189.0         | Top of Snow  |            |        |         |            |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
| 0.0           | Snow and grass   |            | 1      | SS      | WH**       |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
| 188.5         |  |            |        |         |            |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
| 0.5           | Silt<br>some clay, some sand   |            |        |         |            |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
|               | Loose      Grey/      Moist  |            | 2      | SS      | 6          |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   | 0   12   76   12 |  |  |
|               | brown      to wet  |            |        |         |            |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
|               |  |            |        |         |            |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
|               |  |            | 3      | SS      | 6          |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
| 187.0         |  |            |        |         |            |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
| 2.0           | Silty sand, trace clay   |            |        |         |            |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
|               | Loose      Brown      Wet  |            |        |         |            |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
|               |  |            |        |         |            |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
|               |  |            |        |         |            |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
|               |  |            |        |         |            |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
| 185.7         |  |            |        |         |            |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
| 3.3           | Clayey silt, trace sand<br>varved                                      |            | 4      | SS      | WH         |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
|               | Firm      Grey      Wet  |            |        | FV      |            |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
|               |  |            |        |         |            |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
|               |  |            |        |         |            |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
|               |  |            | 5      | SS      | WH         |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   | 0   1   71   28  |  |  |
|               |  |            |        | FV      |            |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
|               |  |            |        |         |            |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
|               |  |            |        |         |            |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
|               |  |            |        |         |            |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
|               |  |            |        |         |            |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
| 182.6         |  |            |        |         |            |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
| 6.4           | Silt<br>trace clay, trace sand   |            | 6      | SS      | 2          |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
|               | Loose      Grey      Wet   |            |        |         |            |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
|               |  |            |        |         |            |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
|               |  |            |        |         |            |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
|               |  |            |        |         |            |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
|               |  |            |        |         |            |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
|               |  |            |        |         |            |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
| 181.1         |  |            |        |         |            |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
| 7.9           | Silty sand   |            | 7      | SS      | WH         |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
|               | Loose      Grey      Wet   |            |        |         |            |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
| 180.5         |  |            |        |         |            |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
| 8.5           | End of borehole  |            |        |         |            |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
|               | Refusal on probable bedrock  |            |        |         |            |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
|               | Samples 6 and 7 : 'N' -<br>values affected by hydraulic<br>disturbance |            |        |         |            |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
|               | *      2007   03   01  |            |        |         |            |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
|               | ▽      Water level observed<br>during drilling                         |            |        |         |            |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
|               | ▼      Water level measured<br>after drilling                          |            |        |         |            |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |
|               | WH**      Denotes penetration due<br>to weight of hammer and<br>rods   |            |        |         |            |                    |                            |                 |   |  |                   |   |  |                                    |                                     |                                   |  |   |                  |  |  |

**METRIC**

20  
15 — 5 (%) STRAIN AT FAILURE  
10



**RECORD OF BOREHOLE No 302-25**

2 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+750, o/s 18.8m Rt. CL Med. ORIGINATED BY T.X.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. + Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 02, 2007 CHECKED BY G.D.

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                  |              |            | PLASTIC<br>LIMIT<br><br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br><br>w | LIQUID<br>LIMIT<br><br>w <sub>L</sub> | UNIT<br>WEIGHT<br><br>γ<br><br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br><br>GR SA SI CL |                   |  |  |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|------------------|--------------|------------|--|---|---------------------------------------|--|--|-------------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |                  |              |            |  |   |                                       |  |  | WATER CONTENT (%) |  |  |
|               |   |            |         |      |            |                            |                 | ○ UNCONFINED                                | ● QUICK TRIAXIAL | ✚ FIELD VANE | ✕ LAB VANE |  |   |                                       |  |  |                   |  |  |
| 173.5         |   |            |         |      |            |                            |                 |   |                  |              |            |  |   |                                       |  |  |                   |  |  |
| 173.3         |   |            |         |      |            |                            |                 |   |                  |              |            |  |   |                                       |  |  |                   |  |  |
| 15.2          | End of dynamic cone<br>penetration test<br><br>Refusal on probable bedrock<br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><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|            |         |      |            |                            |                 |   |                  |              |            |  |   |                                       |  |  |                   |  |  |

**RECORD OF BOREHOLE No 302-27**

1 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+775 CL Med. ORIGINATED BY T.X.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. + Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE March 03, 2007 CHECKED BY G.D.

| SOIL PROFILE  |                              |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |    |     | PLASTIC<br>LIMIT<br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>w | LIQUID<br>LIMIT<br>w <sub>L</sub> | UNIT<br>WEIGHT<br>γ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|------------------------------|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|
| ELEV<br>DEPTH | DESCRIPTION                  | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |    |    |    |     |                                    |                                     |                                   |                     |   |
| 189.0         | Ground Surface               |            |         |      |            |                            |                 | 20  | 40 | 60 | 80 | 100 |                                    |                                     |                                   |                     |   |
| 0.0           | Peat, coarse fibrous         |            | 1       | AS   | -          |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     | 0.5m frozen                                       |
| 0.1           | Dark brown                   |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               | Silt, trace clay             |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               | organics, rootlets           |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               | Grey/ Moist                  |            | 2       | SS   | 7          |                            | 188             |   |    |    |    |     |                                    |                                     |                                   |                     |   |
| 187.5         | layers of sand               |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
| 1.5           | Loose Brown                  |            | 3       | SS   | 1          |                            | 187             |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               | Clayey silt                  |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               | sand seams                   |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
| 186.4         | Very soft Brown Moist to wet |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
| 2.6           | Silty sand                   |            |         |      |            |                            | 186             |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               | Compact Brown Wet            |            | 4       | SS   | 18         |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               |                              |            |         |      |            |                            | 185             |   |    |    |    |     |                                    |                                     |                                   |                     |   |
| 184.8         | Clay, varved                 |            |         |      |            |                            | 184             |   |    |    |    |     |                                    |                                     |                                   |                     |   |
| 4.2           | trace sand                   |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               | layers of silt               |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               | Firm Grey Wet                |            | 5       | SS   | WH**       |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               |                              |            |         |      |            |                            | 183             |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               |                              |            | 6       | SS   | WH         |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     | 0 2 44 54   |
|               |                              |            |         | FV   |            |                            | 182             |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               |                              |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               |                              |            | 7       | SS   | WH         |                            | 181             |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               |                              |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               |                              |            |         |      |            |                            | 180             |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               |                              |            | 8       | SS   | WH         |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               |                              |            |         | FV   |            |                            | 179             |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               |                              |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               |                              |            | 9       | SS   | WH         |                            | 178             |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               |                              |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
| 177.0         |                              |            |         |      |            |                            | 177             |   |    |    |    |     |                                    |                                     |                                   |                     |   |
| 12.0          | Silt                         |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               | trace clay, trace sand       |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               | Loose to Grey Wet            |            | 10      | SS   | 5          |                            | 176             |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               | very loose                   |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               |                              |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               | some sand, trace gravel      |            | 11      | SS   | 2          |                            | 175             |   |    |    |    |     |                                    |                                     |                                   |                     | 7 15 75 3   |
| 174.7         |                              |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
| 14.3          | End of borehole              |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               | Cont'd                       |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |

Cont'd

**METRIC**

20  
15 — 5 (%) STRAIN AT FAILURE  
10

**RECORD OF BOREHOLE No 302-29**

1 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+800, o/s 18.8m Lt. CL Med. ORIGINATED BY T.X.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. + Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE March 04, 2007 CHECKED BY G.D.

| SOIL PROFILE  |  |   | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |  |  |  |  | PLASTIC<br>LIMIT<br>W <sub>P</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|--|---|---------|------|------------|----------------------------|-----------------|---|--|--|--|--|------------------------------------|-------------------------------------|-----------------------------------|--|---|
| ELEV<br>DEPTH | DESCRIPTION  | STRAT PLOT  | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |  |  |  |  |                                    |                                     |                                   |  |   |
| 189.0         | Ground Surface   |   |         |      |            |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |
| 0.0           | Peat, coarse fibrous<br>Dark brown                               |   | 1       | SS   | 13         |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |
| 0.1           |  |   |         |      |            |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |
|               |  | Silt<br>trace clay, trace sand<br>organics and rootlets |         |      |            |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |
|               | Compact Dark Moist<br>to loose brown to wet                      |   | 2       | SS   | 4          |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |
| 187.5         | Sandy silt, trace clay   |   | 3       | SS   | 5          |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |
|               | Loose Mottled Wet<br>brown/grey                                  |   |         |      |            |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |
| 186.4         | Sand<br>trace silt, trace gravel<br>Compact Brown Wet            |   | 4       | SS   | 19         |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |
| 2.6           |  |   |         |      |            |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |
|               |  |   |         |      |            |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |
|               |  |   |         | 5    | SS         | 15                         |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |
|               |  |   |         |      |            |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |
| 183.4         | Silty clay, trace sand<br>layers of clayey silt<br>Firm Grey Wet |   | 6       | SS   | 1          |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |
| 5.6           |  |   |         |      |            |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |
|               |  |   |         |      |            |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |
|               |  |   |         | 7    | TW         | -                          |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |
|               |  |   |         |      | FV         |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |
|               |  |   | 8       | SS   | WH**       |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |
|               |  |   |         | FV   |            |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |
| 177.9         |  |   | 9       | SS   | 1          |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |
| 11.1          | Silt<br>some clay, trace sand<br>Very loose Grey Wet<br>to loose |   | 10      | SS   | 7          |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |
|               |  |   |         |      |            |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |
|               |  |   |         |      |            |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |
|               | sand seams   |   | 11      | SS   | 5          |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |
| 174.7         | End of borehole  |   |         |      |            |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |
| 14.3          |  |   |         |      |            |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |
|               |  |   |         |      |            |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |

Cont'd

**RECORD OF BOREHOLE No 302-29**

2 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+800, o/s 18.8m Lt. CL Med. ORIGINATED BY T.X.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. + Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE March 04, 2007 CHECKED BY G.D.

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>*<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |            |    |     | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|---|------------|---------|------|------------|---------------------------------|-----------------|---|----|------------|----|-----|------------------------------------|-------------------------------------|-----------------------------------|--|---|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                                 |                 | SHEAR STRENGTH kPa                          |    |            |    |     |                                    |                                     |                                   |  |   |
| 174.0         |   |            |         |      |            |                                 |                 | 20  | 40 | 60         | 80 | 100 |                                    |                                     |                                   |  |   |
|               | Probable silt   |            |         |      |            |                                 |                 | ○ UNCONFINED                                | +  | FIELD VANE |    |     |                                    |                                     |                                   |  |   |
|               | Loose to compact  |            |         |      |            |                                 |                 | ● QUICK TRIAXIAL                            | ×  | LAB VANE   |    |     |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                                 |                 | 20  | 40 | 60         | 80 | 100 |                                    |                                     |                                   |  |   |
| 173           |   |            |         |      |            |                                 |                 |   |    |            |    |     |                                    |                                     |                                   |  |   |
| 172           |   |            |         |      |            |                                 |                 |   |    |            |    |     |                                    |                                     |                                   |  |   |
| 171           |   |            |         |      |            |                                 |                 |   |    |            |    |     |                                    |                                     |                                   |  |   |
| 170.4         |   |            |         |      |            |                                 |                 |   |    |            |    |     |                                    |                                     |                                   |  |   |
| 18.6          | End of dynamic cone penetration test                      |            |         |      |            |                                 |                 |   |    |            |    |     |                                    |                                     |                                   |  |   |
|               | * Borehole dry upon completion of drilling                |            |         |      |            |                                 |                 |   |    |            |    |     |                                    |                                     |                                   |  |   |
|               | WH** Denotes penetration due to weight of hammer and rods |            |         |      |            |                                 |                 |   |    |            |    |     |                                    |                                     |                                   |  |   |
|               | C.F.H.S.A. - Denotes Continuous Flight Hollow Stem Augers |            |         |      |            |                                 |                 |   |    |            |    |     |                                    |                                     |                                   |  |   |

**RECORD OF BOREHOLE No 302-30**

1 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+800, o/s 18.8m Rt. CL Med. ORIGINATED BY N.R.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE February 28 and March 01, 2007 CHECKED BY G.D.

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |  |  |  |  | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|--|--|--|--|------------------------------------|-------------------------------------|-----------------------------------|--|---|
| ELEV<br>DEPTH | DESCRIPTION                                     | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |  |  |  |  |                                    |                                     |                                   |  |   |
| 188.0         | Ground Surface                                  |            |         |      |            |                            |                 | 20 40 60 80 100                             |  |  |  |  |                                    |                                     |                                   |  |   |
| 0.0           | Peat, fine fibrous<br>Dark brown                |            |         |      |            |                            |                 | ○ UNCONFINED + FIELD VANE                   |  |  |  |  |                                    |                                     |                                   |  |   |
| 0.3           | Sandy silt                                      |            |         |      |            |                            |                 | ● QUICK TRIAXIAL × LAB VANE                 |  |  |  |  |                                    |                                     |                                   |  |   |
| 186.7         | Compact Mottled Moist<br>brown/grey             |            | 1       | SS   | 25         |                            | 187             |   |  |  |  |  |                                    |                                     |                                   |  |   |
| 1.3           | Sand with silt, trace clay                      |            |         |      |            |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |
| 186.7         | Compact Brown Wet                               |            | 2       | SS   | 20         |                            | 186             |   |  |  |  |  |                                    |                                     |                                   |  | 0 69 28 3   |
|               | trace silt                                      |            |         |      |            |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |
|               | Dense to Grey<br>very dense                     |            | 3       | SS   | 77         |                            | 185             |   |  |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            | 184             |   |  |  |  |  |                                    |                                     |                                   |  |   |
| 183.4         | Silty clay, trace sand<br>layers of clayey silt |            | 4       | SS   | 2          |                            | 183             |   |  |  |  |  |                                    |                                     |                                   |  |   |
| 4.6           | Firm Grey Wet                                   |            |         |      |            |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            | 5       | SS   | 1          |                            | 182             |   |  |  |  |  |                                    |                                     |                                   |  | 0 2 50 48   |
|               |   |            |         | FV   |            |                            | 181             |   |  |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            | 6       | SS   | 2          |                            | 180             |   |  |  |  |  |                                    |                                     |                                   |  |   |
|               | thin layers of silt                             |            |         | FV   |            |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            | 7       | SS   | 3          |                            | 179             |   |  |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            | 178             |   |  |  |  |  |                                    |                                     |                                   |  |   |
| 177.1         | Silt<br>some clay, trace sand                   |            | 8       | SS   | 6          |                            | 177             |   |  |  |  |  |                                    |                                     |                                   |  |   |
| 10.9          | Loose Grey Wet                                  |            |         |      |            |                            | 176             |   |  |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            | 9       | SS   | 10         |                            | 175             |   |  |  |  |  |                                    |                                     |                                   |  | 0 4 85 11   |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |
| 174.9         | Sandy silt<br>layers of silty sand              |            |         |      |            |                            | 174             |   |  |  |  |  |                                    |                                     |                                   |  |   |
| 13.1          | Loose to Grey Wet<br>very loose                 |            | 10      | SS   | 8          |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |

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**RECORD OF BOREHOLE No 302-30**

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**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+800, o/s 18.8m Rt. CL Med. ORIGINATED BY N.R.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE February 28 and March 01, 2007 CHECKED BY G.D.

| SOIL PROFILE  |  |            | SAMPLES |      |            | GROUND WATER | CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT |                  |              |            |  | PLASTIC LIMIT<br>w <sub>p</sub> | NATURAL MOISTURE CONTENT<br>w | LIQUID LIMIT<br>w <sub>L</sub> | UNIT WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS & GRAIN SIZE DISTRIBUTION (%)<br>GR SA SI CL |                   |  |  |
|---------------|--|------------|---------|------|------------|--------------|------------|-----------------|--|------------------|--------------|------------|--|---------------------------------|-------------------------------|--------------------------------|---------------------------------------|--|-------------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION  | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |              |            |                 | SHEAR STRENGTH kPa                       |                  |              |            |  |                                 |                               |                                |                                       |  | WATER CONTENT (%) |  |  |
|               |  |            |         |      |            |              |            |                 | ○ UNCONFINED                             | ● QUICK TRIAXIAL | ✚ FIELD VANE | ✕ LAB VANE |  |                                 |                               |                                |                                       |  |                   |  |  |
| 173.0         |  |            |         |      |            |              |            |                 |  |                  |              |            |  |                                 |                               |                                |                                       |  |                   |  |  |
| 172.2         |  |            | 11      | SS   | 3          |              |            |                 |  |                  |              |            |  |                                 |                               |                                |                                       |  |                   |  |  |
| 15.8          | End of borehole<br>Probable sandy silt<br>Loose  |            |         |      |            |              |            |                 |  |                  |              |            |  |                                 |                               |                                |                                       |  |                   |  |  |
| 168.5         | End of dynamic cone penetration test   |            |         |      |            |              |            |                 |  |                  |              |            |  |                                 |                               |                                |                                       |  |                   |  |  |
| 19.5          |  |            |         |      |            |              |            |                 |  |                  |              |            |  |                                 |                               |                                |                                       |  |                   |  |  |
|               | <div>* 2007 02 28 and<br/>2007 03 01</div> <div>▽ Water level observed during drilling</div> |            |         |      |            |              |            |                 |  |                  |              |            |  |                                 |                               |                                |                                       |  |                   |  |  |

**RECORD OF BOREHOLE No 302-31**

1 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+825, o/s 40.5m Lt. CL Med. ORIGINATED BY T.X.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. + Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE March 06, 2007 CHECKED BY G.D.

| SOIL PROFILE  |                        |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |    |     | UNIT<br>WEIGHT<br><br>$\gamma$<br><br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|------------------------|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|---|---|
| ELEV<br>DEPTH | DESCRIPTION            | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |    |    |    |     |   |   |
| 189.5         | Ground Surface         |            |         |      |            |                            |                 | 20  | 40 | 60 | 80 | 100 |   |   |
| 0.0           | Peat, coarse fibrous   |            | 1       | SS   | 7          |                            | 189             |   |    |    |    |     |   | 0.5m frozen                                       |
| 0.1           | Dark brown             |            |         |      |            |                            |                 |   |    |    |    |     |   |   |
|               | Silt                   |            |         |      |            |                            |                 |   |    |    |    |     |   |   |
|               | trace sand, trace clay |            |         |      |            |                            |                 |   |    |    |    |     |   |   |
|               | Loose to Mottled Moist |            | 2       | SS   | 3          |                            | 188             |   |    |    |    |     |   |   |
|               | very loose grey/       |            |         |      |            |                            |                 |   |    |    |    |     |   |   |
|               | brown                  |            |         |      |            |                            |                 |   |    |    |    |     |   |   |
|               |                        |            | 3       | SS   | 4          |                            | 187             |   |    |    |    |     |   |   |
| 186.2         | Sandy silt, trace clay |            | 4       | SS   | 6          |                            | 186             |   |    |    |    |     |   |   |
| 3.3           | Loose Grey Wet         |            |         |      |            |                            |                 |   |    |    |    |     |   |   |
| 184.8         |                        |            |         |      |            |                            | 185             |   |    |    |    |     |   |   |
|               |                        |            |         |      |            |                            |                 |   |    |    |    |     |   |   |
| 184.8         | Silty sand             |            | 5       | SS   | 7          |                            | 184             |   |    |    |    |     |   |   |
| 4.7           | Loose Grey Wet         |            |         |      |            |                            |                 |   |    |    |    |     |   |   |
|               |                        |            |         |      |            |                            |                 |   |    |    |    |     |   |   |
|               |                        |            |         |      |            |                            |                 |   |    |    |    |     |   |   |
| 183.7         | Silty clay, varved     |            | 6       | SS   | WH**       |                            | 183             |   |    |    |    |     |   |   |
| 5.8           | Firm Grey Wet          |            |         |      |            |                            |                 |   |    |    |    |     |   |   |
|               |                        |            |         |      |            |                            |                 |   |    |    |    |     |   |   |
|               |                        |            |         |      |            |                            |                 |   |    |    |    |     |   |   |
|               | layers of silt         |            | 7       | SS   | 1          |                            | 182             |   |    |    |    |     |   |   |
|               |                        |            |         |      |            |                            |                 |   |    |    |    |     |   |   |
|               |                        |            |         |      |            |                            |                 |   |    |    |    |     |   |   |
|               |                        |            |         |      |            |                            |                 |   |    |    |    |     |   |   |
|               |                        |            | 8       | SS   | WH         |                            | 180             |   |    |    |    |     |   |   |
| 179.5         | Clayey silt            |            |         |      |            |                            |                 |   |    |    |    |     |   |   |
| 10.0          | Firm Grey Wet          |            |         |      |            |                            |                 |   |    |    |    |     |   |   |
|               |                        |            | 9       | SS   | 3          |                            | 179             |   |    |    |    |     |   |   |
| 178.1         | Silt                   |            |         |      |            |                            | 178             |   |    |    |    |     |   | 0 1 82 17   |
| 11.4          | some clay, trace sand  |            |         |      |            |                            |                 |   |    |    |    |     |   |   |
|               | Very loose Grey Wet    |            |         |      |            |                            |                 |   |    |    |    |     |   |   |
|               |                        |            |         |      |            |                            |                 |   |    |    |    |     |   |   |
|               |                        |            | 10      | SS   | 4          |                            | 177             |   |    |    |    |     |   |   |
|               |                        |            |         |      |            |                            |                 |   |    |    |    |     |   |   |
|               |                        |            |         |      |            |                            |                 |   |    |    |    |     |   |   |
|               |                        |            |         |      |            |                            |                 |   |    |    |    |     |   |   |
|               | layers of sandy silt   |            | 11      | SS   | 5          |                            | 176             |   |    |    |    |     |   |   |
| 175.2         |                        |            |         |      |            |                            |                 |   |    |    |    |     |   |   |
| 14.3          | End of borehole        |            |         |      |            |                            | 175             |   |    |    |    |     |   |   |
|               |                        |            |         |      |            |                            |                 |   |    |    |    |     |   |   |
|               | Cont'd                 |            |         |      |            |                            |                 |   |    |    |    |     |   |   |

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## RECORD OF BOREHOLE No 302-31

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METRIC

|        |            |          |  |               |      |
|--------|------------|----------|--|---------------|------|
| G.W.P. | 5203-06-00 | LOCATION | Hwy 69 (New), Sta. 17+825, o/s 40.5m Lt. CL Med. | ORIGINATED BY | T.X. |
|--------|------------|----------|--|---------------|------|

DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. + Dynamic Cone Penetration Test COMPILED BY N.S.B.

DATUM Geodetic DATE March 06, 2007 CHECKED BY G.D.

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RECORD OF BOREHOLE No 302-32

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METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+825 CL Med. ORIGINATED BY T.X.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. + Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE February 19 and March 07, 2007 CHECKED BY G.D.

| SOIL PROFILE  |  |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |  | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|--|------------|---------|------|------------|----------------------------|---|--|------------------------------------|-------------------------------------|-----------------------------------|--|---|
| ELEV<br>DEPTH | DESCRIPTION                                  | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            | SHEAR STRENGTH kPa                          |  |                                    |                                     |                                   |  |   |
| 188.4         | Ground Surface                               |            |         |      |            |                            | 20 40 60 80 100                             |  |                                    |                                     |                                   |  |   |
| 0.0           | Peat, coarse fibrous Dark brown Frozen       |            | 1       | SS   | 9          |                            | 20 40 60 80 100                             |  |                                    |                                     |                                   | 172                                      |   |
| 187.9         | Silt trace sand, trace clay                  |            |         |      |            |                            |   |  |                                    |                                     |                                   |  |   |
| 0.5           | Very loose to loose Mottled Moist grey/brown |            | 2       | SS   | 4          |                            |   |  |                                    |                                     |                                   |  |   |
| 186.6         | Sandy silt                                   |            | 3       | SS   | 9          |                            |   |  |                                    |                                     |                                   |  |   |
| 1.8           | Loose Brown Moist sand seams Grey            |            |         |      |            |                            |   |  |                                    |                                     |                                   |  |   |
| 184.9         | Silty clay, varved Firm Grey Moist           |            | 4       | SS   | 4          |                            |   |  |                                    |                                     |                                   |  |   |
| 3.5           | sand seams                                   |            |         |      |            |                            |   |  |                                    |                                     |                                   |  |   |
|               | layers of silt                               |            | 5       | SS   | 1          |                            |   |  |                                    |                                     |                                   |  |   |
|               |  |            |         | FV   |            |                            |   |  |                                    |                                     |                                   |  |   |
|               |  |            | 6       | SS   | WH**       |                            |   |  |                                    |                                     |                                   |  |   |
|               |  |            |         | FV   |            |                            |   |  |                                    |                                     |                                   |  |   |
|               |  |            | 7       | SS   | WH         |                            |   |  |                                    |                                     |                                   |  |   |
|               |  |            |         | FV   |            |                            |   |  |                                    |                                     |                                   |  |   |
|               |  |            | 8       | SS   | WH         |                            |   |  |                                    |                                     |                                   |  |   |
|               |  |            |         | FV   |            |                            |   |  |                                    |                                     |                                   |  |   |
|               |  |            | 9       | SS   | WH         |                            |   |  |                                    |                                     |                                   |  |   |
| 177.3         | Silt, some clay                              |            |         |      |            |                            |   |  |                                    |                                     |                                   |  |   |
| 11.1          | Very loose Grey Wet to loose                 |            |         |      |            |                            |   |  |                                    |                                     |                                   |  |   |
|               |  |            | 10      | SS   | 5          |                            |   |  |                                    |                                     |                                   |  |   |
|               | trace clay sand seams                        |            |         |      |            |                            |   |  |                                    |                                     |                                   |  |   |
|               |  |            | 11      | SS   | 1          |                            |   |  |                                    |                                     |                                   |  |   |
| 174.1         | layers of silty sand                         |            |         |      |            |                            |   |  |                                    |                                     |                                   |  |   |
| 14.3          | End of borehole                              |            |         |      |            |                            |   |  |                                    |                                     |                                   |  |   |

## 2 of 2

METRIC

| SOIL PROFILE |             |             | SAMPLES |      |            | GROUND WATER CONDITIONS | ELEVATION SCALE   | DYNAMIC CONE PENETRATION RESISTANCE PLOT   |   | PLASTIC LIMIT<br>NATURAL MOISTURE CONTENT<br>LIQUID LIMIT | UNIT WEIGHT<br><br>$\gamma$<br>kN/m <sup>3</sup> | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|--------------|-------------|-------------|---------|------|------------|-------------------------|---|--|---|---|--|---------------------------------------|
| ELEV. DEPTH  | DESCRIPTION | STRAT. PLOT | NUMBER  | TYPE | "N" VALUES |                         |   | 20 40 60 80 100<br> | W <sub>p</sub> W      W <sub>L</sub><br>WATER CONTENT (%)<br>20 40 60 |   |  |                                       |
| 173.4        |             |             |         |      |            |                         | ○ UNCONFINED      + FIELD VANE<br>● QUICK TRIAXIAL      × LAB VANE<br>20 40 60 80 100 |  |   |   |  | GR SA SI CL                           |

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**RECORD OF BOREHOLE No 302-33**

1 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+825, o/s 35.4m Rt. CL Med. ORIGINATED BY F.P.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE February 20, 2007 CHECKED BY G.D.

| SOIL PROFILE  |  |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |    |     | UNIT<br>WEIGHT<br>$\gamma$<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|---|---|
| ELEV<br>DEPTH | DESCRIPTION                            | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |    |    |    |     |   |   |
| 186.5         | Ground Surface                         |            |         |      |            |                            |                 | 20  | 40 | 60 | 80 | 100 |   |   |
| 0.0           | Peat, coarse fibrous<br>Dark brown     |            | 1       | AS   | -          | ↓*                         | 186             |   |    |    |    |     |   | 0.3m frozen                                       |
| 0.3           | Organic clayey silt                    |            |         |      |            |                            |                 |   |    |    |    |     |   |   |
|               | Very soft Dark Wet<br>brown            |            | 2       | SS   | 1          |                            | 185             |   |    |    |    |     | 106   | Org.<br>5.4%                                      |
|               |  |            | 3       | SS   | 1          |                            | 184             |   |    |    |    |     | 98  |   |
| 183.9         | Silty clay<br>trace sand, trace gravel |            |         |      |            |                            | 183             |   |    |    |    |     |   |   |
| 2.6           | Stiff to Grey Wet<br>firm              |            | 4       | SS   | WH         |                            | 182             |   |    |    |    |     |   |   |
|               |  |            |         | FV   |            |                            | 181             |   |    |    |    |     |   |   |
|               | thin layers of silt                    |            | 5       | SS   | 2          |                            | 180             |   |    |    |    |     |   | 0 1 47 52   |
|               |  |            |         | FV   |            |                            | 179             |   |    |    |    |     |   |   |
|               |  |            | 6       | SS   | 1          |                            | 178             |   |    |    |    |     |   |   |
|               |  |            |         | FV   |            |                            | 177             |   |    |    |    |     |   |   |
|               | layers of silt                         |            | 7       | SS   | 1          |                            | 176             |   |    |    |    |     |   |   |
|               |  |            |         | FV   |            |                            | 175             |   |    |    |    |     |   |   |
|               |  |            | 8       | SS   | 8          |                            | 174             |   |    |    |    |     |   | 0 20 77 3   |
| 176.4         | Silt<br>trace clay, trace sand         |            |         |      |            |                            | 173             |   |    |    |    |     |   |   |
| 10.1          | Compact Grey Wet                       |            | 9       | SS   | 11         |                            | 172             |   |    |    |    |     |   |   |
|               | some to with sand                      |            |         |      |            |                            |                 |   |    |    |    |     |   |   |
|               | Loose                                  |            | 10      | SS   | 6          |                            |                 |   |    |    |    |     |   |   |
| 173.7         | End of borehole                        |            |         |      |            |                            |                 |   |    |    |    |     |   |   |
| 12.8          | Probable silt                          |            |         |      |            |                            |                 |   |    |    |    |     |   |   |
|               | Loose to<br>compact                    |            |         |      |            |                            |                 |   |    |    |    |     |   |   |

Cont'd

**RECORD OF BOREHOLE No 302-33**

2 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+825, o/s 35.4m Rt. CL Med. ORIGINATED BY F.P.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE February 20, 2007 CHECKED BY G.D.

| SOIL PROFILE  |   |            |        | SAMPLES |            |                    | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |            |  |  |  | PLASTIC<br>LIMIT<br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>w | LIQUID<br>LIMIT<br>w <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |  |
|---------------|---|------------|--------|---------|------------|--------------------|----------------------------|-----------------|---|------------|--|--|--|------------------------------------|-------------------------------------|-----------------------------------|--|--|--|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER | TYPE    | "N" VALUES | SHEAR STRENGTH kPa |                            |                 |   |            |  |  |  |                                    |                                     |                                   |  |  |  |
|               |   |            |        |         |            | ○ UNCONFINED       |                            |                 | +   | FIELD VANE |  |  |  |                                    |                                     |                                   |  |  |  |
|               |   |            |        |         |            | ● QUICK TRIAXIAL   |                            |                 | ×   | LAB VANE   |  |  |  |                                    |                                     |                                   |  |  |  |
| 171.5         |   |            |        |         |            |                    |                            |                 |   |            |  |  |  |                                    |                                     |                                   |  |  |  |
|               |   |            |        |         |            |                    |                            |                 |   |            |  |  |  |                                    |                                     |                                   |  |  |  |
|               |   |            |        |         |            |                    |                            |                 |   |            |  |  |  |                                    |                                     |                                   |  |  |  |
|               |   |            |        |         |            |                    |                            |                 |   |            |  |  |  |                                    |                                     |                                   |  |  |  |
|               |   |            |        |         |            |                    |                            |                 |   |            |  |  |  |                                    |                                     |                                   |  |  |  |
| 167.9         |   |            |        |         |            |                    |                            |                 |   |            |  |  |  |                                    |                                     |                                   |  |  |  |
| 168.6         | End of dynamic cone penetration test                      |            |        |         |            |                    |                            |                 |   |            |  |  |  |                                    |                                     |                                   |  |  |  |
|               | Sample 11: 'N' value affected by hydraulic disturbance    |            |        |         |            |                    |                            |                 |   |            |  |  |  |                                    |                                     |                                   |  |  |  |
|               | * 2007 02 20  |            |        |         |            |                    |                            |                 |   |            |  |  |  |                                    |                                     |                                   |  |  |  |
|               | ▽ Water level observed during drilling                    |            |        |         |            |                    |                            |                 |   |            |  |  |  |                                    |                                     |                                   |  |  |  |
|               | ▼ Water level measured after drilling                     |            |        |         |            |                    |                            |                 |   |            |  |  |  |                                    |                                     |                                   |  |  |  |
|               | WH** Denotes penetration due to weight of hammer and rods |            |        |         |            |                    |                            |                 |   |            |  |  |  |                                    |                                     |                                   |  |  |  |
|               | C.F.H.S.A. - Denotes Continuous Flight Hollow Stem Augers |            |        |         |            |                    |                            |                 |   |            |  |  |  |                                    |                                     |                                   |  |  |  |



**METRIC**

AM<sup>7</sup>, X<sup>5</sup>: Numbers refer to Sensitivity

20  
15 — ( ) — 5  
10

(%) STRAIN AT FAILURE

**METRIC**

| SOIL PROFILE   |             |            |        | SAMPLES |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT<br> | PLASTIC LIMIT<br>NATURAL<br>MOISTURE<br>CONTENT<br>LIQUID LIMIT<br> | UNIT<br>WEIGHT<br><br>$\gamma$<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|----------------|-------------|------------|--------|---------|------------|----------------------------|-----------------|--|--|---|---|
| ELEV.<br>DEPTH | DESCRIPTION | STRAT PLOT | NUMBER | TYPE    | "N" VALUES |                            |                 |  |  |   |   |
| 173.4          |             |            |        |         |            |                            |                 |  |  |   |   |

[illegible]

**RECORD OF BOREHOLE No 302-35**

1 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+850, o/s 18.8m Rt. CL Med. ORIGINATED BY F.P.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE February 19, 2007 CHECKED BY G.D.

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |    |     | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|---|------------|---------|------|------------|----------------------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|--|---|
| ELEV<br>DEPTH | DESCRIPTION                             | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            | SHEAR STRENGTH kPa                          |    |    |    |     |                                    |                                     |                                   |  |   |
| 186.5         | Ground Surface                          |            |         |      |            |                            | 20  | 40 | 60 | 80 | 100 |                                    |                                     |                                   |  |   |
| 0.0           | Peat, coarse fibrous<br>Dark brown      |            | 1       | AS   | -          | ↓*                         |   |    |    |    |     |                                    |                                     |                                   |  | 0.2m frozen                                       |
| 0.3           | Organic silty clay<br>trace sand        |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               | Soft Dark brown Wet                     |            | 2       | SS   | 1          |                            |   |    |    |    |     |                                    |                                     |                                   | Org.<br>5.4%                             | 0 7 67 26   |
|               | roots                                   |            | 3       | SS   | 21         |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 184.3         | Clayey silt, trace sand                 |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 2.2           | Stiff to Grey Wet<br>firm               |            | 4       | SS   | 3          |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |   |            | 5       | SS   | 4          |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |   |            |         | FV   |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               | thin layers of silt                     |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |   |            | 6       | SS   | 5          |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |   |            |         | FV   |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |   |            | 7       | SS   | 3          |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |   |            |         | FV   |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |   |            | 8       | SS   | 1          |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |   |            |         | FV   |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |   |            | 9       | SS   | 5          |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 176.6         | Silt<br>trace clay, trace sand          |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 9.9           | Loose to Grey Wet<br>very loose         |            | 10      | SS   | 7          |                            |   |    |    |    |     |                                    |                                     |                                   |  | 0 5 86 9  |
|               | some sand                               |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |   |            | 11      | SS   | WR**       |                            |   |    |    |    |     |                                    |                                     |                                   |  | 0 20 78 2   |
| 173.7         | End of borehole                         |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 12.8          | Probable silt<br>Very loose<br>to loose |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |

Cont'd



**RECORD OF BOREHOLE No 302-35**

2 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+850, o/s 18.8m Rt. CL Med. ORIGINATED BY F.P.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE February 19, 2007 CHECKED BY G.D.

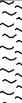
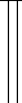

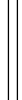


| SOIL PROFILE  |  |            |        | SAMPLES |            |                    | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT                      |                 |  |  |  | PLASTIC<br>LIMIT<br><br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br><br>w | LIQUID<br>LIMIT<br><br>w <sub>L</sub> | UNIT<br>WEIGHT<br><br>γ<br><br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br><br>GR SA SI CL |
|---------------|--|------------|--------|---------|------------|--------------------|----------------------------|-----------------|--|-----------------|--|--|--|--|---|---------------------------------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION  | STRAT PLOT | NUMBER | TYPE    | "N" VALUES | SHEAR STRENGTH kPa |                            |                 |  |                 |  |  |  |  |   |                                       |  |  |
|               |  |            |        |         |            |                    |                            |                 | ○ UNCONFINED      + FIELD VANE<br>● QUICK TRIAXIAL    × LAB VANE |                 |  |  |  |  |   |                                       |  |  |
| 171.5         |  |            |        |         |            |                    |                            |                 |  | 20 40 60 80 100 |  |  |  |  |   |                                       |  |  |
| 170.0         |  |            |        |         |            |                    |                            |                 |  | 20 40 60 80 100 |  |  |  |  |   |                                       |  |  |
| 16.5          | End of dynamic cone<br>penetration test<br><br>Refusal on probable bedrock<br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><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|            |        |         |            |                    |                            |                 |  |                 |  |  |  |  |   |                                       |  |  |

**RECORD OF BOREHOLE No 302-37**

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**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+875 CL Med. ORIGINATED BY T.X.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE February 19, 2007 CHECKED BY G.D.

| SOIL PROFILE  |   |   | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT              |  |  |  |  | PLASTIC<br>LIMIT<br>W <sub>P</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |                   |  |  |
|---------------|---|---|---------|------|------------|----------------------------|--|--|--|--|--|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|-------------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT  | NUMBER  | TYPE | "N" VALUES |                            | SHEAR STRENGTH kPa                                       |  |  |  |  |                                    |                                     |                                   |                     |   | WATER CONTENT (%) |  |  |
|               |   |   |         |      |            |                            | 20 40 60 80 100  |  |  |  |  |                                    |                                     |                                   |                     |   | 20 40 60          |  |  |
|               |   |   |         |      |            |                            | ○ UNCONFINED + FIELD VANE<br>● QUICK TRIAXIAL × LAB VANE |  |  |  |  |                                    |                                     |                                   |                     |   |                   |  |  |
| 186.5<br>0.0  | Ground Surface<br>Peat, coarse fibrous<br>Dark brown                  |    | 1       | SS   | 10         |                            |  |  |  |  |  |                                    |                                     |                                   | Org.<br>94.8%       | GR SA SI CL                                       |                   |  |  |
| 185.4<br>1.1  | Silt, some clay<br>sand seams<br>Very loose Grey Wet                  |    | 2       | SS   | WH**       |                            |  |  |  |  |  |                                    |                                     |                                   |                     |   |                   |  |  |
|               |   |   | 3       | SS   | 2          |                            |  |  |  |  |  |                                    |                                     |                                   |                     |   |                   |  |  |
|               |   |   |         |      |            |                            |  |  |  |  |  |                                    |                                     |                                   |                     |   |                   |  |  |
| 183.6<br>2.9  | Silty clay, trace sand<br>thin layers of clayey silt<br>Firm Grey Wet |    | 4       | SS   | 1          |                            |  |  |  |  |  |                                    |                                     |                                   |                     |   |                   |  |  |
|               |   |   |         | FV   |            |                            |  |  |  |  |  |                                    |                                     |                                   |                     |   |                   |  |  |
|               |   |   | 5       | SS   | WH         |                            |  |  |  |  |  |                                    |                                     |                                   |                     |   |                   |  |  |
|               |   |   |         | FV   |            |                            |  |  |  |  |  |                                    |                                     |                                   |                     |   |                   |  |  |
|               |   |   |         |      |            |                            |  |  |  |  |  |                                    |                                     |                                   |                     |   |                   |  |  |
|               | _____ layers of sandy silt _____                                      |   | 6       | SS   | 1          |                            |  |  |  |  |  |                                    |                                     |                                   |                     |   |                   |  |  |
|               |   |   |         |      |            |                            |  |  |  |  |  |                                    |                                     |                                   |                     |   |                   |  |  |
|               |   |   |         |      |            |                            |  |  |  |  |  |                                    |                                     |                                   |                     |   |                   |  |  |
|               |   |   | 7       | SS   | WH         |                            |  |  |  |  |  |                                    |                                     |                                   |                     |   |                   |  |  |
|               |   |   |         |      |            |                            |  |  |  |  |  |                                    |                                     |                                   |                     |   |                   |  |  |
|               |   |   |         |      |            |                            |  |  |  |  |  |                                    |                                     |                                   |                     |   |                   |  |  |
| 177.3<br>9.2  | Silt<br>trace clay, trace sand<br>Loose Grey Wet                      |  | 8       | SS   | 4          |                            |  |  |  |  |  |                                    |                                     |                                   |                     |   |                   |  |  |
|               |   |   |         |      |            |                            |  |  |  |  |  |                                    |                                     |                                   |                     |   |                   |  |  |
|               | _____ sand seams _____  |   | 9       | SS   | 6          |                            |  |  |  |  |  |                                    |                                     |                                   |                     |   |                   |  |  |
|               |   |   |         |      |            |                            |  |  |  |  |  |                                    |                                     |                                   |                     |   |                   |  |  |
| 174.7<br>11.8 | Silty sand, trace clay<br>Very loose Grey Wet                         |  | 10      | SS   | WH         |                            |  |  |  |  |  |                                    |                                     |                                   |                     |   |                   |  |  |
| 173.7<br>12.8 | End of borehole<br>Probable silty sand<br>Very loose<br>to compact    |  |         |      |            |                            |  |  |  |  |  |                                    |                                     |                                   |                     |   |                   |  |  |
|               | Cont'd  |   |         |      |            |                            |  |  |  |  |  |                                    |                                     |                                   |                     |   |                   |  |  |

Cont'd

## METRIC

$+^7, \times^5$ : Numbers refer to Sensitivity

**RECORD OF BOREHOLE No 302-39**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+900, o/s 18.8m Lt. CL Med. ORIGINATED BY F.P.  
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
DATUM Geodetic DATE February 18, 2007 CHECKED BY G.D.

| SOIL PROFILE            |   |            | SAMPLES |      |              | GROUND WATER<br>CONDITIONS | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT                  |  |  |  |  | PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT |   |                | UNIT<br>WEIGHT<br><br>γ<br><br>kN/m³ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |  |             |  |
|-------------------------|---|------------|---------|------|--------------|----------------------------|--|--|--|--|--|---|---|----------------|--------------------------------------|---|--|-------------|--|
| ELEV<br>DEPTH           | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | "N" VALUES   |                            | SHEAR STRENGTH kPa   |  |  |  |  | W <sub>P</sub>  | W | W <sub>L</sub> |                                      |   |  |             |  |
|                         |   |            |         |      |              |                            | 20   40   60   80   100                                      |  |  |  |  |   |   |                |                                      |   |  |             |  |
|                         |   |            |         |      |              |                            | ○ UNCONFINED   + FIELD VANE<br>● QUICK TRIAXIAL   × LAB VANE |  |  |  |  |   |   |                |                                      |   |  |             |  |
| 20   40   60   80   100 |   |            |         |      | 20   40   60 |                            |  |  |  |  |  |   |   |                |                                      |   |  |             |  |
| 186.5                   | Ground Surface  |            |         |      |              |                            |  |  |  |  |  |   |   |                |                                      |   |  |             |  |
| 0.0                     | Peat, coarse fibrous<br>Dark brown                          |            | 1       | AS   | -            | ▽*                         |  |  |  |  |  |   |   |                |                                      |   |  | 0.2m frozen |  |
| 0.3                     | Clayey silt, trace sand<br>sandy silt layers                |            |         |      |              |                            |  |  |  |  |  |   |   |                |                                      |   |  |             |  |
| 185.6                   | Firm Grey Wet   |            | 2       | SS   | 4            |                            |  |  |  |  |  |   |   |                |                                      |   |  |             |  |
| 0.9                     | Sand and silt<br>trace clay                                 |            |         |      |              |                            |  |  |  |  |  |   |   |                |                                      |   |  |             |  |
|                         | Loose to Grey Wet<br>compact                                |            | 3       | SS   | 11           |                            |  |  |  |  |  |   |   |                |                                      |   |  | 0 53 44 3   |  |
| 184.2                   | Silty clay, trace sand                                      |            |         |      |              |                            |  |  |  |  |  |   |   |                |                                      |   |  |             |  |
| 2.3                     | Stiff to Grey Wet<br>firm                                   |            | 4       | SS   | 2            |                            |  |  |  |  |  |   |   |                |                                      |   |  |             |  |
|                         |   |            |         | FV   |              |                            |  |  |  |  |  |   |   |                |                                      |   |  |             |  |
|                         |   |            | 5       | SS   | 3            |                            |  |  |  |  |  |   |   |                |                                      |   |  | 0 1 62 37   |  |
|                         |   |            |         | FV   |              |                            |  |  |  |  |  |   |   |                |                                      |   |  |             |  |
|                         | thin layers of silt   |            | 6       | SS   | 2            |                            |  |  |  |  |  |   |   |                |                                      |   |  |             |  |
|                         |   |            |         | FV   |              |                            |  |  |  |  |  |   |   |                |                                      |   |  |             |  |
|                         |   |            | 7       | SS   | 1            |                            |  |  |  |  |  |   |   |                |                                      |   |  |             |  |
|                         |   |            |         | FV   |              |                            |  |  |  |  |  |   |   |                |                                      |   |  |             |  |
| 177.7                   | Silt<br>some clay, trace sand<br>thin layers of clayey silt |            | 8       | SS   | 5            |                            |  |  |  |  |  |   |   |                |                                      |   |  | 0 1 86 13   |  |
| 8.8                     | Loose Grey Wet  |            |         |      |              |                            |  |  |  |  |  |   |   |                |                                      |   |  |             |  |
|                         |   |            | 9       | SS   | 7            |                            |  |  |  |  |  |   |   |                |                                      |   |  |             |  |
| 175.2                   | Sand and silt, trace clay                                   |            |         |      |              |                            |  |  |  |  |  |   |   |                |                                      |   |  |             |  |
| 11.3                    | Loose Grey Wet  |            |         |      |              |                            |  |  |  |  |  |   |   |                |                                      |   |  |             |  |
|                         |   |            | 10      | SS   | 6            |                            |  |  |  |  |  |   |   |                |                                      |   |  | 0 50 48 2   |  |
| 173.7                   | End of borehole   |            |         |      |              |                            |  |  |  |  |  |   |   |                |                                      |   |  |             |  |
| 12.8                    |   |            |         |      |              |                            |  |  |  |  |  |   |   |                |                                      |   |  |             |  |
|                         | * 2007 02 18  |            |         |      |              |                            |  |  |  |  |  |   |   |                |                                      |   |  |             |  |
|                         | ▽ Water level observed<br>during drilling                   |            |         |      |              |                            |  |  |  |  |  |   |   |                |                                      |   |  |             |  |
|                         | ▼ Water level measured<br>after drilling                    |            |         |      |              |                            |  |  |  |  |  |   |   |                |                                      |   |  |             |  |

# RECORD OF BOREHOLE No 302-40

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+900, o/s 18.8m Rt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 19, 2007 CHECKED BY G.D.

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                  |            |              |                | PLASTIC<br>LIMIT<br>W <sub>P</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br><br>γ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |                   |                |  |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|------------------|------------|--------------|----------------|------------------------------------|-------------------------------------|-----------------------------------|-------------------------|---|-------------------|----------------|--|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |                  |            |              |                |                                    |                                     |                                   |                         |   | WATER CONTENT (%) |                |  |
|               |   |            |         |      |            |                            |                 | ○ UNCONFINED                                | ● QUICK TRIAXIAL | ✕ LAB VANE | ✚ FIELD VANE | W <sub>P</sub> |                                    |                                     |                                   |                         |   | W                 | W <sub>L</sub> |  |
| 186.5         | Ground Surface  |            |         |      |            |                            | 20              | 40  | 60               | 80         | 100          |                |                                    |                                     |                                   |                         |   |                   |                |  |
| 0.0           | Peat, coarse fibrous                                      |            | 1       | AS   | -          |                            | 186             |   |                  |            |              |                |                                    |                                     |                                   | 135<br>Org.<br>10.2%    |   |                   |                |  |
|               | fine fibrous  |            |         |      |            |                            |                 |   |                  |            |              |                |                                    |                                     |                                   |                         |   |                   |                |  |
|               | amorphous   |            | 2       | SS   | WH**       |                            |                 |   |                  |            |              |                |                                    |                                     |                                   |                         |   |                   |                |  |
|               |   |            | 3       | SS   | WH         |                            | 185             |   |                  |            |              |                |                                    |                                     |                                   |                         |   |                   |                |  |
| 184.4         | Silty clay, trace sand                                    |            |         |      |            |                            | 184             |   |                  |            |              |                |                                    |                                     |                                   | 0 1 43 56               |   |                   |                |  |
| 2.1           | Soft to Grey Wet firm                                     |            | 4       | SS   | WH         |                            |                 |   |                  |            |              |                |                                    |                                     |                                   |                         |   |                   |                |  |
|               |   |            | 5       | SS   | 1          |                            | 183             |   |                  |            |              |                |                                    |                                     |                                   |                         |   |                   |                |  |
|               |   |            |         | FV   |            |                            |                 |   |                  |            |              |                |                                    |                                     |                                   |                         |   |                   |                |  |
|               |   |            | 6       | SS   | WH         |                            | 182             |   |                  |            |              |                |                                    |                                     |                                   |                         |   |                   |                |  |
|               |   |            |         | FV   |            |                            | 181             |   |                  |            |              |                |                                    |                                     |                                   |                         |   |                   |                |  |
|               | thin layers of silt                                       |            |         |      |            |                            |                 |   |                  |            |              |                |                                    |                                     |                                   |                         |   |                   |                |  |
|               |   |            | 7       | SS   | 1          |                            | 180             |   |                  |            |              |                |                                    |                                     |                                   |                         |   |                   |                |  |
|               |   |            |         | FV   |            |                            | 179             |   |                  |            |              |                |                                    |                                     |                                   |                         |   |                   |                |  |
|               |   |            | 8       | SS   | 4          |                            | 178             |   |                  |            |              |                |                                    |                                     |                                   |                         |   |                   |                |  |
|               |   |            | FV      |      |            |                            |                 |   |                  |            |              |                |                                    |                                     |                                   |                         |   |                   |                |  |
| 177.7         | Silt trace clay, trace sand                               |            |         |      |            |                            | 177             |   |                  |            |              |                |                                    |                                     |                                   | 0 3 90 7                |   |                   |                |  |
| 8.8           | thin layers of clayey silt                                |            | 9       | SS   | 6          |                            |                 |   |                  |            |              |                |                                    |                                     |                                   |                         |   |                   |                |  |
|               | Loose to Grey Wet compact                                 |            |         |      |            |                            |                 |   |                  |            |              |                |                                    |                                     |                                   |                         |   |                   |                |  |
|               |   |            | 10      | SS   | 18         |                            | 176             |   |                  |            |              |                |                                    |                                     |                                   |                         |   |                   |                |  |
| 175.1         | End of borehole   |            |         |      |            |                            |                 |   |                  |            |              |                |                                    |                                     |                                   |                         |   |                   |                |  |
| 11.4          | Refusal on probable bedrock                               |            |         |      |            |                            |                 |   |                  |            |              |                |                                    |                                     |                                   |                         |   |                   |                |  |
|               | * 2007 02 19  |            |         |      |            |                            |                 |   |                  |            |              |                |                                    |                                     |                                   |                         |   |                   |                |  |
|               | Water level observed during drilling                      |            |         |      |            |                            |                 |   |                  |            |              |                |                                    |                                     |                                   |                         |   |                   |                |  |
|               | Water level measured after drilling                       |            |         |      |            |                            |                 |   |                  |            |              |                |                                    |                                     |                                   |                         |   |                   |                |  |
|               | WH** Denotes penetration due to weight of hammer and rods |            |         |      |            |                            |                 |   |                  |            |              |                |                                    |                                     |                                   |                         |   |                   |                |  |

**METRIC**

20  
15 — 5 (%) STRAIN AT FAILURE  
10

**RECORD OF BOREHOLE No 302-41**

2 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+925, o/s 34.8m Lt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 18, 2007 CHECKED BY G.D.

| SOIL PROFILE  |  |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |    |     | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|--|---|
| ELEV<br>DEPTH | DESCRIPTION  | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |    |    |    |     |                                    |                                     |                                   |  |   |
| 171.7         |  |            |         |      |            |                            |                 | 20  | 40 | 60 | 80 | 100 |                                    |                                     |                                   |  |   |
| 169.5         |  |            |         |      |            |                            |                 | 20  | 40 | 60 | 80 | 100 |                                    |                                     |                                   |  |   |
| 17.2          | End of dynamic cone<br>penetration test<br><br>Refusal on probable bedrock<br><br>* 2007 02 18<br><br>▽ Water level observed<br>during drilling<br>▼ Water level measured<br>after drilling<br><br>C.F.H.S.A. - Denotes<br>Continuous Flight<br>Hollow Stem Augers |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |  |   |

## 1 of 1

METRIC



**RECORD OF BOREHOLE No 302-44**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+950, o/s 18.8m Lt. CL Med. ORIGINATED BY F.P.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE February 17, 2007 CHECKED BY G.D.

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                  |              |            |                   | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT |   |                | UNIT<br>WEIGHT<br><br>γ<br><br>kN/m³ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |   |    |    |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|------------------|--------------|------------|-------------------|---|---|----------------|--------------------------------------|---|---|----|----|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | 'N' VALUES |                            |                 | SHEAR STRENGTH kPa                          |                  |              |            |                   | w <sub>p</sub>                                      | w | w <sub>L</sub> |                                      | GR  | SA  | SI | CL |
|               |   |            |         |      |            |                            |                 | ○ UNCONFINED                                | ● QUICK TRIAXIAL | + FIELD VANE | × LAB VANE | WATER CONTENT (%) |   |   |                |                                      |   |   |    |    |
| 186.5         | Ground Surface  |            |         |      |            |                            |                 |   |                  |              |            |                   |   |   |                |                                      |   |   |    |    |
| 0.0           | Peat, coarse fibrous<br>Dark brown                              |            | 1       | AS   | -          | ▽*                         | 186             |   |                  |              |            |                   |   |   |                |                                      |   | 0.3m frozen   |    |    |
| 0.3           | Organic silt, trace clay  |            |         |      |            |                            |                 |   |                  |              |            |                   |   |   |                |                                      |   |   |    |    |
|               | Very loose Dark Wet   |            | 2       | SS   | WH**       |                            |                 |   |                  |              |            |                   |   |   |                |                                      |   |   |    |    |
|               | thin layers of silty sand                                       |            |         |      |            |                            |                 |   |                  |              |            |                   |   |   |                |                                      |   |   |    |    |
|               |   |            | 3       | SS   | WH         |                            | 185             |   |                  |              |            |                   |   |   |                |                                      |   |   |    |    |
| 184.4         |   |            |         |      |            |                            |                 |   |                  |              |            |                   |   |   |                |                                      |   |   |    |    |
| 2.1           | Clayey silt, trace sand   |            |         | FV   |            |                            |                 |   |                  |              |            |                   |   |   |                |                                      |   |   |    |    |
|               | Firm Grey Wet   |            |         |      |            |                            | 184             |   |                  |              |            |                   |   |   |                |                                      |   |   |    |    |
|               |   |            | 4       | SS   | 1          |                            |                 |   |                  |              |            |                   |   |   |                |                                      |   |   |    |    |
|               | thin layers of silt   |            |         | FV   |            |                            |                 |   |                  |              |            |                   |   |   |                |                                      |   |   |    |    |
|               |   |            | 5       | TW   | PM         |                            | 182             |   |                  |              |            |                   |   |   |                |                                      |   |   |    |    |
|               |   |            |         | FV   |            |                            |                 |   |                  |              |            |                   |   |   |                |                                      |   |   |    |    |
|               | layers of silt  |            | 6       | TW   | PH         |                            | 180             |   |                  |              |            |                   |   |   |                |                                      |   |   |    |    |
|               |   |            | 7       | SS   | 6          |                            |                 |   |                  |              |            |                   |   |   |                |                                      |   |   |    |    |
| 178.9         |   |            |         | FV   |            |                            | 179             |   |                  |              |            |                   |   |   |                |                                      |   |   |    |    |
| 7.6           | Silt<br>trace clay, trace sand                                  |            | 8       | SS   | 6          |                            |                 |   |                  |              |            |                   |   |   |                |                                      |   |   |    |    |
|               | Loose Grey Wet  |            |         |      |            |                            | 178             |   |                  |              |            |                   |   |   |                |                                      |   |   |    |    |
| 177.8         | Sandy silt, trace clay  |            |         |      |            |                            |                 |   |                  |              |            |                   |   |   |                |                                      |   |   |    |    |
| 8.7           | Very loose Grey Wet   |            | 9       | SS   | WR         |                            | 177             |   |                  |              |            |                   |   |   |                |                                      |   |   |    |    |
| 176.8         |   |            |         |      |            |                            |                 |   |                  |              |            |                   |   |   |                |                                      |   |   |    |    |
| 9.7           | End of borehole   |            |         |      |            |                            |                 |   |                  |              |            |                   |   |   |                |                                      |   |   |    |    |
|               | Probable sandy silt   |            |         |      |            |                            | 176             |   |                  |              |            |                   |   |   |                |                                      |   |   |    |    |
|               | Very loose<br>to loose  |            |         |      |            |                            |                 |   |                  |              |            |                   |   |   |                |                                      |   |   |    |    |
| 174.8         |   |            |         |      |            |                            | 175             |   |                  |              |            |                   |   |   |                |                                      |   |   |    |    |
| 11.7          | End of dynamic cone<br>penetration test                         |            |         |      |            |                            |                 |   |                  |              |            |                   |   |   |                |                                      |   |   |    |    |
|               | Refusal on probable bedrock                                     |            |         |      |            |                            |                 |   |                  |              |            |                   |   |   |                |                                      |   |   |    |    |
|               | * 2007 02 17  |            |         |      |            |                            |                 |   |                  |              |            |                   |   |   |                |                                      |   |   |    |    |
|               | ▽ Water level observed<br>during drilling                       |            |         |      |            |                            |                 |   |                  |              |            |                   |   |   |                |                                      |   |   |    |    |
|               | ▼ Water level measured<br>after drilling                        |            |         |      |            |                            |                 |   |                  |              |            |                   |   |   |                |                                      |   |   |    |    |
|               | WH** Denotes penetration due<br>to weight of hammer and<br>rods |            |         |      |            |                            |                 |   |                  |              |            |                   |   |   |                |                                      |   |   |    |    |
|               | WR Denotes penetration due<br>to weight of rods only            |            |         |      |            |                            |                 |   |                  |              |            |                   |   |   |                |                                      |   |   |    |    |
|               | C.F.H.S.A. - Denotes<br>Continuous Flight<br>Hollow Stem Augers |            |         |      |            |                            |                 |   |                  |              |            |                   |   |   |                |                                      |   |   |    |    |
|               |   |            |         |      |            |                            |                 |   |                  |              |            |                   |   |   |                |                                      |   | Sample 9:<br>'N' value<br>affected by<br>hydraulic<br>disturbance |    |    |

**RECORD OF BOREHOLE No 302-45**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+950, o/s 18.8m Rt. CL Med. ORIGINATED BY F.P.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE February 16, 2007 CHECKED BY G.D.

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |              |    |                  | PLASTIC<br>LIMIT<br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>w | LIQUID<br>LIMIT<br>w <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|---------------|---|------------|---------|------|------------|----------------------------|---|----|--------------|----|------------------|------------------------------------|-------------------------------------|-----------------------------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            | SHEAR STRENGTH kPa                          |    |              |    |                  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            | ○ UNCONFINED                                |    | + FIELD VANE |    | ● QUICK TRIAXIAL |                                    |                                     |                                   |  |  |
| 186.5         | Ground Surface  |            |         |      |            |                            | 20  | 40 | 60           | 80 | 100              |                                    |                                     |                                   |  |  |
| 0.0           | Peat, fine fibrous<br>Dark brown                                |            | 1       | AS   | -          | ▽*                         |   |    |              |    |                  |                                    |                                     |                                   |  |  |
| 0.3           | Organic silty clay  |            |         |      |            |                            |   |    |              |    |                  |                                    |                                     |                                   |  |  |
| 185.9         | Silty clay, trace sand  |            |         |      |            |                            |   |    |              |    |                  |                                    |                                     |                                   |  |  |
| 0.6           | Soft Grey Wet   |            | 2       | SS   | WH**       |                            |   |    |              |    |                  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |   |    |              |    |                  |                                    |                                     |                                   |  |  |
|               |   |            | 3       | SS   | WH         |                            |   |    |              |    |                  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |   |    |              |    |                  |                                    |                                     |                                   |  |  |
|               | thin layers of silt   |            |         | FV   |            |                            |   |    |              |    |                  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |   |    |              |    |                  |                                    |                                     |                                   |  |  |
|               |   |            | 4       | SS   | 1          |                            |   |    |              |    |                  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |   |    |              |    |                  |                                    |                                     |                                   |  |  |
|               | layered with silt   |            |         | FV   |            |                            |   |    |              |    |                  |                                    |                                     |                                   |  |  |
|               | Firm  |            |         |      |            |                            |   |    |              |    |                  |                                    |                                     |                                   |  |  |
|               |   |            | 5       | SS   | 4          |                            |   |    |              |    |                  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |   |    |              |    |                  |                                    |                                     |                                   |  |  |
| 180.7         | Sandy silt, trace clay  |            |         |      |            |                            |   |    |              |    |                  |                                    |                                     |                                   |  |  |
| 5.8           | Very loose Grey Wet   |            | 6       | SS   | WR         |                            |   |    |              |    |                  |                                    |                                     |                                   |  |  |
| 179.8         | End of borehole   |            |         |      |            |                            |   |    |              |    |                  |                                    |                                     |                                   |  |  |
| 6.7           | Probable sandy silt   |            |         |      |            |                            |   |    |              |    |                  |                                    |                                     |                                   |  |  |
|               | Very loose<br>to compact  |            |         |      |            |                            |   |    |              |    |                  |                                    |                                     |                                   |  |  |
| 178.7         | End of dynamic cone<br>penetration test                         |            |         |      |            |                            |   |    |              |    |                  |                                    |                                     |                                   |  |  |
| 7.8           | Refusal on probable bedrock                                     |            |         |      |            |                            |   |    |              |    |                  |                                    |                                     |                                   |  |  |
|               | Sample 6: 'N'~ value<br>affected by hydraulic<br>disturbance    |            |         |      |            |                            |   |    |              |    |                  |                                    |                                     |                                   |  |  |
|               | * 2007 02 16  |            |         |      |            |                            |   |    |              |    |                  |                                    |                                     |                                   |  |  |
|               | ▽ Water level observed<br>during drilling                       |            |         |      |            |                            |   |    |              |    |                  |                                    |                                     |                                   |  |  |
|               | ▼ Water level measured<br>after drilling                        |            |         |      |            |                            |   |    |              |    |                  |                                    |                                     |                                   |  |  |
|               | WH** Denotes penetration due<br>to weight of hammer and<br>rods |            |         |      |            |                            |   |    |              |    |                  |                                    |                                     |                                   |  |  |
|               | WR Denotes penetration due<br>to weight of rods                 |            |         |      |            |                            |   |    |              |    |                  |                                    |                                     |                                   |  |  |
|               | C.F.H.S.A. ~ Denotes<br>Continuous Flight Hollow<br>Stem Augers |            |         |      |            |                            |   |    |              |    |                  |                                    |                                     |                                   |  |  |

**METRIC**

| SOIL PROFILE   |  |            |        |      |            |
|--|--|------------|--------|------|------------|
| ELEV<br>DEPTH  | DESCRIPTION  | STRAT PLOT | NUMBER | TYPE | "N" VALUES |
| 186.5<br>0.0   | Ground Surface   |            |        |      |            |
| 186.0<br>0.5   | Peat, coarse fibrous Dark brown                                      |            | 1      | AS   | -          |
| 185.4<br>1.1   | Organic silt   |            |        |      |            |
|  | Very loose Dark Wet grey/brown                                       |            | 2      | SS   | WH**       |
|  | Clay, trace sand   |            |        |      |            |
|  | Soft to Grey Wet firm  |            | 3      | SS   | WH         |
|  |  |            |        | FV   |            |
|  |  |            |        |      |            |
|  |  |            | 4      | SS   | WH         |
|  |  |            |        | FV   |            |
|  | thin layers of silt  |            |        |      |            |
|  |  |            | 5      | SS   | 2          |
|  |  |            |        | FV   |            |
| 180.7<br>5.8   | Silt trace sand, trace clay thin layers of silty clay Loose Grey Wet |            | 6      | SS   | 5          |
|  |  |            |        |      |            |
|  |  |            | 7      | SS   | 5          |
| 178.1<br>8.4   | Sandy silt, trace clay Loose Grey Wet                                |            |        |      |            |
|  |  |            | 8      | SS   | 5          |
| 176.7<br>9.8   | End of borehole  |            |        |      |            |
| <div>*    2007   02   15</div> <div><div></div> Water level observed during drilling</div> <div><div></div> Water level measured after drilling</div> <div>WH** Denotes penetration due to weight of hammer and rods</div> |  |            |        |      |            |

**RECORD OF BOREHOLE No 302-49**

1 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 18+000, o/s 18.8m Lt. CL Med. ORIGINATED BY F.P.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE February 14, 2007 CHECKED BY G.D.

| SOIL PROFILE  |  |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |    |     | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|--|------------|---------|------|------------|----------------------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|--|---|
| ELEV<br>DEPTH | DESCRIPTION                                    | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            | SHEAR STRENGTH kPa                          |    |    |    |     |                                    |                                     |                                   |  |   |
| 186.5         | Ground Surface                                 |            |         |      |            |                            | 20  | 40 | 60 | 80 | 100 |                                    |                                     |                                   |  |   |
| 0.0           | Peat, fine fibrous<br>Dark brown               |            | 1       | AS   | -          | ↓*                         |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 186.0         | Organic clayey silt<br>sand seams              |            | 2       | SS   | 1          |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 0.5           | Very soft Grey Wet                             |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 185.1         | Clayey silt, trace sand<br>thin layers of silt |            | 3       | SS   | 1          |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 1.4           | Firm Grey Wet                                  |            |         | FV   |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               | thin layers of silt                            |            | 4       | SS   | 1          |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |  |            |         | FV   |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |  |            | 5       | SS   | WH**       |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |  |            |         | FV   |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |  |            | 6       | SS   | 2          |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |  |            |         | FV   |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 179.2         | Silt<br>some clay, trace sand                  |            | 7       | SS   | 4          |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 7.3           | Loose Grey Wet                                 |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |  |            | 8       | SS   | 6          |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 176.7         | End of borehole                                |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 9.8           | Probable silt<br>Very loose<br>to compact      |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |

Cont'd

**RECORD OF BOREHOLE No 302-49**

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**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 18+000, o/s 18.8m Lt. CL Med. ORIGINATED BY F.P.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE February 14, 2007 CHECKED BY G.D.







| SOIL PROFILE  |  |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                  |   |            |  | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|------------------|---|------------|--|------------------------------------|-------------------------------------|-----------------------------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION  | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |                  |   |            |  |                                    |                                     |                                   |  |  |
| 171.5         |  |            |         |      |            |                            |                 | 20 40 60 80 100                             | ○ UNCONFINED     | + | FIELD VANE |  |                                    |                                     |                                   |  |  |
|               |  |            |         |      |            |                            |                 | 20 40 60 80 100                             | ● QUICK TRIAXIAL | × | LAB VANE   |  |                                    |                                     |                                   |  |  |
| 167.7         |  |            |         |      |            |                            |                 |   |                  |   |            |  |                                    |                                     |                                   |  |  |
| 18.8          | End of dynamic cone<br>penetration test<br>Refusal on probable bedrock |            |         |      |            |                            |                 |   |                  |   |            |  |                                    |                                     |                                   |  |  |
|               | * 2007 02 14   |            |         |      |            |                            |                 |   |                  |   |            |  |                                    |                                     |                                   |  |  |
|               | ▽ Water level observed<br>during drilling                              |            |         |      |            |                            |                 |   |                  |   |            |  |                                    |                                     |                                   |  |  |
|               | ▼ Water level measured<br>after drilling                               |            |         |      |            |                            |                 |   |                  |   |            |  |                                    |                                     |                                   |  |  |
|               | WH** Denotes penetration due<br>to weight of hammer and<br>rods        |            |         |      |            |                            |                 |   |                  |   |            |  |                                    |                                     |                                   |  |  |
|               | C.F.H.S.A. - Denotes<br>Continuous Flight Hollow<br>Stem Augers        |            |         |      |            |                            |                 |   |                  |   |            |  |                                    |                                     |                                   |  |  |

**RECORD OF BOREHOLE No 302-50**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 18+000, o/s 18.8m Rt. CL Med. ORIGINATED BY F.P.  
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
DATUM Geodetic DATE February 12, 2007 CHECKED BY G.D.

| SOIL PROFILE  |  |   | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                  |              |            |     | PLASTIC LIMIT<br>NATURAL MOISTURE<br>CONTENT<br>LIQUID LIMIT |   |                | UNIT<br>WEIGHT<br><br>γ<br><br>kN/m³ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |  |  |  |
|---------------|--|---|---------|------|------------|----------------------------|-----------------|---|------------------|--------------|------------|-----|--|---|----------------|--------------------------------------|---|--|--|--|
| ELEV<br>DEPTH | DESCRIPTION  | STRAT PLOT  | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |                  |              |            |     | W <sub>P</sub>   | W | W <sub>L</sub> |                                      |   |  |  |  |
|               |  |   |         |      |            |                            |                 | ○ UNCONFINED                                | ● QUICK TRIAXIAL | + FIELD VANE | × LAB VANE |     |  |   |                |                                      |   |  |  |  |
| 186.5         | Ground Surface   |   |         |      |            |                            |                 | 20  | 40               | 60           | 80         | 100 |  |   |                |                                      |   |  |  |  |
| 0.0           | Peat, fine fibrous<br>Dark brown   |    | 1       | AS   | -          |                            |                 |   |                  |              |            |     |  |   |                |                                      |   |  |  |  |
| 185.6         |  |   |         |      |            |                            | 186             |   |                  |              |            |     |  |   |                |                                      |   |  |  |  |
| 0.9           | Clayey silt, trace sand<br>thin layers of silty clay<br>Soft Grey Wet  |    | 2       | SS   | 1          |                            |                 |   |                  |              |            |     |  |   |                |                                      | 287   |  |  |  |
|               |  |   | 3       | SS   | WH**       |                            |                 |   |                  |              |            |     |  |   |                |                                      |   |  |  |  |
|               |  |   |         | FV   |            |                            |                 |   |                  |              |            |     |  |   |                |                                      |   |  |  |  |
|               | thin silt seams  |   |         |      |            |                            |                 |   |                  |              |            |     |  |   |                |                                      |   |  |  |  |
|               | Firm   |   | 4       | SS   | 1          |                            |                 |   |                  |              |            |     |  |   |                |                                      |   |  |  |  |
|               |  |   |         | FV   |            |                            |                 |   |                  |              |            |     |  |   |                |                                      |   |  |  |  |
|               |  |   | 5       | SS   | 1          |                            |                 |   |                  |              |            |     |  |   |                |                                      |   |  |  |  |
|               |  |   |         | FV   |            |                            |                 |   |                  |              |            |     |  |   |                |                                      |   |  |  |  |
|               | thin layers of sand  |   | 6       | SS   | 4          |                            |                 |   |                  |              |            |     |  |   |                |                                      |   |  |  |  |
|               |  |   |         | FV   |            |                            |                 |   |                  |              |            |     |  |   |                |                                      |   |  |  |  |
| 179.2         |  |   |         |      |            |                            |                 |   |                  |              |            |     |  |   |                |                                      |   |  |  |  |
| 7.3           | Silt, trace clay<br>Loose Grey Wet   |  | 7       | SS   | 7          |                            |                 |   |                  |              |            |     |  |   |                |                                      |   |  |  |  |
|               |  |   |         |      |            |                            |                 |   |                  |              |            |     |  |   |                |                                      |   |  |  |  |
| 177.7         |  |   |         |      |            |                            |                 |   |                  |              |            |     |  |   |                |                                      |   |  |  |  |
| 8.8           | Silty sand<br>Very loose Grey Wet<br>to loose  |  | 8       | SS   | WH         |                            |                 |   |                  |              |            |     |  |   |                |                                      |   |  |  |  |
|               |  |   |         |      |            |                            |                 |   |                  |              |            |     |  |   |                |                                      |   |  |  |  |
|               | trace silt   |   | 9       | SS   | 2          |                            |                 |   |                  |              |            |     |  |   |                |                                      |   |  |  |  |
|               |  |   |         |      |            |                            |                 |   |                  |              |            |     |  |   |                |                                      |   |  |  |  |
|               |  |   | 10      | SS   | 6          |                            |                 |   |                  |              |            |     |  |   |                |                                      |   |  |  |  |
|               |  |   |         |      |            |                            |                 |   |                  |              |            |     |  |   |                |                                      |   |  |  |  |
| 173.5         |  |   |         |      |            |                            |                 |   |                  |              |            |     |  |   |                |                                      |   |  |  |  |
| 13.0          | End of borehole<br>Refusal on probable bedrock<br>* 2007 02 12<br> Water level observed during drilling<br> Water level measured after drilling<br>WH** Denotes penetration due to weight of hammer and rods |   |         |      |            |                            |                 |   |                  |              |            |     |  |   |                |                                      |   | Sample 8 & 9:<br>'N'- values affected by hydraulic disturbance |  |  |

**RECORD OF BOREHOLE No 302-51**

1 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 18+025, o/s 34.0m Lt. CL Med. ORIGINATED BY F.P.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE February 16, 2007 CHECKED BY G.D.

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |    |     | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|---|------------|---------|------|------------|----------------------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|--|---|
| ELEV<br>DEPTH | DESCRIPTION                                     | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            | SHEAR STRENGTH kPa                          |    |    |    |     |                                    |                                     |                                   |  |   |
| 186.5         | Ground Surface                                  |            |         |      |            |                            | 20  | 40 | 60 | 80 | 100 |                                    |                                     |                                   |  |   |
| 0.0           | Peat, coarse fibrous<br>Dark brown              |            | 1       | SS   | 5          | ↓*                         |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 0.3           | Clayey silt, trace sand<br>layers of silty sand |            |         |      |            | ↓                          |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 185.6         | Firm Mottled Moist<br>grey/brown                |            | 2       | SS   | 7          |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 0.9           | Silty sand                                      |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               | Loose to Grey Wet<br>compact                    |            | 3       | SS   | 13         |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 184.1         |   |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 2.4           | Clayey silt, trace sand                         |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               | Firm Grey Wet                                   |            | 4       | SS   | 2          |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |   |            |         | FV   |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |   |            | 5       | SS   | 1          |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |   |            |         | FV   |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               | thin layers of silt                             |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |   |            | 6       | SS   | 2          |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |   |            |         | FV   |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |   |            | 7       | SS   | 5          |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |   |            |         | FV   |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 177.7         |   |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 8.8           | Silt<br>trace sand, trace clay                  |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               | Loose to Grey Wet<br>very loose                 |            | 8       | SS   | 7          |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |   |            | 9       | SS   | WR**       |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 175.2         |   |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 11.3          | End of borehole                                 |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               | Probable silt                                   |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               | Loose to<br>compact                             |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |

Cont'd

**RECORD OF BOREHOLE No 302-51**

2 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 18+025, o/s 34.0m Lt. CL Med. ORIGINATED BY F.P.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE February 16, 2007 CHECKED BY G.D.

| SOIL PROFILE  |  |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS                               | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |     |                   |    | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|---------------|--|------------|---------|------|------------|--|-----------------|---|----|-----|-------------------|----|------------------------------------|-------------------------------------|-----------------------------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION  | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |  |                 | SHEAR STRENGTH kPa                          |    |     |                   |    |                                    |                                     |                                   |  |  |
|               |  |            |         |      |            | ○ UNCONFINED + FIELD VANE<br>● QUICK TRIAXIAL × LAB VANE |                 |   |    |     | WATER CONTENT (%) |    |                                    |                                     |                                   |  |  |
|               |  |            |         |      |            | 20   | 40              | 60  | 80 | 100 | 20                | 40 | 60                                 |                                     |                                   |  |  |
| 171.5         |  |            |         |      |            |  |                 |   |    |     |                   |    |                                    |                                     |                                   |  |  |
|               |  |            |         |      |            |  |                 |   |    |     |                   |    |                                    |                                     |                                   |  |  |
|               |  |            |         |      |            |  |                 |   |    |     |                   |    |                                    |                                     |                                   |  |  |
|               |  |            |         |      |            |  |                 |   |    |     |                   |    |                                    |                                     |                                   |  |  |
|               |  |            |         |      |            |  |                 |   |    |     |                   |    |                                    |                                     |                                   |  |  |
|               |  |            |         |      |            |  |                 |   |    |     |                   |    |                                    |                                     |                                   |  |  |
| 166.7         |  |            |         |      |            |  |                 |   |    |     |                   |    |                                    |                                     |                                   |  |  |
| 19.8          | End of dynamic cone<br>penetration test<br><br>Sample 9: 'N'- value<br>affected by hydraulic<br>disturbance<br><br>* 2007 02 16<br><br>▽ Water level observed<br>during drilling<br><br>▼ Water level measured<br>after drilling<br><br>WR** Denotes penetration due<br>to weight of rods<br><br>C.F.H.S.A. - Denotes<br>Continuous Flight Hollow<br>Stem Augers |            |         |      |            |  |                 |   |    |     |                   |    |                                    |                                     |                                   |  |  |



**RECORD OF BOREHOLE No 302-53**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 18+025, o/s 34.1m Rt. CL Med. ORIGINATED BY F.P.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE February 13, 2007 CHECKED BY G.D.

| SOIL PROFILE  |  |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |    |     | PLASTIC<br>LIMIT<br>W <sub>P</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup>  | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |                   |  |  |
|---------------|--|------------|---------|------|------------|----------------------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|---|---|-------------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION  | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            | SHEAR STRENGTH kPa                          |    |    |    |     |                                    |                                     |                                   |   |   | WATER CONTENT (%) |  |  |
|               |  |            |         |      |            |                            | ○ UNCONFINED      + FIELD VANE              |    |    |    |     |                                    |                                     |                                   |   |   |                   |  |  |
|               |  |            |         |      |            |                            | ● QUICK TRIAXIAL      × LAB VANE            |    |    |    |     |                                    |                                     |                                   |   |   |                   |  |  |
| 186.5         | Ground Surface   |            |         |      |            |                            | 20  | 40 | 60 | 80 | 100 | 20                                 | 40                                  | 60                                |   |   |                   |  |  |
| 0.0           | Peat, fine fibrous<br>Dark brown   |            | 1       | AS   | -          | ▼*                         |   |    |    |    |     |                                    |                                     |                                   |   | 0.5m frozen                                       |                   |  |  |
| 185.9         | Clayey silt, organics  |            |         |      |            | ▼*                         |   |    |    |    |     |                                    |                                     |                                   |   |   |                   |  |  |
| 0.6           | Soft to Grey Wet<br>firm   |            | 2       | SS   | WH**       |                            |   |    |    |    |     |                                    |                                     |                                   |   |   |                   |  |  |
|               |  |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |   |   |                   |  |  |
|               |  |            | 3       | SS   | 1          |                            |   |    |    |    |     |                                    |                                     |                                   |   |   |                   |  |  |
|               |  |            |         | FV   |            |                            |   |    |    |    |     |                                    |                                     |                                   |   |   |                   |  |  |
|               | thin layers of silt  |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |   |   |                   |  |  |
|               |  |            | 4       | SS   | WH         |                            |   |    |    |    |     |                                    |                                     |                                   |   |   |                   |  |  |
|               |  |            |         | FV   |            |                            |   |    |    |    |     |                                    |                                     |                                   |   |   |                   |  |  |
|               |  |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |   |   |                   |  |  |
|               |  |            | 5       | SS   | WH         |                            |   |    |    |    |     |                                    |                                     |                                   |   |   |                   |  |  |
|               |  |            |         | FV   |            |                            |   |    |    |    |     |                                    |                                     |                                   |   |   |                   |  |  |
|               |  |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |   |   |                   |  |  |
| 180.7         | Silt<br>trace clay, trace sand<br>thin layers of clayey silt   |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |   |   |                   |  |  |
| 5.8           | Loose Grey Wet   |            | 6       | SS   | 4          |                            |   |    |    |    |     |                                    |                                     |                                   |   |   |                   |  |  |
|               |  |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |   |   |                   |  |  |
|               |  |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |   |   |                   |  |  |
|               |  |            | 7       | SS   | 5          |                            |   |    |    |    |     |                                    |                                     |                                   |   |   |                   |  |  |
|               |  |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |   |   |                   |  |  |
| 178.0         | Sand, with silt  |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |   |   |                   |  |  |
| 8.5           | Very loose Grey Wet  |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |   |   |                   |  |  |
|               |  |            | 8       | SS   | WH         |                            |   |    |    |    |     |                                    |                                     |                                   |   |   |                   |  |  |
| 176.8         | End of borehole  |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |   |   |                   |  |  |
| 9.7           | Probable sand  |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |   |   |                   |  |  |
|               | Very loose<br>to compact   |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |   |   |                   |  |  |
|               |  |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |   |   |                   |  |  |
| 173.8         |  |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |   |   |                   |  |  |
| 12.7          | End of dynamic cone<br>penetration test<br>* 2007 02 13<br>▽ Water level observed<br>during drilling<br>▼ Water level measured<br>after drilling<br>WH** Denotes penetration due<br>to weight of hammer and<br>rods<br>C.F.H.S.A. - Denotes<br>Continuous Flight Hollow<br>Stem Augers |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   | Refusal on<br>probable<br>bedrock<br><br>Sample 8:<br>'N'- value<br>affected by<br>hydraulic<br>disturbance |   |                   |  |  |

**RECORD OF BOREHOLE No 302-54**

1 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 18+050, o/s 18.8m Lt. CL Med. ORIGINATED BY F.P.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE February 14, 2007 CHECKED BY G.D.

| SOIL PROFILE  |                                  |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |              |     |  | PLASTIC<br>LIMIT<br><br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br><br>w | LIQUID<br>LIMIT<br><br>w <sub>L</sub> | UNIT<br>WEIGHT<br><br>γ<br><br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br><br>GR SA SI CL |                   |  |  |
|---------------|----------------------------------|------------|---------|------|------------|----------------------------|-----------------|---|----|--------------|-----|--|--|---|---------------------------------------|--|--|-------------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION                      | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |    |              |     |  |  |   |                                       |  |  | WATER CONTENT (%) |  |  |
|               |                                  |            |         |      |            |                            |                 | ○ UNCONFINED                                |    | + FIELD VANE |     |  |  |   |                                       |  |  | ○                 |  |  |
|               |                                  |            |         |      |            |                            |                 | ● QUICK TRIAXIAL                            |    | × LAB VANE   |     |  |  |   |                                       |  |  |                   |  |  |
| 186.5         | Ground Surface                   |            |         |      |            |                            | 20              | 40  | 60 | 80           | 100 |  |  |   |                                       |  |  |                   |  |  |
| 0.0           | Peat, fine fibrous<br>Dark brown |            | 1       | AS   | -          | ↓                          |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
| 186.0         | Organic silt                     |            |         |      |            |                            | 186             |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
| 0.5           | Very loose Dark Wet              |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
| 185.6         | Clayey silt, trace sand          |            | 2       | SS   | WH**       |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
| 0.9           | Firm Grey Wet                    |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            | 3       | SS   | WH         |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         | FV   |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            | 185             |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               | thin layers of silt              |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            | 4       | SS   | WH         |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         | FV   |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               | thin layers of silt              |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            | 5       | SS   | WH         |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         | FV   |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            | 6       | SS   | 1          |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         | FV   |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
| 179.2         | Silt                             |            |         |      |            |                            | 181             |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
| 7.3           | trace clay, trace sand           |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               | thin layers of sandy silt        |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               | Loose Grey Wet                   |            | 7       | SS   | 7          |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            | 8       | SS   | 7          |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
| 176.8         | End of borehole                  |            |         |      |            |                            | 180             |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
| 9.7           | Probable silt                    |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               | Loose to compact                 |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |
|               |                                  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |  |

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RECORD OF BOREHOLE No 302-54

2 of 2

METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 18+050, o/s 18.8m Lt. CL Med. ORIGINATED BY F.P.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE February 14, 2007 CHECKED BY G.D.

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |    |     | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|--|---|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |    |    |    |     |                                    |                                     |                                   |  |   |
| 171.5         |   |            |         |      |            |                            |                 | 20  | 40 | 60 | 80 | 100 |                                    |                                     |                                   |  |   |
| 171           |   |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 170           |   |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 169           |   |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 168           |   |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 167.3         |   |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 19.2          | End of dynamic cone<br>penetration test                         |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               | * 2007 02 14  |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               | ▽ Water level observed<br>during drilling                       |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               | ▼ Water level measured<br>after drilling                        |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               | WH** Denotes penetration due<br>to weight of hammer and<br>rods |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               | C.F.H.S.A. - Denotes<br>Continuous Flight Hollow<br>Stem Augers |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |  |   |

**RECORD OF BOREHOLE No 302-55**

1 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 18+050, o/s 18.8m Rt. CL Med. ORIGINATED BY F.P.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE February 13, 2007 CHECKED BY G.D.

| SOIL PROFILE  |                                      |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |    |     | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|--------------------------------------|------------|---------|------|------------|----------------------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|--|---|
| ELEV<br>DEPTH | DESCRIPTION                          | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            | SHEAR STRENGTH kPa                          |    |    |    |     |                                    |                                     |                                   |  |   |
| 186.5         | Ground Surface                       |            |         |      |            |                            | 20  | 40 | 60 | 80 | 100 |                                    |                                     |                                   |  |   |
| 0.0           | Peat, fine fibrous<br>Dark brown     |            | 1       | AS   | -          |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 186.0         | Organic silt<br>trace to some clay   |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 0.5           |                                      |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 185.3         | Very Dark Wet<br>loose grey          |            | 2       | SS   | WH**       |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 1.2           | Clayey silt, trace sand              |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               | Soft to Grey Wet<br>firm             |            | 3       | SS   | 1          |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |                                      |            |         | FV   |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |                                      |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |                                      |            | 4       | SS   | WH         |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |                                      |            |         | FV   |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |                                      |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |                                      |            | 5       | SS   | 3          |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |                                      |            |         | FV   |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |                                      |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |                                      |            | 6       | SS   | 2          |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |                                      |            |         | FV   |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |                                      |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 179.5         | Silt<br>trace clay, trace sand       |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 7.0           | Loose Grey Wet                       |            | 7       | SS   | 6          |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |                                      |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |                                      |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |                                      |            | 8       | SS   | WH         |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 176.8         | End of borehole                      |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 9.7           | Probable silt<br>Loose to<br>compact |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |

Cont'd

## METRIC

(%) STRAIN AT FAILURE

**RECORD OF BOREHOLE No 302-57**

1 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 18+075 CL Med. ORIGINATED BY F.P.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE February 15, 2007 CHECKED BY G.D.

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |    |     | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|---|------------|---------|------|------------|----------------------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|--|---|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            | SHEAR STRENGTH kPa                          |    |    |    |     |                                    |                                     |                                   |  |   |
| 186.5         | Ground Surface  |            |         |      |            |                            | 20  | 40 | 60 | 80 | 100 |                                    |                                     |                                   |  |   |
| 0.0           | Peat, fine fibrous<br>Dark brown                            |            | 1       | AS   | -          |                            |   |    |    |    |     |                                    |                                     |                                   |  | 0.4m frozen                                       |
| 186.0         | Organic silt  |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 0.5           | Very loose Dark Wet<br>brown                                |            | 2       | SS   | 1          |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 185.4         | Silty clay, trace sand                                      |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 1.1           | Firm Grey Wet   |            | 3       | SS   | 1          |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |   |            |         | FV   |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |   |            | 4       | SS   | WH**       |                            |   |    |    |    |     |                                    |                                     |                                   |  | 0 1 38 61   |
|               |   |            |         | FV   |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               | thin layers of silt   |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |   |            | 5       | SS   | 1          |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |   |            |         | FV   |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |   |            | 6       | SS   | 1          |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 179.6         | Silt<br>trace clay, trace sand<br>thin layers of sandy silt |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 6.9           | Loose Grey Wet  |            | 7       | SS   | 7          |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |   |            | 8       | SS   | 5          |                            |   |    |    |    |     |                                    |                                     |                                   |  | 0 6 90 4  |
|               |   |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 176.1         | Sand and silt, trace clay                                   |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 10.4          | Very loose Grey Wet   |            | 9       | SS   | WR***      |                            |   |    |    |    |     |                                    |                                     |                                   |  | 0 45 53 2   |
| 175.2         | End of borehole   |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 11.3          | Probable sand and silt                                      |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               | Very loose<br>to compact                                    |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |

Cont'd

**RECORD OF BOREHOLE No 302-57**

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**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 18+075 CL Med. ORIGINATED BY F.P.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE February 15, 2007 CHECKED BY G.D.

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                   |            |    |    | PLASTIC<br>LIMIT<br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>w | LIQUID<br>LIMIT<br>w <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |  |  |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|-------------------|------------|----|----|------------------------------------|-------------------------------------|-----------------------------------|--|--|--|--|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |                   |            |    |    |                                    |                                     |                                   |  |  |  |  |
|               |   |            |         |      |            |                            |                 | ○ UNCONFINED                                | +                 | FIELD VANE |    |    |                                    |                                     |                                   |  |  |  |  |
|               |   |            |         |      |            | ● QUICK TRIAXIAL           | ×               | LAB VANE                                    | WATER CONTENT (%) |            |    |    |                                    |                                     |                                   |  |  |  |  |
|               |   |            |         |      |            | 20                         | 40              | 60  | 80                | 100        | 20 | 40 | 60                                 |                                     |                                   |  |  |  |  |
| 171.5         |   |            |         |      |            |                            |                 |   |                   |            |    |    |                                    |                                     |                                   |  |  |  |  |
|               |   |            |         |      |            |                            | 171             |   |                   |            |    |    |                                    |                                     |                                   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |                   |            |    |    |                                    |                                     |                                   |  |  |  |  |
| 169.7         |   |            |         |      |            |                            | 170             |   |                   |            |    |    |                                    |                                     |                                   |  |  |  |  |
| 16.8          | End of dynamic cone penetration test                      |            |         |      |            |                            |                 |   |                   |            |    |    |                                    |                                     |                                   |  |  |  |  |
|               | Sample 9: 'N'- value affected by hydraulic disturbance    |            |         |      |            |                            |                 |   |                   |            |    |    |                                    |                                     |                                   |  |  |  |  |
|               | * 2007 02 15  |            |         |      |            |                            |                 |   |                   |            |    |    |                                    |                                     |                                   |  |  |  |  |
|               | ▽ Water level observed during drilling                    |            |         |      |            |                            |                 |   |                   |            |    |    |                                    |                                     |                                   |  |  |  |  |
|               | ▼ Water level measured after drilling                     |            |         |      |            |                            |                 |   |                   |            |    |    |                                    |                                     |                                   |  |  |  |  |
|               | WH** Denotes penetration due to weight of hammer and rods |            |         |      |            |                            |                 |   |                   |            |    |    |                                    |                                     |                                   |  |  |  |  |
|               | WR*** Denotes penetration due to weight of rods only      |            |         |      |            |                            |                 |   |                   |            |    |    |                                    |                                     |                                   |  |  |  |  |
|               | C.F.H.S.A. - Denotes Continuous Flight Hollow Stem Augers |            |         |      |            |                            |                 |   |                   |            |    |    |                                    |                                     |                                   |  |  |  |  |

**RECORD OF BOREHOLE No 302-59**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 18+100, o/s 18.8m Lt. CL Med. ORIGINATED BY T.X.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 18, 2007 CHECKED BY G.D.

| SOIL PROFILE  |  |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE   | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |     |  | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT |   |                | UNIT<br>WEIGHT<br><br>γ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |             |
|---------------|--|------------|---------|------|------------|----------------------------|-------------------|---|----|----|-----|--|---|---|----------------|-------------------------|---|-------------|
| ELEV<br>DEPTH | DESCRIPTION  | STRAT PLOT | NUMBER  | TYPE | *N' VALUES |                            |                   | SHEAR STRENGTH kPa                          |    |    |     |  | w <sub>p</sub>                                      | w | w <sub>L</sub> |                         |   |             |
|               |  |            |         |      |            |                            |                   | ○ UNCONFINED + FIELD VANE                   |    |    |     |  |   |   |                |                         |   |             |
|               |  |            |         |      |            |                            |                   | ● QUICK TRIAXIAL × LAB VANE                 |    |    |     |  |   |   |                |                         |   |             |
|               |  |            |         |      |            |                            | WATER CONTENT (%) |   |    |    |     |  |   |   |                |                         |   |             |
| 186.5         | Top of Ice   |            |         |      |            |                            | 20                | 40  | 60 | 80 | 100 |  |   |   |                |                         |   | GR SA SI CL |
| 0.0           | Ice  |            |         |      |            |                            | 20                | 40  | 60 | 80 | 100 |  |   |   |                |                         |   |             |
| 0.2           | Peat, fine fibrous   |            | 1       | SS   | 6          |                            |                   |   |    |    |     |  |   |   |                |                         |   | 0.3m frozen |
| 186.0         |  |            |         |      |            |                            |                   |   |    |    |     |  |   |   |                |                         |   |             |
| 0.5           | Dark brown   |            |         |      |            |                            |                   |   |    |    |     |  |   |   |                |                         |   |             |
|               | Silty clay, varved   |            |         |      |            |                            |                   |   |    |    |     |  |   |   |                |                         |   |             |
|               | Soft to firm Brown/ Wet  |            | 2       | SS   | WH**       |                            |                   |   |    |    |     |  |   |   |                |                         |   |             |
|               | grey   |            |         |      |            |                            |                   |   |    |    |     |  |   |   |                |                         |   |             |
|               | trace sand   |            |         |      |            |                            |                   |   |    |    |     |  |   |   |                |                         |   |             |
|               | Grey   |            | 3       | SS   | WH         |                            |                   |   |    |    |     |  |   |   |                |                         |   | 0 8 28 64   |
|               |  |            |         | FV   |            |                            |                   |   |    |    |     |  |   |   |                |                         |   |             |
|               |  |            |         |      |            |                            |                   |   |    |    |     |  |   |   |                |                         |   |             |
| 183.5         |  |            |         |      |            |                            |                   |   |    |    |     |  |   |   |                |                         |   |             |
| 3.0           | Clayey silt, trace sand  |            |         |      |            |                            |                   |   |    |    |     |  |   |   |                |                         |   |             |
|               | Soft Brown Wet   |            | 4       | SS   | WH         |                            |                   |   |    |    |     |  |   |   |                |                         |   |             |
|               |  |            |         | FV   |            |                            |                   |   |    |    |     |  |   |   |                |                         |   |             |
|               |  |            |         |      |            |                            |                   |   |    |    |     |  |   |   |                |                         |   |             |
|               |  |            | 5       | SS   | 1          |                            |                   |   |    |    |     |  |   |   |                |                         |   | 0 1 80 19   |
|               |  |            |         | FV   |            |                            |                   |   |    |    |     |  |   |   |                |                         |   |             |
|               |  |            |         |      |            |                            |                   |   |    |    |     |  |   |   |                |                         |   |             |
| 180.6         |  |            |         |      |            |                            |                   |   |    |    |     |  |   |   |                |                         |   |             |
| 5.9           | Silt<br>some clay, trace sand                                      |            |         |      |            |                            |                   |   |    |    |     |  |   |   |                |                         |   |             |
|               | Very loose Grey Wet  |            | 6       | SS   | 2          |                            |                   |   |    |    |     |  |   |   |                |                         |   | 0 1 84 15   |
|               |  |            |         |      |            |                            |                   |   |    |    |     |  |   |   |                |                         |   |             |
|               |  |            |         |      |            |                            |                   |   |    |    |     |  |   |   |                |                         |   |             |
| 179.3         |  |            |         |      |            |                            |                   |   |    |    |     |  |   |   |                |                         |   |             |
| 7.2           | Sandy silt   |            |         |      |            |                            |                   |   |    |    |     |  |   |   |                |                         |   |             |
|               | Very loose Grey Wet<br>to loose                                    |            | 7       | SS   | 4          |                            |                   |   |    |    |     |  |   |   |                |                         |   |             |
|               |  |            |         |      |            |                            |                   |   |    |    |     |  |   |   |                |                         |   |             |
|               |  |            |         |      |            |                            |                   |   |    |    |     |  |   |   |                |                         |   |             |
| 178.0         |  |            |         |      |            |                            |                   |   |    |    |     |  |   |   |                |                         |   |             |
| 8.5           | End of borehole  |            |         |      |            |                            |                   |   |    |    |     |  |   |   |                |                         |   |             |
|               | Refusal on probable bedrock  |            |         |      |            |                            |                   |   |    |    |     |  |   |   |                |                         |   |             |
|               | Samples 6 & 7: 'N'- values<br>affected by hydraulic<br>disturbance |            |         |      |            |                            |                   |   |    |    |     |  |   |   |                |                         |   |             |
|               | * 2007 02 18   |            |         |      |            |                            |                   |   |    |    |     |  |   |   |                |                         |   |             |
|               | ▽ Water level observed<br>during drilling                          |            |         |      |            |                            |                   |   |    |    |     |  |   |   |                |                         |   |             |
|               | ▼ Water level measured<br>after drilling                           |            |         |      |            |                            |                   |   |    |    |     |  |   |   |                |                         |   |             |
|               | WH** Denotes penetration due<br>to weight of hammer and<br>rods    |            |         |      |            |                            |                   |   |    |    |     |  |   |   |                |                         |   |             |



**RECORD OF BOREHOLE No 302-60**

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**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 18+100, o/s 18.8m Rt. CL Med. ORIGINATED BY N.R.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 17, 2007 CHECKED BY G.D.

| SOIL PROFILE  |                        |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |    |     | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>w | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|------------------------|------------|---------|------|------------|----------------------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|--|---|
| ELEV<br>DEPTH | DESCRIPTION            | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            | SHEAR STRENGTH kPa                          |    |    |    |     |                                    |                                     |                                   |  |   |
| 186.5         | Ground Surface         |            |         |      |            |                            | 20  | 40 | 60 | 80 | 100 |                                    |                                     |                                   |  |   |
| 0.0           | Peat, fine fibrous     |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 0.2           | Dark brown             |            | 1       | AS   | -          |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               | Organic silt           |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               | Very loose Dark Wet    |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 185.3         | grey                   |            | 2       | SS   | 2          |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 1.2           | Silty clay, trace sand |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               | Firm Grey Wet          |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |                        |            | 3       | SS   | 1          |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |                        |            |         | FV   |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |                        |            | 4       | SS   | 1          |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |                        |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               | layers of silt         |            |         | FV   |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |                        |            | 5       | SS   | WH**       |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |                        |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               | layers of silt         |            |         | FV   |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |                        |            | 6       | SS   | 2          |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 179.8         | Silt, trace clay       |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 6.7           | layers of sandy silt   |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               | Loose Grey Wet         |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |                        |            | 7       | SS   | 6          |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 178.0         |                        |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 8.5           | Silty sand             |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               | Very loose Grey Wet    |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               |                        |            | 8       | SS   | WR***      |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 176.8         |                        |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
| 9.7           | End of borehole        |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               | Probable silty sand    |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               | Loose                  |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               | to compact             |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |  |   |

Cont'd

**RECORD OF BOREHOLE No 302-60**

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**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 18+100, o/s 18.8m Rt. CL Med. ORIGINATED BY N.R.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 17, 2007 CHECKED BY G.D.

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                  |    |    |            | PLASTIC<br>LIMIT<br><br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br><br>w | LIQUID<br>LIMIT<br><br>w <sub>L</sub> | UNIT<br>WEIGHT<br><br>γ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |                   |  |  |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|------------------|----|----|------------|--|---|---------------------------------------|-------------------------|---|-------------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |                  |    |    |            |  |   |                                       |                         |   | WATER CONTENT (%) |  |  |
|               |   |            |         |      |            |                            |                 | ○ UNCONFINED                                | ● QUICK TRIAXIAL | +  | ×  | FIELD VANE |  |   |                                       |                         |   | LAB VANE          |  |  |
| 171.5         |   |            |         |      |            |                            |                 | 20  | 40               | 60 | 80 | 100        |  |   |                                       |                         |   |                   |  |  |
| 171.3         |   |            |         |      |            |                            |                 |   |                  |    |    |            |  |   |                                       |                         |   |                   |  |  |
| 15.2          | End of dynamic cone penetration test                      |            |         |      |            |                            |                 |   |                  |    |    |            |  |   |                                       |                         |   |                   |  |  |
|               | Sample 8: 'N'- value affected by hydraulic disturbance    |            |         |      |            |                            |                 |   |                  |    |    |            |  |   |                                       |                         |   |                   |  |  |
|               | * 2007 02 17  |            |         |      |            |                            |                 |   |                  |    |    |            |  |   |                                       |                         |   |                   |  |  |
|               | ▽ Water level observed during drilling                    |            |         |      |            |                            |                 |   |                  |    |    |            |  |   |                                       |                         |   |                   |  |  |
|               | WH** Denotes penetration due to weight of hammer and rods |            |         |      |            |                            |                 |   |                  |    |    |            |  |   |                                       |                         |   |                   |  |  |
|               | WR*** Denotes penetration due to weight of rods only      |            |         |      |            |                            |                 |   |                  |    |    |            |  |   |                                       |                         |   |                   |  |  |
|               | C.F.H.S.A. - Denotes Continuous Flight Hollow Stem Augers |            |         |      |            |                            |                 |   |                  |    |    |            |  |   |                                       |                         |   |                   |  |  |

## METRIC

**+<sup>7</sup>, X<sup>5</sup>:** Numbers refer to Sensitivity

**RECORD OF BOREHOLE No 302-63**

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**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 18+125, o/s 44.5m Rt. CL Med. ORIGINATED BY N.R.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE February 18, 2007 CHECKED BY G.D.

| SOIL PROFILE  |   | SAMPLES    |        |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |    |     | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|---|------------|--------|------|------------|----------------------------|-----------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |    |    |    |     |                                    |                                     |                                   |                     |   |
| 171.5         |   |            |        |      |            |                            |                 | 20  | 40 | 60 | 80 | 100 |                                    |                                     |                                   |                     |   |
|               | * 2007 02 18  |            |        |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               | ▽ Water level observed during drilling                    |            |        |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               | ▼ Water level measured after drilling                     |            |        |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               | WH** Denotes penetration due to weight of hammer and rods |            |        |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               | WR Denotes penetration due to weight of rods              |            |        |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               | C.F.H.S.A. - Denotes Continuous Flight Hollow Stem Augers |            |        |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |

**RECORD OF BOREHOLE No 302-64**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 18+150, o/s 18.8m Lt. CL Med. ORIGINATED BY N.R.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE February 26, 2007 CHECKED BY G.D.

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |    |     | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |    |    |    |     |                                    |                                     |                                   |                     |   |
| 186.5         | Top of Ice  |            |         |      |            |                            |                 | 20  | 40 | 60 | 80 | 100 |                                    |                                     |                                   |                     |   |
| 0.0           | Ice/Snow  |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
| 0.1           | Peat, fine fibrous<br>Dark brown                                |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
| 185.8         | Organic silt  |            |         |      |            |                            | 186             |   |    |    |    |     |                                    |                                     |                                   |                     |   |
| 0.7           | Very loose  |            | 1       | SS   | 2          |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
| 185.3         | Clayey silt, trace sand<br>layers of silt                       |            |         |      |            |                            | 185             |   |    |    |    |     |                                    |                                     |                                   |                     |   |
| 1.2           | Soft Grey Wet   |            | 2       | SS   | 1          |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               |   |            |         |      |            |                            | 184             |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               |   |            |         |      |            |                            | 183             |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               |   |            | 3       | SS   | 1          |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               |   |            |         | FV   |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
| 182.3         | Silt<br>trace clay, trace sand                                  |            |         |      |            |                            | 182             |   |    |    |    |     |                                    |                                     |                                   |                     |   |
| 4.2           | Loose Grey Wet  |            | 4       | SS   | 7          |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               |   |            |         |      |            |                            | 181             |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               | some sand   |            |         |      |            |                            | 180             |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               |   |            | 5       | SS   | 4          |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
| 179.8         | End of borehole   |            |         |      |            |                            | 179             |   |    |    |    |     |                                    |                                     |                                   |                     |   |
| 6.7           | Probable silt   |            |         |      |            |                            | 178             |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               | Very loose<br>to compact  |            |         |      |            |                            | 177             |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               |   |            |         |      |            |                            | 176             |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               |   |            |         |      |            |                            | 175             |   |    |    |    |     |                                    |                                     |                                   |                     |   |
| 174.3         | End of dynamic cone<br>penetration test                         |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
| 12.2          |   |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               | * 2007 02 26  |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               | Water level observed<br>during drilling                         |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               | Water level measured<br>after drilling                          |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
|               | C.F.H.S.A. - Denotes<br>Continuous Flight Hollow<br>Stem Augers |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |

**RECORD OF BOREHOLE No 302-65**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 18+150, o/s 18.8m Rt. CL Med. ORIGINATED BY N.R.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE February 20, 2007 CHECKED BY G.D.

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |              |     |  | PLASTIC<br>LIMIT<br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>w | LIQUID<br>LIMIT<br>w <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|----|--------------|-----|--|------------------------------------|-------------------------------------|-----------------------------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 | ○ UNCONFINED                                |    | + FIELD VANE |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            | 20              | 40  | 60 | 80           | 100 |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            | 20              | 40  | 60 | 80           | 100 |  |                                    |                                     |                                   |  |  |
| 186.5         | Top of Ice  |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
| 0.0           | Ice and snow  |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
| 0.2           | Peat, fine fibrous  |            | 1       | AS   | -          |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
| 0.3           | Dark brown  |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               | Organic silty clay  |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               | Very soft Dark Wet  |            | 2       | SS   | WH**       |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               | grey  |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
| 185.0         |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
| 1.5           | Clayey silt, trace sand   |            | 3       | SS   | WH         |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               | Firm Grey Wet   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         | FV   |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               | layers of silt  |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            | 4       | SS   | 2          |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         | FV   |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
| 181.4         |   |            | 5       | SS   | 4          |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
| 5.1           | Silt, trace clay  |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               | Loose to Grey Wet   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               | compact   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            | 6       | SS   | 22         |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
| 179.3         | Sand and silt, trace clay                                       |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
| 7.2           | Very loose Grey Wet   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            | 7       | SS   | WH         |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
| 178.3         |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
| 8.2           | End of borehole   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               | Probable sand and silt  |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               | Loose to  |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               | compact   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
| 174.3         |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
| 12.2          | End of dynamic cone<br>penetration test                         |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               | * 2007 02 20  |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               | Water level observed<br>during drilling                         |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               | Water level measured<br>after drilling                          |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               | WH** Denotes penetration due<br>to weight of hammer and<br>rods |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               | C.F.H.S.A. - Denotes<br>Continuous Flight Hollow<br>Stem Augers |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |

RECORD OF PENETRATION TEST No 302-22

1 of 1 METRIC



G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+725 CL Med. ORIGINATED BY T.X.  
DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE March 01, 2007 CHECKED BY G.D.

| SOIL PROFILE   |                                      |             | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |            |    |     | UNIT<br>WEIGHT<br>$\gamma$<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|----------------|--------------------------------------|-------------|---------|------|------------|----------------------------|-----------------|---|----|------------|----|-----|---|---|
| ELEV.<br>DEPTH | DESCRIPTION                          | STRAT. PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |    |            |    |     |   |   |
| 189.0          | Ground Surface                       |             |         |      |            |                            |                 | 20  | 40 | 60         | 80 | 100 |   |   |
| 0.0            | Probable peat                        |             |         |      |            |                            |                 | ○ UNCONFINED                                | +  | FIELD VANE |    |     |   |   |
|                | Probable silt/silty sand             |             |         |      |            |                            |                 | ● QUICK TRIAXIAL                            | x  | LAB VANE   |    |     |   |   |
|                | Loose to compact                     |             |         |      |            |                            |                 | 20  | 40 | 60         | 80 | 100 |   |   |
|                | Probable clayey silt                 |             |         |      |            |                            |                 |   |    |            |    |     |   |   |
|                | Firm to stiff                        |             |         |      |            |                            |                 |   |    |            |    |     |   |   |
|                | Probable silt                        |             |         |      |            |                            |                 |   |    |            |    |     |   |   |
|                | compact                              |             |         |      |            |                            |                 |   |    |            |    |     |   |   |
| 179.7          | End of dynamic cone penetration test |             |         |      |            |                            |                 |   |    |            |    |     |   |   |
| 9.3            | Refusal on probable bedrock          |             |         |      |            |                            |                 |   |    |            |    |     |   |   |

RECORD OF PENETRATION TEST No 302-26

1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+775, o/s 34.1m Lt. CL Med. ORIGINATED BY T.X.  
DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE March 03, 2007 CHECKED BY G.D.

| SOIL PROFILE  |  |  | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE  | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                            | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br><br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br><br>GR SA SI CL |                   |
|---------------|--|--|---------|------|------------|----------------------------|--|---|----------------------------|------------------------------------|-------------------------------------|-----------------------------------|--|--|-------------------|
| ELEV<br>DEPTH | DESCRIPTION  | STRAT PLOT   | NUMBER  | TYPE | "N" VALUES |                            |  | SHEAR STRENGTH kPa                          |                            |                                    |                                     |                                   |  |  | WATER CONTENT (%) |
|               |  |  |         |      |            |                            |  | ○ UNCONFINED<br>● QUICK TRIAXIAL            | + FIELD VANE<br>× LAB VANE |                                    |                                     |                                   |  |  |                   |
| 189.0<br>0.0  | Ground Surface<br><br>Probable peat<br>Probable silt/silty sand<br><br>Very loose<br>to compact<br><br><br><br>Probable clayey silt<br><br>Firm to<br>stiff<br><br><br>Probable silt/silty sand<br>Compact |  |         |      |            |                            |  |   |                            |                                    |                                     |                                   |  |  |                   |
| 180.8<br>8.2  | End of dynamic cone<br>penetration test<br>Refusal on probable bedrock   |  |         |      |            |                            |  | 120/0cm                                     |                            |                                    |                                     |                                   |  |  |                   |



## RECORD OF PENETRATION TEST No 302-28

1 of 2 **METRIC**

|        |            |          |  |               |                               |
|--------|------------|----------|--|---------------|-------------------------------|
| G.W.P. | 5203-06-00 | LOCATION | Hwy 69 (New), Sta. 17+775, o/s 34.1m Rt. CL Med. | ORIGINATED BY | T.X.                          |
| DIST   | 54         | HWY      | 69   | BOREHOLE TYPE | Dynamic Cone Penetration Test |
|        |            |          |  | COMPILED BY   | N.S.B.                        |
| DATUM  | Geodetic   | DATE     | March 03, 2007                                   | CHECKED BY    | G.D.                          |

[illegible]

**RECORD OF PENETRATION TEST No 302-28**

2 of 2 **METRIC**

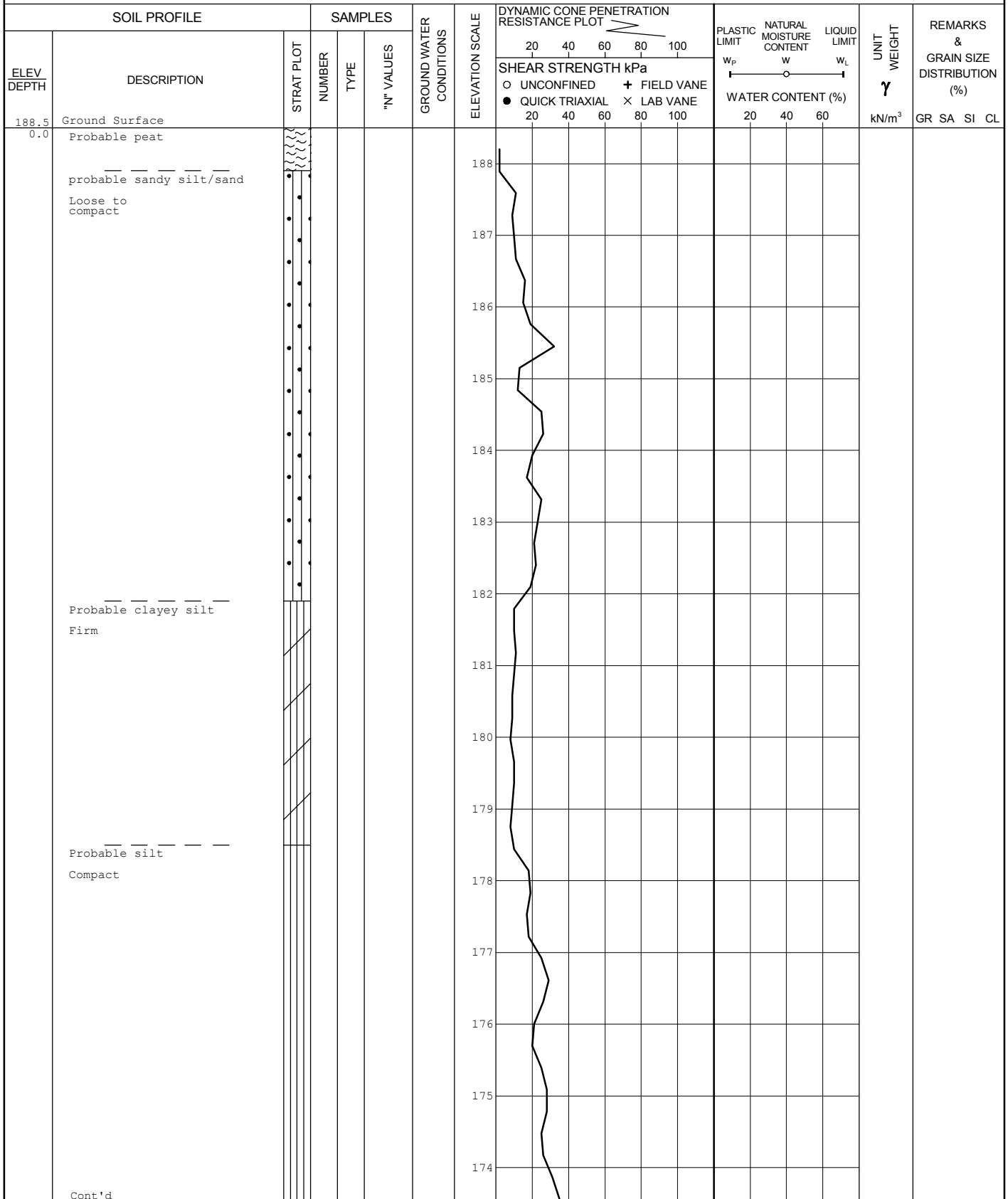
G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+775, o/s 34.1m Rt. CL Med. ORIGINATED BY T.X.  
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 03, 2007 CHECKED BY G.D.

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |    |     | UNIT<br>WEIGHT<br>$\gamma$<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|---|--|
| ELEV<br>DEPTH | DESCRIPTION                             | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |    |    |    |     |   |  |
| 173.2         | Probable silt/ silty sand<br>Compact    |            |         |      |            |                            | 173             | 20  | 40 | 60 | 80 | 100 |   |  |
|               |   |            |         |      |            |                            | 172             |   |    |    |    |     |   |  |
|               |   |            |         |      |            |                            | 171             |   |    |    |    |     |   |  |
|               |   |            |         |      |            |                            | 170             |   |    |    |    |     |   |  |
|               |   |            |         |      |            |                            | 169             |   |    |    |    |     |   |  |
| 168.4<br>19.8 | End of dynamic cone<br>penetration test |            |         |      |            |                            |                 |   |    |    |    |     |   |  |

RECORD OF PENETRATION TEST No 302-36

1 of 2 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+875, o/s 34.1m Lt. CL Med. ORIGINATED BY T.X.  
DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE March 04, 2007 CHECKED BY G.D.



RECORD OF PENETRATION TEST No 302-36

2 of 2 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+875, o/s 34.1m Lt. CL Med. ORIGINATED BY T.X.  
DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE March 04, 2007 CHECKED BY G.D.

| SOIL PROFILE  |   | SAMPLES    |        |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |    |     | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|---|------------|--------|------|------------|----------------------------|-----------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|
| ELEV<br>DEPTH | DESCRIPTION                             | STRAT PLOT | NUMBER | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |    |    |    |     |                                    |                                     |                                   |                     |   |
| 173.5         | Probable silt<br>Compact                |            |        |      |            |                            | 173             | 20  | 40 | 60 | 80 | 100 |                                    |                                     |                                   |                     | GR SA SI CL                                       |
| 172           |   |            |        |      |            |                            | 172             |   |    |    |    |     |                                    |                                     |                                   |                     |   |
| 171           |   |            |        |      |            |                            | 171             |   |    |    |    |     |                                    |                                     |                                   |                     |   |
| 170           |   |            |        |      |            |                            | 170             |   |    |    |    |     |                                    |                                     |                                   |                     |   |
| 169           |   |            |        |      |            |                            | 169             |   |    |    |    |     |                                    |                                     |                                   |                     |   |
| 168.7         | End of dynamic cone<br>penetration test |            |        |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |
| 19.8          |   |            |        |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |                     |   |

RECORD OF PENETRATION TEST No 302-38

1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+875, o/s 35.4m Rt. CL Med. ORIGINATED BY F.P.  
DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE February 19, 2007 CHECKED BY G.D.

| SOIL PROFILE   |   |             | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                   | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|----------------|---|-------------|---------|------|------------|----------------------------|-----------------|---|-------------------|------------------------------------|-------------------------------------|-----------------------------------|--|--|
| ELEV.<br>DEPTH | DESCRIPTION                             | STRAT. PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          | WATER CONTENT (%) |                                    |                                     |                                   |  |  |
| 186.5<br>0.0   | Ground Surface<br>Probable peat         |             |         |      |            |                            |                 |   |                   |                                    |                                     |                                   |  |  |
|                | Probable silty clay<br>Soft to firm     |             |         |      |            |                            |                 |   |                   |                                    |                                     |                                   |  |  |
|                | Probable silt<br>Loose to compact       |             |         |      |            |                            |                 |   |                   |                                    |                                     |                                   |  |  |
| 173.7<br>12.8  | End of dynamic cone<br>penetration test |             |         |      |            |                            |                 |   |                   |                                    |                                     |                                   |  |  |

1 of 1 **METRIC**

(%) STRAIN AT FAILURE

RECORD OF PENETRATION TEST No 302-46

1 of 2 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 New), Sta. 17+975, o/s 34.1m Lt. CL Med. ORIGINATED BY F.P.  
DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE February 16, 2007 CHECKED BY G.D.

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|----|------------------------------------|-------------------------------------|-----------------------------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | 20  | 40 |                                    |                                     |                                   |  |  |
| 186.5<br>0.0  | Ground Surface<br>Probable peat<br><br>Probable clayey silt<br>Soft to firm |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            | 186             |   |    |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            | 185             |   |    |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            | 184             |   |    |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            | 183             |   |    |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            | 182             |   |    |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            | 181             |   |    |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            | 180             |   |    |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            | 179             |   |    |                                    |                                     |                                   |  |  |
|               | Probable silt<br>Loose to compact   |            |         |      |            |                            | 178             |   |    |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            | 177             |   |    |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            | 176             |   |    |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            | 175             |   |    |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            | 174             |   |    |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            | 173             |   |    |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            | 172             |   |    |                                    |                                     |                                   |  |  |
| 171.5         | Cont'd  |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |

## 2 of 2 METRIC

(%) STRAIN AT FAILURE



RECORD OF PENETRATION TEST No 302-48

1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+975, o/s 34.1m Rt. CL Med. ORIGINATED BY F.P.  
DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE February 12, 2007 CHECKED BY G.D.

| SOIL PROFILE   |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |          | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|----------------|---|------------|---------|------|------------|----------------------------|-----------------|---|----------|------------------------------------|-------------------------------------|-----------------------------------|--|--|
| ELEV.<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |          |                                    |                                     |                                   |  |  |
| 186.5<br>0.0   | Ground Surface<br>Probable peat<br><br>Probable organic silt<br>Very loose<br><br>Probable clay<br>Soft |            |         |      |            |                            | 186             | 20 40 60 80 100                             | 20 40 60 |                                    |                                     |                                   |  |  |
| 181            | Probable silt<br>Loose to compact   |            |         |      |            |                            | 181             | 20 40 60 80 100                             | 20 40 60 |                                    |                                     |                                   |  |  |
| 178.0<br>8.5   | End of dynamic cone<br>penetration test<br>Refusal on probable bedrock                                  |            |         |      |            |                            | 178             | 20 40 60 80 100                             | 20 40 60 |                                    |                                     |                                   |  |  |

**RECORD OF PENETRATION TEST No 302-52**

1 of 2 **METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 18+025 CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 13, 2007 CHECKED BY G.D.

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                 | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT |  |  | UNIT<br>WEIGHT<br>$\gamma$<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|-----------------|---|--|--|---|--|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | 20 40 60 80 100                             | 20 40 60 80 100 | W <sub>p</sub> w W <sub>L</sub>                     |  |  |   |  |
| 186.5<br>0.0  | Ground Surface<br>Probable peat<br><br>Probable clayey silt<br>Soft to firm |            |         |      |            |                            | 186             |   |                 |   |  |  |   |  |
|               | Probable silt/silty sand<br>Loose to compact                                |            |         |      |            |                            | 185             |   |                 |   |  |  |   |  |
|               |   |            |         |      |            |                            | 184             |   |                 |   |  |  |   |  |
|               |   |            |         |      |            |                            | 183             |   |                 |   |  |  |   |  |
|               |   |            |         |      |            |                            | 182             |   |                 |   |  |  |   |  |
|               |   |            |         |      |            |                            | 181             |   |                 |   |  |  |   |  |
|               |   |            |         |      |            |                            | 180             |   |                 |   |  |  |   |  |
|               |   |            |         |      |            |                            | 179             |   |                 |   |  |  |   |  |
|               |   |            |         |      |            |                            | 178             |   |                 |   |  |  |   |  |
|               |   |            |         |      |            |                            | 177             |   |                 |   |  |  |   |  |
|               |   |            |         |      |            |                            | 176             |   |                 |   |  |  |   |  |
|               |   |            |         |      |            |                            | 175             |   |                 |   |  |  |   |  |
|               |   |            |         |      |            |                            | 174             |   |                 |   |  |  |   |  |
|               |   |            |         |      |            |                            | 173             |   |                 |   |  |  |   |  |
|               |   |            |         |      |            |                            | 172             |   |                 |   |  |  |   |  |

Cont'd

**RECORD OF PENETRATION TEST No 302-52**

2 of 2 **METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 18+025 CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 13, 2007 CHECKED BY G.D.

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |    |     | PLASTIC LIMIT<br>NATURAL<br>MOISTURE<br>CONTENT |   |                | LIQUID LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|---|---|----------------|--------------------------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION                             | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | 20  | 40 | 60 | 80 | 100 | W <sub>p</sub>                                  | W | W <sub>L</sub> |                                |  |  |
| 171.5         |   |            |         |      |            |                            |                 |   |    |    |    |     |   |   |                |                                |  |  |
| 171.3         |   |            |         |      |            |                            |                 |   |    |    |    |     |   |   |                |                                |  |  |
| 15.2          | End of dynamic cone<br>penetration test |            |         |      |            |                            |                 |   |    |    |    |     |   |   |                |                                |  |  |

RECORD OF PENETRATION TEST No 302-56

1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 18+075, o/s 44.5m Lt. CL Med. ORIGINATED BY F.P.  
DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE February 16, 2007 CHECKED BY G.D.

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION<br>SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                 |                 |                 |                 | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|---------------|---|------------|---------|------|------------|----------------------------|--------------------|---|-----------------|-----------------|-----------------|-----------------|------------------------------------|-------------------------------------|-----------------------------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                    | SHEAR STRENGTH kPa                          |                 |                 |                 |                 |                                    |                                     |                                   |  |  |
| 186.8<br>0.0  | Ground Surface<br>Probable peat<br><br>Probable silty clay<br>Firm to stiff |            |         |      |            |                            |                    | 20 40 60 80 100                             | 20 40 60 80 100 | 20 40 60 80 100 | 20 40 60 80 100 | 20 40 60 80 100 | 20 40 60 80 100                    | 20 40 60 80 100                     | 20 40 60 80 100                   |  |  |
| 186           |   |            |         |      |            |                            |                    |   |                 |                 |                 |                 |                                    |                                     |                                   |  |  |
| 185           |   |            |         |      |            |                            |                    |   |                 |                 |                 |                 |                                    |                                     |                                   |  |  |
| 184           |   |            |         |      |            |                            |                    |   |                 |                 |                 |                 |                                    |                                     |                                   |  |  |
| 183           |   |            |         |      |            |                            |                    |   |                 |                 |                 |                 |                                    |                                     |                                   |  |  |
| 182           |   |            |         |      |            |                            |                    |   |                 |                 |                 |                 |                                    |                                     |                                   |  |  |
| 181           | Probable silt/sand<br>Loose to compact                                      |            |         |      |            |                            |                    |   |                 |                 |                 |                 |                                    |                                     |                                   |  |  |
| 180           |   |            |         |      |            |                            |                    |   |                 |                 |                 |                 |                                    |                                     |                                   |  |  |
| 179           |   |            |         |      |            |                            |                    |   |                 |                 |                 |                 |                                    |                                     |                                   |  |  |
| 178           |   |            |         |      |            |                            |                    |   |                 |                 |                 |                 |                                    |                                     |                                   |  |  |
| 177           |   |            |         |      |            |                            |                    |   |                 |                 |                 |                 |                                    |                                     |                                   |  |  |
| 176.1<br>10.7 | End of dynamic cone<br>penetration test<br>Refusal on probable bedrock      |            |         |      |            |                            |                    |   |                 |                 |                 |                 |                                    |                                     |                                   |  |  |

RECORD OF PENETRATION TEST No 302-58

1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 18+075, o/s 44.5m Rt. CL Med. ORIGINATED BY F.P.  
DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE February 15, 2007 CHECKED BY G.D.

| SOIL PROFILE   |   |             | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |  | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|----------------|---|-------------|---------|------|------------|----------------------------|-----------------|---|--|------------------------------------|-------------------------------------|-----------------------------------|--|--|
| ELEV.<br>DEPTH | DESCRIPTION   | STRAT. PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |  |                                    |                                     |                                   |  |  |
| 186.5<br>0.0   | Ground Surface<br>Probable peat<br>Probable organic silt<br>Probable silty clay<br>Soft to firm |             |         |      |            |                            | 20 40 60 80 100 | 20 40 60                                    |  |                                    |                                     |                                   |  |  |
| 186            |   |             |         |      |            |                            |                 |   |  |                                    |                                     |                                   |  |  |
| 185            |   |             |         |      |            |                            |                 |   |  |                                    |                                     |                                   |  |  |
| 184            |   |             |         |      |            |                            |                 |   |  |                                    |                                     |                                   |  |  |
| 183            |   |             |         |      |            |                            |                 |   |  |                                    |                                     |                                   |  |  |
| 182            |   |             |         |      |            |                            |                 |   |  |                                    |                                     |                                   |  |  |
| 181            |   |             |         |      |            |                            |                 |   |  |                                    |                                     |                                   |  |  |
| 180            |   |             |         |      |            |                            |                 |   |  |                                    |                                     |                                   |  |  |
| 179            | Probable silt<br>Loose  |             |         |      |            |                            |                 |   |  |                                    |                                     |                                   |  |  |
| 178            |   |             |         |      |            |                            |                 |   |  |                                    |                                     |                                   |  |  |
| 177            |   |             |         |      |            |                            |                 |   |  |                                    |                                     |                                   |  |  |
| 176            |   |             |         |      |            |                            |                 |   |  |                                    |                                     |                                   |  |  |
| 175.8<br>10.7  | End of dynamic cone<br>penetration test   |             |         |      |            |                            |                 |   |  |                                    |                                     |                                   |  |  |

RECORD OF PENETRATION TEST No 302-62

1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 18+125 CL Med. ORIGINATED BY T.X.  
DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE February 18, 2007 CHECKED BY G.D.

| SOIL PROFILE  |  |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |    |     | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION  | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |    |    |    |     |                                    |                                     |                                   |  |  |
| 186.5<br>0.0  | Ground Surface<br>Probable peat<br>Probable organic silt<br><br>Probable clayey silt<br>Soft |            |         |      |            |                            | 186             | 20  | 40 | 60 | 80 | 100 |                                    |                                     |                                   |  |  |
|               |  |            |         |      |            |                            | 185             |   |    |    |    |     |                                    |                                     |                                   |  |  |
|               |  |            |         |      |            |                            | 184             |   |    |    |    |     |                                    |                                     |                                   |  |  |
|               |  |            |         |      |            |                            | 183             |   |    |    |    |     |                                    |                                     |                                   |  |  |
|               |  |            |         |      |            |                            | 182             |   |    |    |    |     |                                    |                                     |                                   |  |  |
|               |  |            |         |      |            |                            | 181             |   |    |    |    |     |                                    |                                     |                                   |  |  |
|               |  |            |         |      |            |                            | 180             |   |    |    |    |     |                                    |                                     |                                   |  |  |
|               |  |            |         |      |            |                            | 179             |   |    |    |    |     |                                    |                                     |                                   |  |  |
|               |  |            |         |      |            |                            | 178             |   |    |    |    |     |                                    |                                     |                                   |  |  |
|               |  |            |         |      |            |                            | 177             |   |    |    |    |     |                                    |                                     |                                   |  |  |
|               |  |            |         |      |            |                            | 176             |   |    |    |    |     |                                    |                                     |                                   |  |  |
| 175.2<br>11.3 | End of dynamic cone<br>penetration test<br>Refusal on probable bedrock                       |            |         |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |  |  |

## 1 of 1

METRIC

## Foundation Design

| SOIL PROFILE  |   |            |        |      |            | SAMPLES |
|---------------|---|------------|--------|------|------------|---------|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER | TYPE | "N" VALUES |         |
| 187.8         | Ground surface  |            |        |      |            |         |
| 0.0           | Topsoil   |            |        |      |            |         |
| 0.1           | Clayey silt, trace sand                                   |            | 1      | SS   | 2          |         |
| 187.1         | Soft Brown Moist  |            |        |      |            |         |
| 0.7           | Sand, with silt trace to some clay                        |            | 2      | SS   | 6          |         |
| 186.4         | Loose Brown Wet   |            |        |      |            |         |
| 1.4           | Silt with sand, trace clay                                |            | 3      | SS   | WH**       |         |
| 185.8         | Very loose Brown Wet                                      |            |        |      |            |         |
| 2.0           | Clay, trace sand  |            |        | FV   |            |         |
| 185.1         | Very soft Grey Wet  |            |        |      |            |         |
| 2.7           | Clayey silt, some sand                                    |            |        |      |            |         |
|               | Very soft Grey Wet  |            | 4      | SS   | WH         |         |
| 183.9         |   |            |        |      |            |         |
| 3.9           | Silt, some sand trace to some clay                        |            |        |      |            |         |
|               | Very loose Grey Wet                                       |            | 5      | SS   | 1          |         |
|               |   |            |        |      |            |         |
|               |   |            | 6      | SS   | 2          |         |
|               |   |            |        |      |            |         |
| 180.6         |   |            |        |      |            |         |
| 7.2           | End of borehole   |            |        |      |            |         |
|               | Refusal on probable bedrock                               |            |        |      |            |         |
|               | *     2007   03   05                                      |            |        |      |            |         |
|               | ▽ Water level observed during drilling                    |            |        |      |            |         |
|               | ▼ Water level measured after drilling                     |            |        |      |            |         |
|               | WH** Denotes penetration due to weight of hammer and rods |            |        |      |            |         |


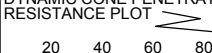

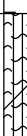










## 1 of 1

METRIC

| SOIL PROFILE |             | SAMPLES    |        |      | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT   | PLASTIC LIMIT | NATURAL MOISTURE CONTENT | LIQUID LIMIT | UNIT WEIGHT<br><br>γ<br><br>kN/m <sup>3</sup> | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|--------------|-------------|------------|--------|------|-------------------------|-----------------|--|---------------|--------------------------|--------------|---|---------------------------------------|
| ELEV. DEPTH  | DESCRIPTION | STRAT PLOT | NUMBER | TYPE |                         |                 | "N" VALUES   |               | w <sub>p</sub>           | w            |   |                                       |
| 187.5        | Top of Ice  |            |        |      |                         |                 | SHEAR STRENGTH kPa<br>○ UNCONFINED    + FIELD VANE<br>● QUICK TRIAXIAL    × LAB VANE |               |                          |              | 20    40    60                                | GR SA SI CL                           |

| SOIL PROFILE   |  |   | SAMPLES |      |            | GROUND WATER<br>CONDITIONS  | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT  |   |    |    |     | PLASTIC<br>LIMIT<br>W <sub>p</sub>  | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br><br>γ<br><br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br><br>GR SA SI CL |                   |  |  |
|--|--|---|---------|------|------------|---|--|---|----|----|-----|---|-------------------------------------|-----------------------------------|--|--|-------------------|--|--|
| ELEV<br>DEPTH  | DESCRIPTION                                    | STRAT PLOT  | NUMBER  | TYPE | "N" VALUES |   | SHEAR STRENGTH kPa   |   |    |    |     |   |                                     |                                   |  |  | WATER CONTENT (%) |  |  |
|  |  |   |         |      |            |   | 20   | 40  | 60 | 80 | 100 |   |                                     |                                   |  |  |                   |  |  |
| 187.5<br>0.0   | Top of Ice                                     |   |         |      |            |  |  |   |    |    |     |  |                                     |                                   |  |  |                   |  |  |
| 0.3  | Ice  |   |         |      |            |   |  |   |    |    |     |   |                                     |                                   |  |  |                   |  |  |
| 186.6<br>0.9   | Water  |   |         |      |            |   |  |   |    |    |     |   |                                     |                                   |  |  |                   |  |  |
| Organic clayey silt<br>Very soft    Dark    Wet<br>grey  |  |    | 1       | SS   | WR**       |   | 187  |   |    |    |     |   |                                     |                                   |  |  |                   |  |  |
|  |  |   | 2       | SS   | WR         |   | 186  |   |    |    |     |   |                                     |                                   |  |  |                   |  |  |
| Sandy silt<br>Very loose Grey    Wet   |  |    | 3       | SS   | WR         |   | 185  |   |    |    |     |   |                                     |                                   |  |  |                   |  |  |
|  |  |   | 4       | SS   | WH***      |   | 184  |   |    |    |     |   |                                     |                                   |  |  |                   |  |  |
| Silty clay, trace sand<br>Very soft    Grey    Wet   |  |    | 5       | SS   | 1          |   | 183  |   |    |    |     |   |                                     |                                   |  |  |                   |  |  |
|  |  |   |         | FV   |            |   | 182  |  <sup>2</sup> |    |    |     |   |                                     |                                   |  |  |                   |  |  |
| Silt, trace sand<br>thin layers of silty sand<br>Very soft    Grey    Wet  |  |  | 6       | SS   | WR         |   | 181  |   |    |    |     |   |                                     |                                   |  |  |                   |  |  |
|  |  |   |         |      |            |   |  |   |    |    |     |   |                                     |                                   |  |  |                   |  |  |
| 180.5<br>7.0   | End of borehole<br>Refusal on probable bedrock |   |         |      |            |   |  |   |    |    |     |   |                                     |                                   |  |  |                   |  |  |
| <div>*    2007   03   11</div> <div> Water level observed during drilling</div> <div> Water level measured after drilling</div> <div>WR**    Denotes penetration due to weight of rods only</div> <div>WH***    Denotes penetration due to weight of rods and hammer</div> |  |   |         |      |            |   |  |   |    |    |     |   |                                     |                                   |  |  |                   |  |  |

**RECORD OF BOREHOLE No 305-16**

1 of 2

**METRIC**


G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 16+125, o/s 20.5m Lt. CL Med. ORIGINATED BY M.R.  
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
DATUM Geodetic DATE March 07, 2007 CHECKED BY G.D.

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |    |     | PLASTIC<br>LIMIT<br>W <sub>P</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br><br>γ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |                   |  |  |
|---------------|---|------------|---------|------|------------|----------------------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|-------------------------|---|-------------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            | SHEAR STRENGTH kPa                          |    |    |    |     |                                    |                                     |                                   |                         |   | WATER CONTENT (%) |  |  |
|               |   |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |                         |   |                   |  |  |
| 187.5<br>0.0  | Top of Ice<br>Ice and peat<br><br>Dark brown  |            |         |      |            |                            | 20  | 40 | 60 | 80 | 100 |                                    |                                     |                                   |                         |   |                   |  |  |
| 186.3<br>1.2  | Peat, fine fibrous<br>Dark brown  |            | 1       | SS   | WH**       |                            |   |    |    |    |     |                                    |                                     |                                   | 620                     | Org.<br>65.2%                                     |                   |  |  |
| 184.7<br>2.8  | Organic clayey silt<br>Very soft Olive Wet<br>brown                                     |            | 2       | SS   | WH         |                            |   |    |    |    |     |                                    |                                     |                                   |                         |   |                   |  |  |
| 183.9<br>3.6  | Sand, trace silt<br>Very loose Grey Wet   |            | 3       | SS   | WH         |                            |   |    |    |    |     |                                    |                                     |                                   |                         |   |                   |  |  |
| 182.0<br>5.5  | Sandy silt<br>Very loose Grey Wet   |            | 4       | SS   | 2          |                            |   |    |    |    |     |                                    |                                     |                                   |                         |   |                   |  |  |
| 181.2<br>6.3  | Clay, trace sand<br>Very soft Grey Wet  |            | 5       | SS   | WR***      |                            |   |    |    |    |     |                                    |                                     |                                   |                         | 0 95 (5)  |                   |  |  |
| 180.3<br>7.2  | Silt, trace clay<br>thin layers of silty sand<br>Very loose Grey Wet                    |            | 6       | SS   | WR         |                            |   |    |    |    |     |                                    |                                     |                                   |                         |   |                   |  |  |
| 179.0<br>8.5  | Clay, trace sand<br>thin layers of silty clay<br>Soft to Mottled Wet<br>firm grey/brown |            | 7       | SS   | 1          |                            |   |    |    |    |     |                                    |                                     |                                   |                         |   |                   |  |  |
|               |   |            |         | FV   |            |                            |   |    |    |    |     |                                    |                                     |                                   |                         |   |                   |  |  |
|               |   |            | 8       | TW   | PM         |                            |   |    |    |    |     |                                    |                                     |                                   |                         | 0 3 43 54   |                   |  |  |
|               |   |            |         | FV   |            |                            |   |    |    |    |     |                                    |                                     |                                   |                         |   |                   |  |  |
|               |   |            | 9       | SS   | 1          |                            |   |    |    |    |     |                                    |                                     |                                   |                         |   |                   |  |  |
|               |   |            |         | FV   |            |                            |   |    |    |    |     |                                    |                                     |                                   |                         |   |                   |  |  |
|               |   |            | 10      | SS   | 1          |                            |   |    |    |    |     |                                    |                                     |                                   |                         | 0 4 41 55   |                   |  |  |
|               |   |            |         | FV   |            |                            |   |    |    |    |     |                                    |                                     |                                   |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |   |    |    |    |     |                                    |                                     |                                   |                         |   |                   |  |  |

Cont'd

## 2 of 2

METRIC

| SOIL PROFILE |             |             | SAMPLES |      |            | GROUND WATER CONDITIONS | ELEVATION SCALE   | DYNAMIC CONE PENETRATION RESISTANCE PLOT  | PLASTIC LIMIT  | NATURAL MOISTURE CONTENT | LIQUID LIMIT   | UNIT WEIGHT<br><br>γ<br><br>kN/m <sup>3</sup> | REMARKS & GRAIN SIZE DISTRIBUTION (%) |
|--------------|-------------|-------------|---------|------|------------|-------------------------|---|---|----------------|--------------------------|----------------|---|---------------------------------------|
| ELEV. DEPTH  | DESCRIPTION | STRAT. PLOT | NUMBER  | TYPE | "N" VALUES |                         |   |  | W <sub>p</sub> | W                        | W <sub>L</sub> |   |                                       |
| 172.5        |             |             |         |      |            |                         | SHEAR STRENGTH kPa<br>○ UNCONFINED + FIELD VANE<br>● QUICK TRIAXIAL × LAB VANE<br>20 40 60 80 100 |   |                |                          | 20 40 60       |   | GR SA SI C                            |

[illegible]

**RECORD OF BOREHOLE No 305-19**

1 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 16+150, o/s 38.8m Lt. CL Med. ORIGINATED BY W.L.  
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
DATUM Geodetic DATE March 10 and 11, 2008 CHECKED BY G.D.

| SOIL PROFILE  |                              |  |  | SAMPLES    |        |      | * GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT                      |                    |    |    | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT |                |    | UNIT<br>WEIGHT<br><br>$\gamma$<br><br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |    |    |    |    |  |
|---------------|------------------------------|--|--|------------|--------|------|------------------------------|-----------------|--|--------------------|----|----|---|----------------|----|---|---|----|----|----|----|--|
| ELEV<br>DEPTH | DESCRIPTION                  |  |  | STRAT PLOT | NUMBER | TYPE |                              |                 | "N" VALUES   | SHEAR STRENGTH kPa |    |    |   | W <sub>p</sub> | W  |   | W <sub>L</sub>                                    | GR | SA | SI | CL |  |
|               |                              |  |  |            |        |      |                              |                 | ○ UNCONFINED      + FIELD VANE<br>● QUICK TRIAXIAL    × LAB VANE |                    |    |    | WATER CONTENT (%)                                   |                |    |   |   |    |    |    |    |  |
|               |                              |  |  |            |        |      |                              |                 | 20   | 40                 | 60 | 80 | 100   | 20             | 40 |   | 60  |    |    |    |    |  |
| 187.5         | Top of Ice                   |  |  |            |        |      |                              |                 |  |                    |    |    |   |                |    |   |   |    |    |    |    |  |
| 0.0           | Ice                          |  |  |            |        |      |                              |                 |  |                    |    |    |   |                |    |   |   |    |    |    |    |  |
| 186.9         | Peat, fine fibrous           |  |  |            |        |      |                              |                 |  |                    |    |    |   |                |    |   |   |    |    |    |    |  |
| 0.6           | Dark brown                   |  |  |            | 1      | SS   | WH**                         |                 |  |                    |    |    |   |                |    |   |   |    |    |    |    |  |
|               |                              |  |  |            | 2      | SS   | WH                           |                 |  |                    |    |    |   |                |    |   |   |    |    |    |    |  |
| 185.4         | Silty clay organics          |  |  |            |        |      |                              |                 |  |                    |    |    |   |                |    |   |   |    |    |    |    |  |
| 2.1           | Very soft Grey Wet to soft   |  |  |            | 3      | SS   | WH                           |                 |  |                    |    |    |   |                |    |   |   |    |    |    |    |  |
|               |                              |  |  |            | 4      | SS   | 2                            |                 |  |                    |    |    |   |                |    |   |   |    |    |    |    |  |
| 183.9         | Sand, trace silt             |  |  |            |        |      |                              |                 |  |                    |    |    |   |                |    |   |   |    |    |    |    |  |
| 3.6           | Loose to Grey Wet very loose |  |  |            | 5      | SS   | 5                            |                 |  |                    |    |    |   |                |    |   |   |    |    |    |    |  |
|               |                              |  |  |            | 6      | SS   | 4                            |                 |  |                    |    |    |   |                |    |   |   |    |    |    |    |  |
|               |                              |  |  |            |        |      |                              |                 |  |                    |    |    |   |                |    |   |   |    |    |    |    |  |
|               |                              |  |  |            | 7      | SS   | 3                            |                 |  |                    |    |    |   |                |    |   |   |    |    |    |    |  |
|               |                              |  |  |            |        |      |                              |                 |  |                    |    |    |   |                |    |   |   |    |    |    |    |  |
| 180.4         | Silt some sand, some clay    |  |  |            |        |      |                              |                 |  |                    |    |    |   |                |    |   |   |    |    |    |    |  |
| 7.1           | Very loose Grey Wet          |  |  |            | 8      | SS   | 1                            |                 |  |                    |    |    |   |                |    |   |   |    |    |    |    |  |
|               |                              |  |  |            |        |      |                              |                 |  |                    |    |    |   |                |    |   |   |    |    |    |    |  |
| 178.7         | Clay, trace sand             |  |  |            |        |      |                              |                 |  |                    |    |    |   |                |    |   |   |    |    |    |    |  |
| 8.8           | Firm to Grey Wet stiff       |  |  |            | 9      | SS   | WH                           |                 |  |                    |    |    |   |                |    |   |   |    |    |    |    |  |
|               |                              |  |  |            |        | FV   |                              |                 |  |                    |    |    |   |                |    |   |   |    |    |    |    |  |
|               |                              |  |  |            | 10     | SS   | WH                           |                 |  |                    |    |    |   |                |    |   |   |    |    |    |    |  |
|               |                              |  |  |            |        | FV   |                              |                 |  |                    |    |    |   |                |    |   |   |    |    |    |    |  |
|               |                              |  |  |            | 11     | SS   | 3                            |                 |  |                    |    |    |   |                |    |   |   |    |    |    |    |  |
|               |                              |  |  |            |        | FV   |                              |                 |  |                    |    |    |   |                |    |   |   |    |    |    |    |  |
|               |                              |  |  |            | 12     | SS   | WR***                        |                 |  |                    |    |    |   |                |    |   |   |    |    |    |    |  |
|               |                              |  |  |            |        | FV   |                              |                 |  |                    |    |    |   |                |    |   |   |    |    |    |    |  |
| 172.5         | Cont'd                       |  |  |            |        |      |                              |                 |  |                    |    |    |   |                |    |   |   |    |    |    |    |  |

ON\_MOT VER3 SWAMP 305-MAR 13.GPJ ON\_MOT.GDT 7/30/2008 2:16:46 PM

+<sup>7</sup>, X<sup>5</sup>: Numbers refer to Sensitivity  
20  
15—5  
10  
(%) STRAIN AT FAILURE

**RECORD OF BOREHOLE No 305-19**

2 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 16+150, o/s 38.8m Lt. CL Med. ORIGINATED BY W.L.  
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
DATUM Geodetic DATE March 10 and 11, 2008 CHECKED BY G.D.

| SOIL PROFILE  |  |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |  |  |  |  | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|--|--|--|--|------------------------------------|-------------------------------------|-----------------------------------|--|---|
| ELEV<br>DEPTH | DESCRIPTION  | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |  |  |  |  |                                    |                                     |                                   |  |   |
| 172.5<br>15.0 |  |            | 13      | TW   | PM         |                            | 172             |   |  |  |  |  |                                    |                                     |                                   |  |   |
|               |  |            |         |      |            |                            | 171             |   |  |  |  |  |                                    |                                     |                                   |  |   |
|               |  |            | 14      | SS   | WR         |                            | 170             |   |  |  |  |  |                                    |                                     |                                   |  |   |
|               |  |            |         | FV   |            |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |
|               |  |            | 15      | SS   | WH         |                            | 169             |   |  |  |  |  |                                    |                                     |                                   |  |   |
|               |  |            |         | FV   |            |                            | 168             |   |  |  |  |  |                                    |                                     |                                   |  |   |
| 167.0<br>20.5 | Silty clay, trace sand<br>Firm Grey Wet                        |            | 16      | SS   | WR         |                            | 167             |   |  |  |  |  |                                    |                                     |                                   |  |   |
|               |  |            |         | FV   |            |                            | 166             |   |  |  |  |  |                                    |                                     |                                   |  |   |
|               |  |            |         |      |            |                            | 165             |   |  |  |  |  |                                    |                                     |                                   |  |   |
| 163.2<br>24.3 | Silt, trace clay<br>trace sand, trace gravel<br>Loose Grey Wet |            | 17      | SS   | 4          |                            | 163             |   |  |  |  |  |                                    |                                     |                                   |  | 1 5 88 6  |
| 161.3<br>26.2 | End of borehole<br>Refusal on probable bedrock                 |            |         |      |            |                            | 162             |   |  |  |  |  |                                    |                                     |                                   |  |   |

**RECORD OF BOREHOLE No 305-21**

1 of 3

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 16+175, o/s 58.5m Lt. CL Med. ORIGINATED BY W.L.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A + Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE March 12 and 14, 2008 CHECKED BY G.D.

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |    |     | UNIT<br>WEIGHT<br>$\gamma$<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |                                   |  |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|---|---|-----------------------------------|--|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |    |    |    |     |   |   |                                   |  |
| 187.5<br>0.0  | Top of Ice<br>Ice                                   |            |         |      |            |                            |                 | 20  | 40 | 60 | 80 | 100 | PLASTIC<br>LIMIT<br>W <sub>P</sub>              | NATURAL<br>MOISTURE<br>CONTENT<br>W               | LIQUID<br>LIMIT<br>W <sub>L</sub> |  |
| 186.9<br>0.6  | Peat, fine fibrous<br>Dark brown                    |            | 1       | SS   | WR**       |                            |                 |   |    |    |    |     |   |   |                                   |  |
|               |   |            | 2       | SS   | WR         |                            |                 |   |    |    |    |     |   |   |                                   |  |
|               |   |            | 3       | SS   | WR         |                            |                 |   |    |    |    |     |   |   |                                   |  |
| 184.6<br>2.9  | Silty clay  |            |         |      |            |                            |                 |   |    |    |    |     |   |   |                                   |  |
| 184.1<br>3.4  | Soft Grey Wet<br>Sand, trace silt<br>Loose Grey Wet |            | 4       | SS   | 2          |                            |                 |   |    |    |    |     |   |   |                                   |  |
|               |   |            | 5       | SS   | 9          |                            |                 |   |    |    |    |     |   |   |                                   |  |
|               |   |            | 6       | SS   | 7          |                            |                 |   |    |    |    |     |   |   |                                   |  |
| 180.3<br>7.2  | Clayey silt, trace sand<br>Firm Grey Wet            |            | 7       | SS   | 1          |                            |                 |   |    |    |    |     |   |   |                                   |  |
|               |   |            |         | FV   |            |                            |                 |   |    |    |    |     |   |   |                                   |  |
| 178.5<br>9.0  | Clay, trace sand<br>Firm Grey Wet                   |            | 8       | TW   | PH         |                            |                 |   |    |    |    |     |   |   |                                   |  |
|               |   |            | 9       | SS   | WH***      |                            |                 |   |    |    |    |     |   |   |                                   |  |
|               |   |            |         | FV   |            |                            |                 |   |    |    |    |     |   |   |                                   |  |
|               |   |            | 10      | SS   | WH         |                            |                 |   |    |    |    |     |   |   |                                   |  |
|               |   |            |         | FV   |            |                            |                 |   |    |    |    |     |   |   |                                   |  |
|               |   |            | 11      | SS   | WR         |                            |                 |   |    |    |    |     |   |   |                                   |  |
|               |   |            |         | FV   |            |                            |                 |   |    |    |    |     |   |   |                                   |  |

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**RECORD OF BOREHOLE No 305-21**

2 of 3

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 16+175, o/s 58.5m Lt. CL Med. ORIGINATED BY W.L.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A + Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE March 12 and 14, 2008 CHECKED BY G.D.

| SOIL PROFILE  |                       |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                 | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|-----------------------|------------|---------|------|------------|----------------------------|-----------------|---|-----------------|------------------------------------|-------------------------------------|-----------------------------------|--|---|
| ELEV<br>DEPTH | DESCRIPTION           | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |                 |                                    |                                     |                                   |  |   |
| 172.5         |                       |            |         |      |            |                            |                 | 20 40 60 80 100                             | 20 40 60 80 100 |                                    |                                     |                                   |  |   |
|               | silt seams            |            | 12      | SS   | 6          |                            | 172             |   |                 |                                    |                                     |                                   |  |   |
|               | stiff                 |            |         | FV   |            |                            |                 |   |                 |                                    |                                     |                                   |  |   |
|               |                       |            |         |      |            |                            | 171             |   |                 |                                    |                                     |                                   |  |   |
|               | trace gravel          |            | 13      | SS   | WH         |                            |                 |   |                 |                                    |                                     |                                   |  |   |
|               |                       |            |         | FV   |            |                            | 170             |   |                 |                                    |                                     |                                   |  |   |
|               |                       |            |         |      |            |                            |                 |   |                 |                                    |                                     |                                   |  |   |
|               | silt and sand seams   |            | 14      | SS   | 1          |                            | 169             |   |                 |                                    |                                     |                                   |  |   |
|               | very stiff            |            |         | FV   |            |                            |                 |   |                 |                                    |                                     |                                   |  |   |
|               |                       |            |         |      |            |                            | 168             |   |                 |                                    |                                     |                                   |  |   |
| 167.7         |                       |            |         |      |            |                            |                 |   |                 |                                    |                                     |                                   |  |   |
| 19.8          | Clayey silt           |            |         |      |            |                            | 167             |   |                 |                                    |                                     |                                   |  |   |
|               | silt layers           |            |         |      |            |                            |                 |   |                 |                                    |                                     |                                   |  |   |
|               | Stiff Grey Wet        |            |         |      |            |                            |                 |   |                 |                                    |                                     |                                   |  |   |
|               |                       |            | 15      | SS   | 2          |                            | 166             |   |                 |                                    |                                     |                                   |  |   |
|               |                       |            |         | FV   |            |                            |                 |   |                 |                                    |                                     |                                   |  |   |
|               |                       |            |         |      |            |                            | 165             |   |                 |                                    |                                     |                                   |  |   |
| 164.5         |                       |            |         |      |            |                            |                 |   |                 |                                    |                                     |                                   |  |   |
| 23.0          | Silt                  |            |         |      |            |                            | 164             |   |                 |                                    |                                     |                                   |  |   |
|               | some clay, trace sand |            |         |      |            |                            |                 |   |                 |                                    |                                     |                                   |  |   |
|               | Very loose Grey Wet   |            |         |      |            |                            |                 |   |                 |                                    |                                     |                                   |  |   |
|               |                       |            | 16      | SS   | 2          |                            | 163             |   |                 |                                    |                                     |                                   |  |   |
|               |                       |            |         |      |            |                            |                 |   |                 |                                    |                                     |                                   |  |   |
| 162.2         |                       |            |         |      |            |                            | 162             |   |                 |                                    |                                     |                                   |  |   |
| 25.3          | End of borehole       |            |         |      |            |                            |                 |   |                 |                                    |                                     |                                   |  |   |
|               | Probable silt         |            |         |      |            |                            |                 |   |                 |                                    |                                     |                                   |  |   |
|               | Loose to compact      |            |         |      |            |                            |                 |   |                 |                                    |                                     |                                   |  |   |
|               |                       |            |         |      |            |                            | 161             |   |                 |                                    |                                     |                                   |  |   |
|               |                       |            |         |      |            |                            | 160             |   |                 |                                    |                                     |                                   |  |   |
|               |                       |            |         |      |            |                            | 159             |   |                 |                                    |                                     |                                   |  |   |
|               |                       |            |         |      |            |                            | 158             |   |                 |                                    |                                     |                                   |  |   |

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**RECORD OF BOREHOLE No 305-21**

3 of 3

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 16+175, o/s 58.5m Lt. CL Med. ORIGINATED BY W.L.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. + Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE March 12 and 14, 2008 CHECKED BY G.D.

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT                                    |  |  |  |  | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|--|--|--|--|--|------------------------------------|-------------------------------------|-----------------------------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa<br>○ UNCONFINED + FIELD VANE<br>● QUICK TRIAXIAL × LAB VANE |  |  |  |  |                                    |                                     |                                   |  |  |
| 157.5         |   |            |         |      |            |                            |                 |  |  |  |  |  |                                    |                                     |                                   |  |  |
| 155.9         |   |            |         |      |            |                            |                 |  |  |  |  |  |                                    |                                     |                                   |  |  |
| 31.6          | End of dynamic cone<br>penetration test<br>Refusal on probable bedrock  |            |         |      |            |                            |                 |  |  |  |  |  |                                    |                                     |                                   |  |  |
|               | * 2008 03 12/14   |            |         |      |            |                            |                 |  |  |  |  |  |                                    |                                     |                                   |  |  |
|               | ▽ Water level observed<br>during drilling   |            |         |      |            |                            |                 |  |  |  |  |  |                                    |                                     |                                   |  |  |
|               | ▼ Water level measured<br>after drilling  |            |         |      |            |                            |                 |  |  |  |  |  |                                    |                                     |                                   |  |  |
|               | WR** Penetration due to the<br>rods only  |            |         |      |            |                            |                 |  |  |  |  |  |                                    |                                     |                                   |  |  |
|               | WH*** Denotes penetration due<br>to weight of hammer and<br>rods<br>C.F.H.S.A. Denotes<br>Continuous Flight Hollow<br>Stem Augers |            |         |      |            |                            |                 |  |  |  |  |  |                                    |                                     |                                   |  |  |



# RECORD OF BOREHOLE No 305-25

1 of 3

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 16+200, o/s 38.8m Lt. CL Med. ORIGINATED BY W.L.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A + Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 15, 2008 CHECKED BY G.D.

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |    |     | UNIT<br>WEIGHT<br>$\gamma$<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|---|---|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |    |    |    |     |   |   |
| 187.5         | Top of Ice  |            |         |      |            |                            |                 | 20  | 40 | 60 | 80 | 100 |   |   |
| 0.0           | Ice   |            |         |      |            |                            |                 |   |    |    |    |     |   |   |
| 187.2         |   |            |         |      |            |                            |                 |   |    |    |    |     |   |   |
| 0.4           | Peat, fine fibrous<br>Dark brown                      |            | 1       | SS   | WR**       |                            | 187             |   |    |    |    |     |   |   |
|               |   |            | 2       | SS   | WR         |                            | 186             |   |    |    |    |     | 508   |   |
| 184.8         |   |            | 3       | SS   | WH***      |                            | 185             |   |    |    |    |     | 131   |   |
| 2.7           | Organic clayey silt<br>Very soft Grey Wet             |            | 4       | SS   | WR         |                            | 184             |   |    |    |    |     | 130   |   |
| 183.5         |   |            | 5       | SS   | 4          |                            | 183             |   |    |    |    |     |   |   |
| 4.0           | Sand, some silt<br>Loose Grey Wet                     |            | 6       | SS   | 5          |                            | 182             |   |    |    |    |     |   |   |
|               |   |            | 7       | SS   | 4          |                            | 181             |   |    |    |    |     |   |   |
| 180.2         |   |            | 8       | SS   | 5          |                            | 180             |   |    |    |    |     |   |   |
| 7.3           | Silty clay<br>sand seams<br>Firm to Grey Wet<br>stiff |            | 9       | SS   | WH         |                            | 179             |   |    |    |    |     |   |   |
|               |   |            |         | FV   |            |                            | 178             |   |    |    |    |     |   |   |
|               |   |            | 10      | SS   | WH         |                            | 177             |   |    |    |    |     |   |   |
|               |   |            |         | FV   |            |                            | 176             |   |    |    |    |     |   |   |
|               |   |            | 11      | SS   | 1          |                            | 175             |   |    |    |    |     |   |   |
|               |   |            |         | FV   |            |                            | 174             |   |    |    |    |     |   |   |
|               |   |            | 12      | SS   | 2          |                            | 173             |   |    |    |    |     |   |   |
|               |   |            |         | FV   |            |                            |                 |   |    |    |    |     |   |   |

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**RECORD OF BOREHOLE No 305-25**

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**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 16+200, o/s 38.8m Lt. CL Med. ORIGINATED BY W.L.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A + Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE March 15, 2008 CHECKED BY G.D.

| SOIL PROFILE  |                           |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    | PLASTIC<br>LIMIT<br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>w | LIQUID<br>LIMIT<br>w <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |              |  |  |
|---------------|---------------------------|------------|---------|------|------------|----------------------------|-----------------|---|----|------------------------------------|-------------------------------------|-----------------------------------|--|--|--------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION               | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 | ○ UNCONFINED                                |    |                                    |                                     |                                   |  |  | + FIELD VANE |  |  |
|               |                           |            |         |      |            | ● QUICK TRIAXIAL           |                 | × LAB VANE                                  |    |                                    | WATER CONTENT (%)                   |                                   |  |  |              |  |  |
| 172.5         |                           |            |         |      |            | 20                         | 40              | 60  | 80 | 100                                | 20                                  | 40                                | 60                                       |  |              |  |  |
| 172.3         |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
| 15.2          | Clayey silt, trace sand   |            | 13      | SS   | 2          |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               | Stiff      Grey/      Wet |            |         | FV   |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            | 14      | SS   | WH         |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         | FV   |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            | 15      | SS   | WH         |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         | FV   |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |
|               |                           |            |         |      |            |                            |                 |   |    |                                    |                                     |                                   |  |  |              |  |  |

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RECORD OF BOREHOLE No 305-25

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METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 16+200, o/s 38.8m Lt. CL Med. ORIGINATED BY W.L.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A + Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE March 15, 2008 CHECKED BY G.D.

| SOIL PROFILE  |  | SAMPLES    |        |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |    |     | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|--|------------|--------|------|------------|----------------------------|-----------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|--|---|
| ELEV<br>DEPTH | DESCRIPTION  | STRAT PLOT | NUMBER | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |    |    |    |     |                                    |                                     |                                   |  |   |
| 157.5         |  |            |        |      |            |                            |                 | 20  | 40 | 60 | 80 | 100 |                                    |                                     |                                   |  |   |
| 155.8         |  |            |        |      |            |                            |                 | 20  | 40 | 60 | 80 | 100 |                                    |                                     |                                   |  |   |
| 31.7          | End of dynamic cone<br>penetration test                          |            |        |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               | * 2007 03 15   |            |        |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               | ▽ Water level observed<br>during drilling                        |            |        |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               | ▼ Water level measured<br>after drilling                         |            |        |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               | WR** Penetration due to the<br>rods only                         |            |        |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               | WH*** Denotes penetration due<br>to weight of hammer and<br>rods |            |        |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |  |   |
|               | C.F.H.S.A. Denotes<br>Continuous Flight Hollow<br>Stem Augers    |            |        |      |            |                            |                 |   |    |    |    |     |                                    |                                     |                                   |  |   |

**RECORD OF BOREHOLE No 305-28**

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**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 16+225, o/s 20.5m Lt. CL Med. ORIGINATED BY M.R.  
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
DATUM Geodetic DATE March 09 and 10, 2007 CHECKED BY G.D.

| SOIL PROFILE      |  |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |    |     | PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT |   |                | UNIT<br>WEIGHT<br><br>γ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |               |  |
|-------------------|--|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|---|---|----------------|-------------------------|---|---------------|--|
| ELEV<br>DEPTH     | DESCRIPTION                            | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |    |    |    |     | W <sub>P</sub>  | W | W <sub>L</sub> |                         |   |               |  |
|                   |  |            |         |      |            |                            |                 | ○ UNCONFINED      + FIELD VANE              |    |    |    |     |   |   |                |                         |   |               |  |
|                   |  |            |         |      |            |                            |                 | ● QUICK TRIAXIAL    × LAB VANE              |    |    |    |     |   |   |                |                         |   |               |  |
| WATER CONTENT (%) |  |            |         |      |            |                            |                 |   |    |    |    |     |   |   |                |                         |   |               |  |
| 187.5             | Top of Ice                             |            |         |      |            |                            |                 | 20  | 40 | 60 | 80 | 100 |   |   |                |                         |   |               |  |
| 0.0               | Ice                                    |            |         |      |            |                            |                 | 20  | 40 | 60 | 80 | 100 |   |   |                |                         |   |               |  |
| 0.3               | Peat, fine fibrous                     |            |         |      |            |                            | 187             |   |    |    |    |     |   |   |                |                         |   |               |  |
|                   | Dark brown                             |            |         |      |            |                            |                 |   |    |    |    |     |   |   |                |                         |   |               |  |
|                   |  |            | 1       | SS   | WH**       |                            | 186             |   |    |    |    |     |   |   |                |                         |   |               |  |
|                   | amorphous                              |            |         |      |            |                            |                 |   |    |    |    |     |   |   |                |                         |   |               |  |
|                   | Grey                                   |            | 2       | SS   | WH         |                            | 185             |   |    |    |    |     |   |   |                |                         | 177   | Org.<br>12.8% |  |
| 184.0             |  |            | 3       | SS   | WH         |                            | 184             |   |    |    |    |     |   |   |                |                         |   |               |  |
| 3.5               | Silt, trace clay                       |            |         |      |            |                            |                 |   |    |    |    |     |   |   |                |                         |   |               |  |
| 183.4             | Very loose Grey Wet                    |            |         |      |            |                            |                 |   |    |    |    |     |   |   |                |                         |   |               |  |
| 4.1               | Silty sand, trace clay                 |            |         |      |            |                            | 183             |   |    |    |    |     |   |   |                |                         |   |               |  |
|                   | Very loose Grey Wet                    |            | 4       | SS   | WH         |                            |                 |   |    |    |    |     |   |   |                |                         |   | 0 61 32 7     |  |
| 182.0             |  |            |         |      |            |                            | 182             |   |    |    |    |     |   |   |                |                         |   |               |  |
| 5.5               | Silt, trace clay layers of clay        |            | 5       | SS   | WH         |                            | 181             |   |    |    |    |     |   |   |                |                         |   |               |  |
|                   | Very loose Grey Wet                    |            |         |      |            |                            |                 |   |    |    |    |     |   |   |                |                         |   |               |  |
| 179.6             |  |            | 6       | SS   | WH         |                            | 180             |   |    |    |    |     |   |   |                |                         |   |               |  |
| 7.9               | Silty clay, trace sand layers of silt  |            |         |      |            |                            |                 |   |    |    |    |     |   |   |                |                         |   |               |  |
|                   | Soft to firm      Brown/ grey      Wet |            |         | FV   |            |                            | 179             |   | 2  |    |    |     |   |   |                |                         |   |               |  |
|                   |  |            | 7       | SS   | WH         |                            | 178             |   | 2  |    |    |     |   |   |                |                         |   |               |  |
|                   | no layering                            |            |         | FV   |            |                            |                 |   |    |    |    |     |   |   |                |                         |   |               |  |
|                   |  |            | 8       | SS   | WH         |                            | 177             |   |    |    |    |     |   |   |                |                         |   |               |  |
|                   |  |            |         | FV   |            |                            | 176             |   | 3  |    |    |     |   |   |                |                         |   | 0 4 55 41     |  |
|                   |  |            | 9       | SS   | 1          |                            | 175             |   |    |    |    |     |   |   |                |                         |   |               |  |
|                   |  |            |         | FV   |            |                            |                 |   | 3  |    |    |     |   |   |                |                         |   |               |  |
|                   |  |            | 10      | SS   | 2          |                            | 174             |   |    |    |    |     |   |   |                |                         |   |               |  |
|                   | thin layers of silt                    |            |         | FV   |            |                            | 173             |   | 3  |    |    |     |   |   |                |                         |   |               |  |
|                   |  |            |         |      |            |                            |                 |   |    |    |    |     |   |   |                |                         |   |               |  |




Cont'd

**RECORD OF BOREHOLE No 305-28**

2 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 16+225, o/s 20.5m Lt. CL Med. ORIGINATED BY M.R.  
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
DATUM Geodetic DATE March 09 and 10, 2007 CHECKED BY G.D.

| SOIL PROFILE  |  |   | SAMPLES |      |            | GROUND WATER | CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT |    |    |              |     |  | PLASTIC LIMIT<br><br>w <sub>p</sub> | NATURAL MOISTURE CONTENT<br><br>w | LIQUID LIMIT<br><br>w <sub>L</sub> | UNIT WEIGHT<br><br>γ<br><br>kN/m <sup>3</sup> | REMARKS & GRAIN SIZE DISTRIBUTION (%)<br><br>GR SA SI CL |                   |  |  |
|---------------|--|---|---------|------|------------|--------------|------------|-----------------|--|----|----|--------------|-----|--|-------------------------------------|-----------------------------------|------------------------------------|---|--|-------------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION  | STRAT PLOT  | NUMBER  | TYPE | "N" VALUES |              |            |                 | SHEAR STRENGTH kPa                       |    |    |              |     |  |                                     |                                   |                                    |   |  | WATER CONTENT (%) |  |  |
|               |  |   |         |      |            |              |            |                 | ○ UNCONFINED                             |    |    | + FIELD VANE |     |  |                                     |                                   |                                    |   |  | ● QUICK TRIAXIAL  |  |  |
| 172.5         |  |   |         |      |            |              |            |                 | 20                                       | 40 | 60 | 80           | 100 |  |                                     |                                   |                                    |   |  |                   |  |  |
|               | _____ layers of silt _____   |  | 11      | SS   | WH         |              |            | 172             |  |    |    |              |     |  |                                     |                                   |                                    |   |  |                   |  |  |
|               |  |   |         |      |            |              |            |                 |  |    |    |              |     |  |                                     |                                   |                                    |   |  |                   |  |  |
|               |  |   |         |      |            |              |            |                 |  |    |    |              |     |  |                                     |                                   |                                    |   |  |                   |  |  |
| 170.6         |  |   | 12      | SS   | 5/15cm     |              |            | 171             |  |    |    |              |     |  |                                     |                                   |                                    |   |  |                   |  |  |
| 16.9          | End of borehole<br>Refusal on probable bedrock<br><br>Sample 12: Sampler bouncing<br><br>* 2007 03 09/10<br><br> Water level observed during drilling<br><br> Water level measured after drilling<br><br>WH** Denotes penetration due to weight of hammer and rods |   |         |      |            |              |            |                 |  |    |    |              |     |  |                                     |                                   |                                    |   |  |                   |  |  |

## 1 of 2

METRIC

## Foundation Design

[illegible]

**RECORD OF BOREHOLE No 305-31**

2 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 16+250, o/s 38.8m Lt. CL Med. ORIGINATED BY W.L.  
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
DATUM Geodetic DATE March 17, 2008 CHECKED BY G.D.

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |  |  |  |  | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|--|--|--|--|------------------------------------|-------------------------------------|-----------------------------------|--|---|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |  |  |  |  |                                    |                                     |                                   |  |   |
| 172.5<br>15.0 | trace gravel  |            | 13      | SS   | WH         |                            | 172             |   |  |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         | FV   |            |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |
| 170.8<br>16.8 | Clayey silt, trace sand<br>silt seams<br>Stiff Grey Wet         |            | 14      | SS   | WH         |                            | 171             |   |  |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         | FV   |            |                            | 170             |   |  |  |  |  |                                    |                                     |                                   |  |   |
|               | sand seams  |            | 15      | SS   | WH         |                            | 169             |   |  |  |  |  |                                    |                                     |                                   |  |   |
| 167.4<br>20.1 | End of borehole<br>Refusal on probable bedrock                  |            |         |      |            |                            | 168             |   |  |  |  |  |                                    |                                     |                                   |  |   |
|               | * 2008 03 17  |            |         |      |            |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |
|               | ∇ Water level observed<br>during drilling                       |            |         |      |            |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |
|               | WH** Denotes penetration due<br>to weight of hammer and<br>rods |            |         |      |            |                            |                 |   |  |  |  |  |                                    |                                     |                                   |  |   |

**RECORD OF BOREHOLE No 305-33**

1 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 16+275, o/s 60.5m Lt. CL Med. ORIGINATED BY W.L.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A + Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE March 16 and 17, 2008 CHECKED BY G.D.

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                  |              |            |                   | PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT |   |                | UNIT<br>WEIGHT<br><br>$\gamma$<br><br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |     |                 |  |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|------------------|--------------|------------|-------------------|---|---|----------------|---|---|-----|-----------------|--|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |                  |              |            |                   | W <sub>P</sub>  | W | W <sub>L</sub> |   |   |     |                 |  |
|               |   |            |         |      |            |                            |                 | ○ UNCONFINED                                | ● QUICK TRIAXIAL | + FIELD VANE | × LAB VANE | WATER CONTENT (%) |   |   |                |   |   |     |                 |  |
| 187.5<br>0.0  | Top of Ice<br>Ice   |            |         |      |            |                            |                 | 20  | 40               | 60           | 80         | 100               |   |   |                |   |   |     |                 |  |
| 186.9<br>0.6  | Water   |            |         |      |            |                            | 187             |   |                  |              |            |                   |   |   |                |   |   |     |                 |  |
| 186.0<br>1.5  | Peat  |            | 1       | SS   | WR**       |                            | 186             |   |                  |              |            |                   |   |   |                |   |   |     |                 |  |
| 184.8<br>2.7  | Organic clayey silt<br>Very soft   Grey/   Wet<br>brown                     |            | 2       | SS   | WH***      |                            | 185             |   |                  |              |            |                   |   |   |                |   |   | 126 | ○               |  |
|               | _____   |            | 3       | SS   | WH         |                            | 184             |   |                  |              |            |                   |   |   |                |   |   |     |                 |  |
|               | sand seams  |            | 4       | SS   | 1          |                            |                 |   |                  |              |            |                   |   |   |                |   |   | 101 | ○               |  |
| 182.9<br>4.6  | Clayey silt<br>silty sand seams<br>Very soft Grey   Wet                     |            | 5       | SS   | WH         |                            | 183             |   |                  |              |            |                   |   |   |                |   |   |     |                 |  |
| 181.4<br>6.1  | Silt<br>trace sand, trace clay<br>Very loose Grey   Wet                     |            | 6       | SS   | 1          |                            | 182             |   |                  |              |            |                   |   |   |                |   |   |     |                 |  |
|               |   |            |         |      |            |                            | 181             |   |                  |              |            |                   |   |   |                |   |   |     | 0   9   82   9  |  |
| 180.2<br>7.3  | Silty clay, trace sand<br>sandy silt seams<br>Firm to   Grey   Wet<br>stiff |            | 7       | SS   | WH         |                            | 180             |   |                  |              |            |                   |   |   |                |   |   |     |                 |  |
|               |   |            |         | FV   |            |                            | 179             |   | 4                | +            |            |                   |   |   |                |   |   |     |                 |  |
|               |   |            | 8       | SS   | WH         |                            | 178             |   |                  |              |            |                   |   |   |                |   |   |     | 0   1   57   42 |  |
|               |   |            |         | FV   |            |                            |                 |   | 4                | +            |            |                   |   |   |                |   |   |     |                 |  |
|               | _____   |            |         |      |            |                            | 177             |   |                  |              |            |                   |   |   |                |   |   |     |                 |  |
|               | trace gravel  |            | 9       | SS   | WH         |                            | 176             |   |                  |              |            |                   |   |   |                |   |   |     |                 |  |
|               |   |            |         | FV   |            |                            |                 |   | 4                | +            |            |                   |   |   |                |   |   |     |                 |  |
|               |   |            | 10      | SS   | WR         |                            | 175             |   |                  |              |            |                   |   |   |                |   |   |     |                 |  |
|               |   |            |         | FV   |            |                            |                 |   | 5                | +            |            |                   |   |   |                |   |   |     |                 |  |
|               |   |            |         |      |            |                            | 174             |   |                  |              |            |                   |   |   |                |   |   |     |                 |  |
|               |   |            | 11      | SS   | WH         |                            |                 |   |                  |              |            |                   |   |   |                |   |   |     |                 |  |
|               |   |            |         | FV   |            |                            | 173             |   |                  |              |            |                   |   |   |                |   |   |     |                 |  |
|               |   |            |         |      |            |                            |                 |   | 6                | +            |            |                   |   |   |                |   |   |     |                 |  |
| 172.5         |   |            |         |      |            |                            |                 |   |                  |              |            |                   |   |   |                |   |   |     |                 |  |

ON\_MOT VER3 SWAMP 305-MAR 13.GPJ ON\_MOT.GDT 7/30/2008 2:18:55 PM

+<sup>7</sup>, X<sup>5</sup>: Numbers refer to  
Sensitivity

20  
15—O—5  
10

(%) STRAIN AT FAILURE



**RECORD OF BOREHOLE No 305-33**

2 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 16+275, o/s 60.5m Lt. CL Med. ORIGINATED BY W.L.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A + Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE March 16 and 17, 2008 CHECKED BY G.D.

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |            |                  |    | PLASTIC<br>LIMIT<br><br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br><br>w | LIQUID<br>LIMIT<br><br>w <sub>L</sub> | UNIT<br>WEIGHT<br><br>γ<br><br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br><br>GR SA SI CL |                   |  |  |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|----|------------|------------------|----|--|---|---------------------------------------|--|--|-------------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |    |            |                  |    |  |   |                                       |  |  | WATER CONTENT (%) |  |  |
|               |   |            |         |      |            |                            |                 | ○ UNCONFINED                                | +  | FIELD VANE | ● QUICK TRIAXIAL | ×  |  |   |                                       |  |  | LAB VANE          |  |  |
| 172.5<br>15.0 |   |            |         |      |            |                            | 20              | 40  | 60 | 80         | 100              | 20 | 40                                     | 60                                      |                                       |  |  |                   |  |  |
|               | some sand<br>silty sand seams   |            | 12      | SS   | WH         |                            |                 |   |    |            |                  |    |  |   |                                       |  |  |                   |  |  |
|               |   |            |         | FV   |            |                            |                 |   |    |            |                  |    |  |   |                                       |  |  |                   |  |  |
|               | trace gravel<br>sand seams  |            | 13      | SS   | WH         |                            |                 |   |    |            |                  |    |  |   |                                       |  |  |                   |  |  |
|               | trace sand  |            |         |      |            |                            |                 |   |    |            |                  |    |  |   |                                       |  |  |                   |  |  |
|               |   |            | 14      | SS   | 2          |                            |                 |   |    |            |                  |    |  |   |                                       |  |  |                   |  |  |
| 168.3<br>19.2 | End of borehole<br>Probable silty clay<br>Firm  |            |         |      |            |                            |                 |   |    |            |                  |    |  |   |                                       |  |  |                   |  |  |
| 166.8<br>20.7 | Probable silt<br>Loose to compact   |            |         |      |            |                            |                 |   |    |            |                  |    |  |   |                                       |  |  |                   |  |  |
| 163.7<br>23.8 | End of dynamic cone<br>penetration test   |            |         |      |            |                            |                 |   |    |            |                  |    |  |   |                                       |  |  |                   |  |  |
|               | * 2008 03 16  |            |         |      |            |                            |                 |   |    |            |                  |    |  |   |                                       |  |  |                   |  |  |
|               | ▽ Water level observed<br>during drilling   |            |         |      |            |                            |                 |   |    |            |                  |    |  |   |                                       |  |  |                   |  |  |
|               | WR** Denotes penetration due<br>to weight of rods only  |            |         |      |            |                            |                 |   |    |            |                  |    |  |   |                                       |  |  |                   |  |  |
|               | WH*** Denotes penetration due<br>to weight of hammer and<br>rods<br>C.F.H.S.A. Denotes<br>Continuous Flight Hollow<br>Stem Augers |            |         |      |            |                            |                 |   |    |            |                  |    |  |   |                                       |  |  |                   |  |  |

**RECORD OF BOREHOLE No 305-37**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 16+300, o/s 38.8m Lt. CL Med. ORIGINATED BY N.L.B.  
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
DATUM Geodetic DATE March 08, 2007 CHECKED BY G.D.



| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |              |    |     | PLASTIC<br>LIMIT<br>W <sub>P</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |                   |  |  |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|----|--------------|----|-----|------------------------------------|-------------------------------------|-----------------------------------|--|---|-------------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |    |              |    |     |                                    |                                     |                                   |  |   | WATER CONTENT (%) |  |  |
|               |   |            |         |      |            |                            |                 | ○ UNCONFINED                                |    | + FIELD VANE |    |     |                                    |                                     |                                   |  |   | ○                 |  |  |
|               |   |            |         |      |            |                            |                 | ● QUICK TRIAXIAL                            |    | × LAB VANE   |    |     |                                    |                                     |                                   |  |   | —                 |  |  |
| 187.5         | Ground Surface  |            |         |      |            | ▼*                         |                 | 20  | 40 | 60           | 80 | 100 |                                    |                                     |                                   |  |   |                   |  |  |
| 0.0           | Peat, fine fibrous<br>Dark brown Wet                      |            |         |      |            | ▼*                         | 187             |   |    |              |    |     |                                    |                                     |                                   |  |   |                   |  |  |
| 186.9         | Organic clay  |            |         |      |            |                            |                 |   |    |              |    |     |                                    |                                     |                                   |  |   |                   |  |  |
| 0.6           | Soft Grey Moist   |            | 1       | SS   | 1          |                            |                 |   |    |              |    |     |                                    | ○                                   |                                   |  |   |                   |  |  |
| 186.6         | Silt, trace clay  |            |         |      |            |                            |                 |   |    |              |    |     |                                    |                                     |                                   |  |   |                   |  |  |
| 0.9           | Very loose Grey Wet                                       |            |         |      |            |                            | 186             |   |    |              |    |     |                                    |                                     |                                   |  |   |                   |  |  |
|               | layers of silty clay                                      |            | 2       | SS   | 1          |                            |                 |   |    |              |    |     |                                    | ○                                   |                                   |  |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |     |                                    |                                     |                                   |  |   |                   |  |  |
| 184.8         | Clayey silt, trace sand                                   |            |         |      |            |                            | 185             |   |    |              |    |     |                                    |                                     |                                   |  |   |                   |  |  |
| 2.7           | Soft to Grey/ Wet<br>firm brown                           |            | 3       | SS   | WH**       |                            | 184             |   |    |              |    |     |                                    | ▬▬▬○                                |                                   |  | 0 5 66 29   |                   |  |  |
|               | layers of silt  |            |         |      |            |                            |                 |   |    |              |    |     |                                    |                                     |                                   |  |   |                   |  |  |
|               |   |            | 4       | SS   | WH         |                            | 183             |   |    |              |    |     |                                    | ○                                   |                                   |  |   |                   |  |  |
| 182.0         | Silt, trace clay<br>thin layers of silty clay             |            |         | FV   |            |                            | 182             |   |    |              |    |     |                                    |                                     |                                   |  |   |                   |  |  |
| 5.5           | Very loose Grey Wet                                       |            | 5       | SS   | WH         |                            |                 | +   | 2  |              |    |     |                                    |                                     |                                   |  |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |     |                                    |                                     |                                   |  |   |                   |  |  |
| 180.5         | Clay, varved<br>layers of silt                            |            |         |      |            |                            | 181             |   |    |              |    |     |                                    | ○                                   |                                   |  |   |                   |  |  |
| 7.0           | Soft Grey/ Wet<br>brown                                   |            |         |      |            |                            | 180             |   |    |              |    |     |                                    |                                     |                                   | ○  |   |                   |  |  |
|               |   |            | 6       | SS   | WH         |                            | 179             |   |    |              |    |     |                                    |                                     |                                   |  |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |     |                                    |                                     |                                   |  |   |                   |  |  |
|               |   |            | 7       | SS   | WH         |                            | 178             |   |    |              |    |     |                                    | ○                                   |                                   |  |   |                   |  |  |
|               | no layers   |            |         |      |            |                            |                 |   |    |              |    |     |                                    |                                     |                                   |  |   |                   |  |  |
|               |   |            |         |      |            |                            | 177             |   |    |              |    |     |                                    |                                     |                                   |  |   |                   |  |  |
|               |   |            | 8       | SS   | WH         |                            |                 |   |    |              |    |     |                                    | ▬▬▬○                                |                                   |  |   |                   |  |  |
|               |   |            |         | FV   |            |                            | 176             |   |    |              |    |     |                                    |                                     |                                   |  |   |                   |  |  |
|               | layers of silt  |            |         |      |            |                            |                 | +   | 4  |              |    |     |                                    |                                     |                                   |  |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |     |                                    |                                     |                                   |  |   |                   |  |  |
| 175.0         | Silt, trace clay  |            | 9       | SS   | WH         |                            | 175             |   |    |              |    |     |                                    | ○                                   |                                   |  |   |                   |  |  |
| 12.5          | Very loose Grey Wet                                       |            | 10      | AS   | -          |                            |                 |   |    |              |    |     |                                    |                                     |                                   |  |   |                   |  |  |
| 174.7         | Sand, trace silt  |            |         |      |            |                            |                 |   |    |              |    |     |                                    |                                     |                                   |  |   |                   |  |  |
| 12.8          | Very loose Grey Wet                                       |            |         |      |            |                            |                 |   |    |              |    |     |                                    |                                     |                                   |  |   |                   |  |  |
| 174.4         | End of borehole<br>Refusal on probable bedrock            |            |         |      |            |                            |                 |   |    |              |    |     |                                    |                                     |                                   |  |   |                   |  |  |
| 13.1          |   |            |         |      |            |                            |                 |   |    |              |    |     |                                    |                                     |                                   |  |   |                   |  |  |
|               | * 2007 03 08  |            |         |      |            |                            |                 |   |    |              |    |     |                                    |                                     |                                   |  |   |                   |  |  |
|               | ▽ Water level observed during drilling                    |            |         |      |            |                            |                 |   |    |              |    |     |                                    |                                     |                                   |  |   |                   |  |  |
|               | ▼ Water level measured after drilling                     |            |         |      |            |                            |                 |   |    |              |    |     |                                    |                                     |                                   |  |   |                   |  |  |
|               | WH** denotes penetration due to weight of hammer and rods |            |         |      |            |                            |                 |   |    |              |    |     |                                    |                                     |                                   |  |   |                   |  |  |

# RECORD OF BOREHOLE No 305-39

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 16+325, o/s 50.5m Lt. CL Med. ORIGINATED BY W.L.  
 DIST 54 HWY 69 BOREHOLE TYPE Excavator COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 26, 2007 CHECKED BY G.D.

| SOIL PROFILE  |  |   | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                  |    |    |            |          | PLASTIC<br>LIMIT<br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>w | LIQUID<br>LIMIT<br>w <sub>L</sub> | UNIT<br>WEIGHT<br>γ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |  |  |    |    |    |    |
|---------------|--|---|---------|------|------------|----------------------------|-----------------|---|------------------|----|----|------------|----------|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|--|--|----|----|----|----|
| ELEV<br>DEPTH | DESCRIPTION                                    | STRAT PLOT  | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |                  |    |    |            |          |                                    |                                     |                                   |                     | WATER CONTENT (%)                                 |  |  | GR | SA | SI | CL |
|               |  |   |         |      |            |                            |                 | ○ UNCONFINED                                | ● QUICK TRIAXIAL | +  | ×  | FIELD VANE | LAB VANE |                                    |                                     |                                   |                     |   |  |  |    |    |    |    |
| 191.5<br>0.0  | Ground Surface<br>Topsoil                      |  |         |      |            |                            |                 | 20  | 40               | 60 | 80 | 100        |          |                                    |                                     |                                   |                     |   |  |  |    |    |    |    |
| 190.9<br>0.6  | End of borehole<br>Refusal on probable bedrock |  |         |      |            |                            | 191             |   |                  |    |    |            |          |                                    |                                     |                                   |                     |   |  |  |    |    |    |    |
|               | * Borehole dry upon completion of drilling     |   |         |      |            |                            |                 |   |                  |    |    |            |          |                                    |                                     |                                   |                     |   |  |  |    |    |    |    |

# RECORD OF BOREHOLE No 305-40

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 16+325, o/s 28.5m Lt. CL Med. ORIGINATED BY W.L.  
 DIST 54 HWY 69 BOREHOLE TYPE Manual Probing COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 26, 2007 CHECKED BY G.D.


| SOIL PROFILE  |                    | SAMPLES    |        |      |            | GROUND WATER<br>*<br>ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |  |  |  |  | PLASTIC LIMIT<br>NATURAL MOISTURE CONTENT<br>LIQUID LIMIT |   |                | UNIT<br>WEIGHT<br>$\gamma$<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|---------------|--------------------|------------|--------|------|------------|--------------------------------------|---|--|--|--|--|---|---|----------------|---|--|
| ELEV<br>DEPTH | DESCRIPTION        | STRAT PLOT | NUMBER | TYPE | "N" VALUES |                                      | SHEAR STRENGTH kPa                          |  |  |  |  | W <sub>p</sub>  | W | W <sub>L</sub> |   |  |
| 191.2         | Ground Surface     |            |        |      |            |                                      |   |  |  |  |  |   |   |                |   |  |
| 0.0           | Bedrock at surface |            |        |      |            |                                      |   |  |  |  |  |   |   |                |   |  |
|               | * Borehole dry     |            |        |      |            |                                      |   |  |  |  |  |   |   |                |   |  |

**RECORD OF BOREHOLE No 305-43**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 16+350, o/s 38.8m Lt. CL Med. ORIGINATED BY W.L.  
 DIST 54 HWY 69 BOREHOLE TYPE Excavator COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 26, 2007 CHECKED BY G.D.

| SOIL PROFILE  |  |   | SAMPLES |      |            |                    | GROUND WATER<br>CONDITIONS<br>* | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |  |  |  |  | PLASTIC<br>LIMIT<br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>w | LIQUID<br>LIMIT<br>w <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |  |  |  |
|---------------|--|---|---------|------|------------|--------------------|---------------------------------|-----------------|---|--|--|--|--|------------------------------------|-------------------------------------|-----------------------------------|--|--|--|--|--|
| ELEV<br>DEPTH | DESCRIPTION                                    | STRAT PLOT  | NUMBER  | TYPE | "N" VALUES | SHEAR STRENGTH kPa |                                 |                 |   |  |  |  |  |                                    |                                     |                                   |  |  |  |  |  |
| 192.1         | Ground Surface                                 |  |         |      |            |                    | 192                             |                 |   |  |  |  |  |                                    |                                     |                                   |  |  |  |  |  |
| 0.0           | Topsoil  |   |         |      |            |                    |                                 |                 |   |  |  |  |  |                                    |                                     |                                   |  |  |  |  |  |
| 0.3           | Silt<br>some sand, trace clay                  |   |         |      |            |                    |                                 |                 |   |  |  |  |  |                                    |                                     |                                   |  |  |  |  |  |
| 191.0         | Light brown Moist                              |   |         |      |            |                    | 191                             |                 |   |  |  |  |  |                                    |                                     |                                   |  |  |  |  |  |
| 1.1           | End of borehole<br>Refusal on probable bedrock |   |         |      |            |                    |                                 |                 |   |  |  |  |  |                                    |                                     |                                   |  |  |  |  |  |
|               | * Borehole dry upon<br>completion of drilling  |   |         |      |            |                    |                                 |                 |   |  |  |  |  |                                    |                                     |                                   |  |  |  |  |  |

1 of 1 **METRIC**

MOT\_DCPT R2004 SWAMP 305-MAR 13.GPJ ON\_MOT.GDT 12/14/2007 6:54:36 PM

RECORD OF PENETRATION TEST No 305-15

1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 16+125, o/s 58.5m Lt. CL Med. ORIGINATED BY M.R.  
DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE March 05, 2007 CHECKED BY G.D.

| SOIL PROFILE  |  |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |  | PLASTIC<br>LIMIT<br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>w | LIQUID<br>LIMIT<br>w <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|--|------------------------------------|-------------------------------------|-----------------------------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION  | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |  |                                    |                                     |                                   |  |  |
| 187.5<br>0.0  | Top of Ice<br>Ice<br>Water<br><br>Probable peat<br><br>Probable organic clayey<br>silt<br><br>Probable silty sand<br>Very loose<br>to loose<br><br>Probable clay<br>Soft |            |         |      |            |                            |                 |   |  |                                    |                                     |                                   |  |  |
| 177.9<br>9.6  | End of dynamic cone<br>penetration test<br>Refusal on probable bedrock   |            |         |      |            |                            |                 |   |  |                                    |                                     |                                   |  |  |

RECORD OF PENETRATION TEST No 305-22

1 of 2 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 16+175, o/s 20.5m Lt. CL Med. ORIGINATED BY W.L.  
DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE March 12, 2008 CHECKED BY G.D.

| SOIL PROFILE   |                                   |             | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                 | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|----------------|-----------------------------------|-------------|---------|------|------------|----------------------------|-----------------|---|-----------------|------------------------------------|-------------------------------------|-----------------------------------|--|--|
| ELEV.<br>DEPTH | DESCRIPTION                       | STRAT. PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | 20 40 60 80 100                             | 20 40 60 80 100 |                                    |                                     |                                   |  |  |
| 187.5<br>0.0   | Top of Ice                        |             |         |      |            |                            |                 |   |                 |                                    |                                     |                                   |  |  |
|                | Ice                               |             |         |      |            |                            |                 |   |                 |                                    |                                     |                                   |  |  |
|                | Water                             |             |         |      |            |                            |                 |   |                 |                                    |                                     |                                   |  |  |
|                | Probable peat                     |             |         |      |            |                            |                 |   |                 |                                    |                                     |                                   |  |  |
|                | Probable sand<br>Loose to compact |             |         |      |            |                            |                 |   |                 |                                    |                                     |                                   |  |  |
|                | Probable silty clay<br>Firm       |             |         |      |            |                            |                 |   |                 |                                    |                                     |                                   |  |  |

MOT\_DCPT R2004 SWAMP 305-MAR 13.GPJ ON\_MOT.GDT 7/30/2008 11:50:22 AM

+ , X<sup>5</sup> : Numbers refer to  
Sensitivity

20  
15—5  
10

(%) STRAIN AT FAILURE



RECORD OF PENETRATION TEST No 305-22

2 of 2 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 16+175, o/s 20.5m Lt. CL Med. ORIGINATED BY W.L.  
DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE March 12, 2008 CHECKED BY G.D.

| SOIL PROFILE   |   | SAMPLES     |        |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                 |          |  |  | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|----------------|---|-------------|--------|------|------------|----------------------------|-----------------|---|-----------------|----------|--|--|------------------------------------|-------------------------------------|-----------------------------------|--|--|
| ELEV.<br>DEPTH | DESCRIPTION                             | STRAT. PLOT | NUMBER | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |                 |          |  |  |                                    |                                     |                                   |  |  |
| 172.5          |   |             |        |      |            |                            |                 | 20 40 60 80 100                             | 20 40 60 80 100 | 20 40 60 |  |  |                                    |                                     |                                   |  |  |
|                | Probable silty clay<br>Firm             |             |        |      |            |                            | 172             |   |                 |          |  |  |                                    |                                     |                                   |  |  |
|                |   |             |        |      |            |                            | 171             |   |                 |          |  |  |                                    |                                     |                                   |  |  |
|                |   |             |        |      |            |                            | 170             |   |                 |          |  |  |                                    |                                     |                                   |  |  |
|                |   |             |        |      |            |                            | 169             |   |                 |          |  |  |                                    |                                     |                                   |  |  |
|                |   |             |        |      |            |                            | 168             |   |                 |          |  |  |                                    |                                     |                                   |  |  |
|                |   |             |        |      |            |                            | 167             |   |                 |          |  |  |                                    |                                     |                                   |  |  |
|                |   |             |        |      |            |                            | 166             |   |                 |          |  |  |                                    |                                     |                                   |  |  |
|                | Probable clayey silt<br>Stiff           |             |        |      |            |                            | 165             |   |                 |          |  |  |                                    |                                     |                                   |  |  |
|                |   |             |        |      |            |                            | 164             |   |                 |          |  |  |                                    |                                     |                                   |  |  |
|                |   |             |        |      |            |                            | 163             |   |                 |          |  |  |                                    |                                     |                                   |  |  |
|                | Probable silt<br>Compact                |             |        |      |            |                            | 162             |   |                 |          |  |  |                                    |                                     |                                   |  |  |
|                |   |             |        |      |            |                            | 161             |   |                 |          |  |  |                                    |                                     |                                   |  |  |
|                |   |             |        |      |            |                            | 160             |   |                 |          |  |  |                                    |                                     |                                   |  |  |
|                |   |             |        |      |            |                            | 159             |   |                 |          |  |  |                                    |                                     |                                   |  |  |
| 158.5<br>29.0  | End of dynamic cone<br>penetration test |             |        |      |            |                            |                 |   |                 |          |  |  |                                    |                                     |                                   |  |  |

1 of 2 **METRIC**

MOT\_DCPT R2004 SWAMP 305-MAR 13.GPJ ON\_MOT.GDT 7/30/2008 11:52:23 AM

+7, X<sup>5</sup>: Numbers refer to Sensitivity

20  
15—○—5 (%) STRAIN AT FAILURE  
10

## 2 of 2 METRIC

1 of 1 **METRIC**

PM<sup>7</sup>, X<sup>5</sup>: Numbers refer to Sensitivity

**METRIC**

20  
15 — 5 (%) STRAIN AT FAILURE  
10

**RECORD OF BOREHOLE No 306-16**

1 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+375, o/s 14.5m Lt. CL Med. ORIGINATED BY M.R.  
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
DATUM Geodetic DATE November 10, 2006 CHECKED BY C.N.

| SOIL PROFILE  |  |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS<br>* | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |     |  | PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT |   |                | UNIT<br>WEIGHT<br><br>$\gamma$<br><br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|--|------------|---------|------|------------|---------------------------------|-----------------|---|----|----|-----|--|---|---|----------------|---|---|
| ELEV<br>DEPTH | DESCRIPTION  | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                                 |                 | SHEAR STRENGTH kPa                          |    |    |     |  | W <sub>p</sub>  | W | W <sub>L</sub> |   |   |
|               |  |            |         |      |            |                                 |                 |   |    |    |     |  |   |   |                |   |   |
|               |  |            |         |      |            |                                 |                 |   |    |    |     |  |   |   |                |   |   |
| 189.0         | Ground Surface   |            |         |      |            |                                 | 20              | 40  | 60 | 80 | 100 |  |   |   |                |   |   |
| 0.0           | Peat, coarse fibrous                                   |            | 1       | SS   | 1          |                                 |                 |   |    |    |     |  |   |   |                | 239   |   |
|               | Dark brown fine fibrous                                |            |         |      |            |                                 |                 |   |    |    |     |  |   |   |                |   |   |
| 188.1         |  |            |         |      |            |                                 |                 |   |    |    |     |  |   |   |                |   |   |
| 0.9           | Silty clay, trace sand inclusions of fine fibrous peat |            | 2       | SS   | 1          |                                 |                 |   |    |    |     |  |   |   |                |   |   |
|               | Very soft Blueish Wet grey                             |            | 3       | SS   | WH**       |                                 |                 |   |    |    |     |  |   |   |                |   |   |
|               |  |            |         |      |            |                                 |                 |   |    |    |     |  |   |   |                |   |   |
|               |  |            | 4       | SS   | WH         |                                 |                 |   |    |    |     |  |   |   |                | 90  |   |
| 186.0         |  |            |         |      |            |                                 |                 |   |    |    |     |  |   |   |                |   |   |
| 3.0           | Clay, trace sand layers of silty clay                  |            | 5       | SS   | WH         |                                 |                 |   |    |    |     |  |   |   |                | 91  |   |
|               | Soft to Grey Wet firm                                  |            |         | FV   |            |                                 |                 |   |    |    |     |  |   |   |                |   |   |
|               |  |            |         |      |            |                                 |                 |   |    |    |     |  |   |   |                |   |   |
|               |  |            | 6       | SS   | WH         |                                 |                 |   |    |    |     |  |   |   |                | 84  |   |
|               |  |            |         | FV   |            |                                 |                 |   |    |    |     |  |   |   |                |   |   |
|               |  |            |         |      |            |                                 |                 |   |    |    |     |  |   |   |                |   |   |
|               |  |            | 7       | TW   | PM         |                                 |                 |   |    |    |     |  |   |   |                |   |   |
|               |  |            |         | FV   |            |                                 |                 |   |    |    |     |  |   |   |                |   |   |
|               |  |            |         |      |            |                                 |                 |   |    |    |     |  |   |   |                |   |   |
|               |  |            | 8       | SS   | WH         |                                 |                 |   |    |    |     |  |   |   |                | 84  |   |
|               |  |            |         | FV   |            |                                 |                 |   |    |    |     |  |   |   |                |   |   |
|               |  |            |         |      |            |                                 |                 |   |    |    |     |  |   |   |                |   |   |
| 180.0         |  |            |         |      |            |                                 |                 |   |    |    |     |  |   |   |                |   |   |
| 9.0           | Silty clay, trace sand                                 |            | 9       | SS   | WH         |                                 |                 |   |    |    |     |  |   |   |                |   |   |
|               | Firm Grey Wet  |            |         | FV   |            |                                 |                 |   |    |    |     |  |   |   |                |   |   |
|               |  |            |         |      |            |                                 |                 |   |    |    |     |  |   |   |                |   |   |
|               | thin layers of silt                                    |            |         |      |            |                                 |                 |   |    |    |     |  |   |   |                |   |   |
|               |  |            | 10      | SS   | WH         |                                 |                 |   |    |    |     |  |   |   |                |   |   |
|               |  |            |         | FV   |            |                                 |                 |   |    |    |     |  |   |   |                |   |   |
|               |  |            |         |      |            |                                 |                 |   |    |    |     |  |   |   |                |   |   |
| 177.1         |  |            |         |      |            |                                 |                 |   |    |    |     |  |   |   |                |   |   |
| 11.9          | Silt, some to trace clay trace sand                    |            | 11      | SS   | WH         |                                 |                 |   |    |    |     |  |   |   |                |   |   |
|               | Very loose Grey Wet                                    |            |         |      |            |                                 |                 |   |    |    |     |  |   |   |                |   |   |
|               |  |            |         |      |            |                                 |                 |   |    |    |     |  |   |   |                |   |   |
|               |  |            | 12      | SS   | WH         |                                 |                 |   |    |    |     |  |   |   |                |   |   |
|               |  |            |         |      |            |                                 |                 |   |    |    |     |  |   |   |                |   |   |
|               |  |            |         |      |            |                                 |                 |   |    |    |     |  |   |   |                |   |   |

Cont'd

**RECORD OF BOREHOLE No 306-16**

2 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+375, o/s 14.5m Lt. CL Med. ORIGINATED BY M.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
 DATUM Geodetic DATE November 10, 2006 CHECKED BY C.N.

| SOIL PROFILE  |  |            | SAMPLES |      |            | GROUND WATER<br>*<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT                      |    |    |    |     | PLASTIC<br>LIMIT<br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>w | LIQUID<br>LIMIT<br>w <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br><br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |    |    |    |    |  |  |
|---------------|--|------------|---------|------|------------|---------------------------------|-----------------|--|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|--|---|----|----|----|----|--|--|
| ELEV<br>DEPTH | DESCRIPTION  | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                                 |                 | SHEAR STRENGTH kPa   |    |    |    |     |                                    |                                     |                                   |  |   |    |    |    |    |  |  |
|               |  |            |         |      |            |                                 |                 | ○ UNCONFINED      + FIELD VANE<br>● QUICK TRIAXIAL    × LAB VANE |    |    |    |     |                                    |                                     |                                   |  | WATER CONTENT (%)                                 |    |    |    |    |  |  |
| 174.0         |  |            |         |      |            |                                 |                 | 20   | 40 | 60 | 80 | 100 |                                    |                                     |                                   |  |   | GR | SA | SI | CL |  |  |
| 172.2<br>16.8 | brown layering   |            |         |      |            |                                 | 173             |  |    |    |    |     |                                    |                                     |                                   |  |   | 0  | 9  | 83 | 8  |  |  |
|               |  | 13         | SS      | 3    |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |   |    |    |    |    |  |  |
|               |  |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |   |    |    |    |    |  |  |
| 16.8          | End of borehole<br>Refusal on probable bedrock   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |   |    |    |    |    |  |  |
|               | <div>* Borehole dry on completion of drilling</div> <div>WH** denotes penetration due to weight of rods and hammer</div> |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |   |    |    |    |    |  |  |

## 1 of 1

METRIC

## Foundation Design

| SOIL PROFILE  |  |            |        |      |            |                           |
|---------------|--|------------|--------|------|------------|---------------------------|
| ELEV<br>DEPTH | DESCRIPTION  | STRAT PLOT | NUMBER | TYPE | "N" VALUES | * GROUND WATER CONDITIONS |
| 189.1<br>0.0  | Ground Surface<br>Peat, amorphous  |            | 1      | SS   | WH**       |                           |
| 188.5<br>0.6  | Dark brown<br><br>Organic silty clay layers of silt and peaty organics, decayed wood |            | 2      | SS   | WH         |                           |
|               | Soft Blueish Moist grey  |            | 3      | SS   | WH         |                           |
| 186.7<br>2.4  | Clay, trace sand<br><br>Firm Grey Moist  |            |        | FV   |            |                           |
|               |  |            |        |      |            |                           |
|               |  |            | 4      | SS   | WH         |                           |
|               |  |            |        | FV   |            |                           |
|               |  |            |        |      |            |                           |
|               | thin layers of silt  |            | 5      | SS   | WH         |                           |
|               |  |            |        | FV   |            |                           |
|               |  |            |        |      |            |                           |
|               |  |            | 6      | SS   | WH         |                           |
|               |  |            |        | FV   |            |                           |
|               |  |            |        |      |            |                           |
|               |  | 7          | SS     | WH   |            |                           |
|               |  |            | FV     |      |            |                           |
|               |  |            |        |      |            |                           |
| 180.0<br>9.1  | End of borehole<br><br>Refusal on probable bedrock                                   |            |        |      |            |                           |
|               |  |            |        |      |            |                           |
| *             | Borehole dry on completion of drilling   |            |        |      |            |                           |
| WH**          | Denotes penetration due to weight of rods and hammer                                 |            |        |      |            |                           |



## 1 of 1

METRIC

## Foundation Design

[illegible]

**METRIC**

**+<sup>7</sup>, ×<sup>5</sup>:** Numbers refer to Sensitivity

20  
15 — ○ — 5  
10

(%) STRAIN AT FAILURE

**METRIC**

**+<sup>7</sup>, ×<sup>5</sup>:** Numbers refer to Sensitivity

20  
15 — ○ — 5  
10

(%) STRAIN AT FAILURE

**METRIC**























20  
15 — 5 (%) STRAIN AT FAILURE  
10

**RECORD OF BOREHOLE No 306-31**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+500, o/s 38.8m Lt. CL Med. ORIGINATED BY M.R.  
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
DATUM Geodetic DATE November 14, 2006 CHECKED BY C.N.

| SOIL PROFILE  |  |   |        | SAMPLES |           |   | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |                   |     |  | PLASTIC<br>LIMIT<br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>w | LIQUID<br>LIMIT<br>w <sub>L</sub> | UNIT<br>WEIGHT<br>γ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |  |  |
|---------------|--|---|--------|---------|-----------|---|----------------------------|-----------------|---|----|-------------------|-----|--|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|--|--|
| ELEV<br>DEPTH | DESCRIPTION  | STRAT PLOT  | NUMBER | TYPE    | *N VALUES | SHEAR STRENGTH kPa  |                            |                 |   |    | WATER CONTENT (%) |     |  |                                    |                                     |                                   |                     |   |  |  |
|               |  |   |        |         |           | ○ UNCONFINED  |                            |                 | + FIELD VANE                                |    |                   | ○   |  |                                    |                                     |                                   |                     |   |  |  |
|               |  |   |        |         |           | ● QUICK TRIAXIAL  |                            |                 | × LAB VANE                                  |    |                   |     |  |                                    |                                     |                                   |                     |   |  |  |
| 189.2         | Ground Surface   |   |        |         |           |   |                            | 20              | 40  | 60 | 80                | 100 |  |                                    |                                     |                                   |                     |   |  |  |
| 0.0           | Peat, fine fibrous<br>Dark brown   |  | 1      | SS      | WH**      |  | 189                        |                 |   |    |                   |     |  |                                    |                                     |                                   | Org.<br>15.2%       | GR SA SI CL                                       |  |  |
| 0.3           | Organic silty clay<br>shell fragments and layers<br>of amorphous peat  |  |        |         |           |   |                            |                 |   |    |                   |     |  |                                    |                                     |                                   |                     |   |  |  |
| 188.1         | Very soft Olive<br>brown   |  | 2      | SS      | WH        |   | 188                        |                 |   |    |                   |     |  |                                    |                                     |                                   |                     |   |  |  |
| 1.1           | Sandy silt   |  |        |         |           |   |                            |                 |   |    |                   |     |  |                                    |                                     |                                   |                     |   |  |  |
| 187.4         | Very loose Grey<br>Clay, trace sand  |  | 3      | SS      | WH        |   |                            |                 |   |    |                   |     |  |                                    |                                     |                                   |                     |   |  |  |
| 1.8           | Soft to Grey<br>firm   |  |        | FV      |           |   | 187                        | +               | 3   |    |                   |     |  |                                    |                                     |                                   |                     |   |  |  |
|               | _____  |  |        |         |           |   |                            |                 |   |    |                   |     |  |                                    |                                     |                                   |                     |   |  |  |
|               | inclusions of silt   |  |        |         |           |   |                            |                 |   |    |                   |     |  |                                    |                                     |                                   |                     |   |  |  |
|               | _____  |  |        |         |           |   |                            |                 |   |    |                   |     |  |                                    |                                     |                                   |                     |   |  |  |
|               | brown layering   |  |        |         |           |   |                            |                 |   |    |                   |     |  |                                    |                                     |                                   |                     |   |  |  |
|               | _____  |  |        |         |           |   |                            |                 |   |    |                   |     |  |                                    |                                     |                                   |                     |   |  |  |
|               | thin layers of silt  |  |        |         |           |   |                            |                 |   |    |                   |     |  |                                    |                                     |                                   |                     |   |  |  |
|               | _____  |  |        |         |           |   |                            |                 |   |    |                   |     |  |                                    |                                     |                                   |                     |   |  |  |
|               |  |  |        |         |           |   |                            |                 |   |    |                   |     |  |                                    |                                     |                                   |                     |   |  |  |
|               |  |  |        |         |           |   |                            |                 |   |    |                   |     |  |                                    |                                     |                                   |                     |   |  |  |
|               |  |  |        |         |           |   |                            |                 |   |    |                   |     |  |                                    |                                     |                                   |                     |   |  |  |
| 177.3         | Silt, some clay<br>thin layers of silty clay   |  |        |         |           |   |                            |                 |   |    |                   |     |  |                                    |                                     |                                   |                     |   |  |  |
| 11.9          | Loose Grey<br>Wet  |  | 10     | SS      | 5         |   | 177                        |                 |   |    |                   |     |  | ○                                  |                                     |                                   | 0 4 85 11           |   |  |  |
| 176.0         | End of borehole<br>Refusal on probable bedrock   |  |        |         |           |   | 176                        |                 |   |    |                   |     |  |                                    |                                     |                                   |                     |   |  |  |
| 13.2          | * 2006 11 14<br> Water level observed<br>during drilling<br> Water level measured<br>after drilling<br>WH** denotes penetration due<br>to weight of rods and<br>hammer |   |        |         |           |   |                            |                 |   |    |                   |     |  |                                    |                                     |                                   |                     |   |  |  |

**RECORD OF BOREHOLE No 306-33**

1 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+525, o/s 56.5m Lt. CL Med. ORIGINATED BY M.R.  
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
DATUM Geodetic DATE November 14, 2006 CHECKED BY C.N.

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |   |  |  |  | PLASTIC<br>LIMIT<br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>w | LIQUID<br>LIMIT<br>w <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|---|------------|---------|------|------------|----------------------------|---|---|--|--|--|------------------------------------|-------------------------------------|-----------------------------------|--|---|
| ELEV<br>DEPTH | DESCRIPTION                                       | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            | SHEAR STRENGTH kPa                          |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            | ○ UNCONFINED      + FIELD VANE              |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            | ● QUICK TRIAXIAL    × LAB VANE              |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            | WATER CONTENT (%)                           |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            | 20   40   60   80   100                     |   |  |  |  | 20   40   60                       |                                     |                                   |  |   |
| 189.2         | Ground Surface                                    |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
| 0.0           | Peat, fine fibrous<br>Dark brown                  |            | 1       | SS   | WH**       | 189                        |   |   |  |  |  |                                    |                                     |                                   | 145                                      |   |
| 0.3           | Organic clay, trace sand<br>layers of clayey silt |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               | Very soft    Olive    Wet<br>brown                |            | 2       | SS   | WH         | 188                        |   |   |  |  |  |                                    |                                     |                                   | 87                                       | Org.<br>3.7%                                      |
| 187.8         |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
| 1.4           | Sandy silt  |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
| 187.4         |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
| 1.8           | Very loose Grey    Wet<br>Clay, trace sand        |            | 3       | SS   | WH         | 187                        | +   | 3 |  |  |  |                                    |                                     |                                   | 85                                       |   |
|               | Very soft    Grey    Wet<br>to firm               |            |         | FV   |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               | _____   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               | layers of silt                                    |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               | _____   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               | brown layering                                    |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |
|               |   |            |         |      |            |                            |   |   |  |  |  |                                    |                                     |                                   |  |   |

# RECORD OF BOREHOLE No 306-33

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**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+525, o/s 56.5m Lt. CL Med. ORIGINATED BY M.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
 DATUM Geodetic DATE November 14, 2006 CHECKED BY C.N.

| SOIL PROFILE  |  |            |        | SAMPLES |            |                    | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |  |  |                   |  |  | PLASTIC<br>LIMIT<br><br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br><br>w | LIQUID<br>LIMIT<br><br>w <sub>L</sub> | UNIT<br>WEIGHT<br><br>γ<br><br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |  |  |  |  |
|---|--|------------|--------|---------|------------|--------------------|----------------------------|-----------------|---|--|--|-------------------|--|--|--|---|---------------------------------------|--|---|--|--|--|--|
| ELEV<br>DEPTH   | DESCRIPTION  | STRAT PLOT | NUMBER | TYPE    | "N" VALUES | SHEAR STRENGTH kPa |                            |                 |   |  |  | WATER CONTENT (%) |  |  |  |   |                                       |  |   |  |  |  |  |
|   |  |            |        |         |            | ○ UNCONFINED       |                            |                 | + FIELD VANE                                |  |  |                   |  |  |  |   |                                       |  |   |  |  |  |  |
|   |  |            |        |         |            | ● QUICK TRIAXIAL   |                            |                 | × LAB VANE                                  |  |  |                   |  |  |  |   |                                       |  |   |  |  |  |  |
| 174.2   | Silt<br>some clay, trace sand<br>Very loose Grey Wet |            |        |         |            |                    |                            |                 |   |  |  |                   |  |  |  |   | GR SA SI CL                           |  |   |  |  |  |  |
| 15.0  |  |            | 12     | SS      | WH         |                    |                            |                 |   |  |  |                   |  |  |  |   |                                       | 0 1 84 15  |   |  |  |  |  |
|   |  |            |        |         |            |                    |                            |                 |   |  |  |                   |  |  |  |   |                                       |  |   |  |  |  |  |
|   |  |            |        |         |            |                    |                            |                 |   |  |  |                   |  |  |  |   |                                       |  |   |  |  |  |  |
| 172.0   |  |            | 13     | SS      | WH         |                    |                            |                 |   |  |  |                   |  |  |  |   |                                       |  |   |  |  |  |  |
| 17.2  | Sandy silt, with gravel<br>Very loose Grey Wet       |            |        |         |            |                    |                            |                 |   |  |  |                   |  |  |  |   |                                       |  |   |  |  |  |  |
| 171.2   |  |            |        |         |            |                    |                            |                 |   |  |  |                   |  |  |  |   |                                       |  |   |  |  |  |  |
| 18.0  | End of borehole<br>Refusal on probable bedrock       |            |        |         |            |                    |                            |                 |   |  |  |                   |  |  |  |   |                                       |  |   |  |  |  |  |
| <div>* 2006 11 14</div> <div> Water level observed during drilling</div> <div> Water level measured after drilling</div> <div>WH** denotes penetration due to weight of rods and hammer</div> |  |            |        |         |            |                    |                            |                 |   |  |  |                   |  |  |  |   |                                       |  |   |  |  |  |  |

**RECORD OF BOREHOLE No 306-37**

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**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+550, o/s 38.8m Lt. CL Med. ORIGINATED BY M.R.  
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
DATUM Geodetic DATE November 15, 2006 CHECKED BY C.N.

| SOIL PROFILE  |                                    |            |        | SAMPLES |            |                    | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |  |                   |  |  | PLASTIC<br>LIMIT<br><br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br><br>w | LIQUID<br>LIMIT<br><br>w <sub>L</sub> | UNIT<br>WEIGHT<br><br>γ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |  |  |  |  |  |
|---------------|------------------------------------|------------|--------|---------|------------|--------------------|----------------------------|-----------------|---|--|-------------------|--|--|--|---|---------------------------------------|-------------------------|---|--|--|--|--|--|
| ELEV<br>DEPTH | DESCRIPTION                        | STRAT PLOT | NUMBER | TYPE    | "N" VALUES | SHEAR STRENGTH kPa |                            |                 |   |  | WATER CONTENT (%) |  |  |  |   |                                       |                         |   |  |  |  |  |  |
|               |                                    |            |        |         |            | ○ UNCONFINED       |                            |                 | + FIELD VANE                                |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |
|               |                                    |            |        |         |            | ● QUICK TRIAXIAL   |                            |                 | × LAB VANE                                  |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |
| 189.3         | Ground Surface                     |            |        |         |            |                    |                            |                 |   |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |
| 0.0           | Peat, fine fibrous<br>Dark brown   |            | 1      | SS      | WH**       |                    |                            |                 |   |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |
| 0.3           | Organic silty clay<br>trace sand   |            |        |         |            |                    |                            |                 |   |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |
| 188.4         | Very soft Brown Wet                |            | 2      | SS      | WH         |                    |                            |                 |   |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |
| 0.9           | Silt<br>trace sand, trace clay     |            |        |         |            |                    |                            |                 |   |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |
| 187.6         | Very loose Brown Wet               |            | 3      | SS      | WH         |                    |                            |                 |   |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |
| 1.7           | Clay, trace sand<br>layers of silt |            |        | FV      |            |                    |                            |                 |   |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |
|               | Soft to Grey Wet<br>firm           |            |        |         |            |                    |                            |                 |   |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |
|               |                                    |            |        |         |            |                    |                            |                 |   |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |
|               |                                    |            | 4      | SS      | WH         |                    |                            |                 |   |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |
|               |                                    |            |        | FV      |            |                    |                            |                 |   |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |
|               | _____                              |            |        |         |            |                    |                            |                 |   |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |
|               | _____                              |            |        |         |            |                    |                            |                 |   |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |
|               | _____                              |            | 5      | SS      | WH         |                    |                            |                 |   |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |
|               | _____                              |            |        | FV      |            |                    |                            |                 |   |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |
|               | _____                              |            |        |         |            |                    |                            |                 |   |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |
|               | _____                              |            | 6      | SS      | WH         |                    |                            |                 |   |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |
|               | _____                              |            |        | FV      |            |                    |                            |                 |   |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |
|               | _____                              |            |        |         |            |                    |                            |                 |   |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |
|               | _____                              |            | 7      | SS      | WH         |                    |                            |                 |   |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |
|               | _____                              |            |        | FV      |            |                    |                            |                 |   |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |
|               | _____                              |            |        |         |            |                    |                            |                 |   |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |
|               | _____                              |            | 8      | SS      | WH         |                    |                            |                 |   |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |
|               | _____                              |            |        | FV      |            |                    |                            |                 |   |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |
|               | _____                              |            |        |         |            |                    |                            |                 |   |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |
|               | _____                              |            | 9      | SS      | WH         |                    |                            |                 |   |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |
|               | _____                              |            |        | FV      |            |                    |                            |                 |   |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |
|               | _____                              |            |        |         |            |                    |                            |                 |   |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |
|               | _____                              |            | 10     | SS      | WH         |                    |                            |                 |   |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |
|               | _____                              |            |        | FV      |            |                    |                            |                 |   |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |
|               | _____                              |            |        |         |            |                    |                            |                 |   |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |
| 175.9         | Silt, trace clay                   |            |        |         |            |                    |                            |                 |   |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |
| 13.4          | Loose Grey Wet                     |            | 11     | SS      | 7          |                    |                            |                 |   |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |
| 174.8         | End of borehole                    |            |        |         |            |                    |                            |                 |   |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |
| 14.5          | Refusal on probable bedrock        |            |        |         |            |                    |                            |                 |   |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |
|               | Cont'd                             |            |        |         |            |                    |                            |                 |   |  |                   |  |  |  |   |                                       |                         |   |  |  |  |  |  |



**RECORD OF BOREHOLE No 306-37**

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**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+550, o/s 38.8m Lt. CL Med. ORIGINATED BY M.R.  
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
DATUM Geodetic DATE November 15, 2006 CHECKED BY C.N.

| SOIL PROFILE  |  | SAMPLES    |        |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT              |                 |                 |                 |                 | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|---------------|--|------------|--------|------|------------|----------------------------|-----------------|--|-----------------|-----------------|-----------------|-----------------|------------------------------------|-------------------------------------|-----------------------------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION  | STRAT PLOT | NUMBER | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                                       |                 |                 |                 |                 |                                    |                                     |                                   |  |  |
| 174.3         |  |            |        |      |            |                            |                 | 20 40 60 80 100  | 20 40 60 80 100 | 20 40 60 80 100 | 20 40 60 80 100 | 20 40 60 80 100 | 20 40 60 80 100                    | 20 40 60 80 100                     | 20 40 60 80 100                   | 20 40 60 80 100                          | 20 40 60 80 100  |
|               | * 2006 11 15<br>▽ Water level observed during drilling<br>▴ Water level measured after drilling<br>WH** denotes penetration due to weight of rods and hammer |            |        |      |            |                            |                 | ○ UNCONFINED + FIELD VANE<br>● QUICK TRIAXIAL × LAB VANE |                 |                 |                 |                 |                                    |                                     |                                   |  |  |

## METRIC

| SOIL PROFILE |                | SAMPLES    |        |      | GROUND WATER CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT |    | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT |    |     | UNIT WEIGHT | REMARKS & GRAIN SIZE DISTRIBUTION (%) |     |                |   |                |                   |
|--------------|----------------|------------|--------|------|-------------------------|-----------------|--|----|---|----|-----|-------------|---------------------------------------|-----|----------------|---|----------------|-------------------|
| ELEV. DEPTH  | DESCRIPTION    | STRAT PLOT | NUMBER | TYPE |                         |                 | "N" VALUES                               | 20 | 40  | 60 | 80  |             |                                       | 100 | W <sub>p</sub> | W | W <sub>L</sub> | WATER CONTENT (%) |
|              |                |            |        |      |                         |                 | SHEAR STRENGTH kPa                       |    |   |    |     |             |                                       |     |                |   |                |                   |
| 189.3        | Ground Surface |            |        |      |                         |                 | ○ UNCONFINED                             | +  | FIELD VANE  |    |     |             | ○                                     |     |                |   |                |                   |
|              |                |            |        |      |                         |                 | ● QUICK TRIAXIAL                         | ×  | LAB VANE  |    |     |             |                                       |     |                |   |                |                   |
|              |                |            |        |      |                         |                 | 20                                       | 40 | 60  | 80 | 100 |             |                                       |     |                |   |                |                   |

[illegible]

```
*      2006  11  20

▽      Water level measured
      after drilling

WH**   denotes penetration due
      to weight of rods and
      hammer
```

## 1 of 1

METRIC

## Foundation Design

| SOIL PROFILE   |   |            |        | SAMPLES |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                         | PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT |              |    | UNIT<br>WEIGHT<br><br>γ<br><br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |    |    |  |
|--|---|------------|--------|---------|------------|----------------------------|-----------------|---|-------------------------|---|--------------|----|--|---|----|----|--|
| ELEV<br>DEPTH  | DESCRIPTION   | STRAT PLOT | NUMBER | TYPE    | "N" VALUES |                            |                 | 20   40   60   80   100                     | 20   40   60   80   100 | W <sub>P</sub> W   W <sub>L</sub>                       | 20   40   60 | GR |  | SA  | SI | CL |  |
| 189.5<br>0.0<br>0.1  | Ground Surface<br>Topsoil<br>Silt, trace sand<br>Very loose   Brown   Wet |            | 1      | SS      | 2          |                            | 189             |   |                         |   |              |    |  |   |    |    |  |
| 188.5<br>1.0   | Silty clay, trace sand<br>Soft   Brown   Wet                              |            | 2      | SS      | WH**       |                            | 188             |   |                         |   |              |    |  |   |    |    |  |
| 186.8<br>2.7   | Clay, trace sand<br>Soft to   Grey/   Wet<br>firm   brown                 |            | 3      | SS      | WH         |                            | 187             | +   | 5                       |   |              |    |  |   |    |    |  |
|  |   |            |        | FV      |            |                            | 186             | +   | 4                       |   |              |    |  |   |    |    |  |
|  |   |            | 4      | SS      | WH         |                            | 185             |   |                         |   |              |    |  |   |    |    |  |
|  |   |            |        | FV      |            |                            | 184             | +   | 4                       |   |              |    |  |   |    |    |  |
| 180.8<br>8.7   | Silt<br>some clay, trace sand<br>Very loose   Grey   Wet                  |            | 6      | SS      | WH         |                            | 183             | +   | 4                       |   |              |    |  |   |    |    |  |
|  |   |            |        | FV      |            |                            | 182             |   |                         |   |              |    |  |   |    |    |  |
|  |   |            | 7      | SS      | WH         |                            | 181             |   |                         |   |              |    |  |   |    |    |  |
|  |   |            |        |         |            |                            | 180             |   |                         |   |              |    |  |   |    |    |  |
| 179.4<br>10.1  | End of borehole<br>Refusal on probable bedrock                            |            |        |         |            |                            |                 |   |                         |   |              |    |  |   |    |    |  |
| <div>*   2006   11   20</div> <div>   Water level measured after drilling</div> <div>WH**   denotes penetration due to weight of rods and hammer</div> |   |            |        |         |            |                            |                 |   |                         |   |              |    |  |   |    |    |  |

**RECORD OF BOREHOLE No 306-45**

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**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+625, o/s 56.5m Lt. CL Med. ORIGINATED BY M.R.  
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
DATUM Geodetic DATE November 21, 2006 CHECKED BY C.N.

| SOIL PROFILE   |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION<br>SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |              |     | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |                   |  |  |
|--|---|------------|---------|------|------------|----------------------------|--------------------|---|----|--------------|-----|------------------------------------|-------------------------------------|-----------------------------------|--|---|-------------------|--|--|
| ELEV<br>DEPTH  | DESCRIPTION                                     | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                    | SHEAR STRENGTH kPa                          |    |              |     |                                    |                                     |                                   |  |   | WATER CONTENT (%) |  |  |
|  |   |            |         |      |            |                            |                    | ○ UNCONFINED                                |    | + FIELD VANE |     |                                    |                                     |                                   |  |   | -----             |  |  |
|  |   |            |         |      |            |                            |                    | ● QUICK TRIAXIAL                            |    | × LAB VANE   |     |                                    |                                     |                                   |  |   |                   |  |  |
| 190.1  | Ground Surface                                  |            |         |      |            |                            | 20                 | 40  | 60 | 80           | 100 | 20                                 | 40                                  | 60                                |  |   |                   |  |  |
| 0.0  | Topsoil   |            |         |      |            |                            |                    |   |    |              |     |                                    |                                     |                                   |  |   |                   |  |  |
| 0.1  | Clayey silt, trace sand<br>layers of silty clay |            | 1       | SS   | 4          |                            |                    |   |    |              |     |                                    | ○                                   |                                   |  |   |                   |  |  |
|  | Firm Brown Wet                                  |            |         |      |            |                            |                    |   |    |              |     |                                    |                                     |                                   |  |   |                   |  |  |
|  |   |            | 2       | SS   | 2          |                            |                    |   |    |              |     |                                    | ○                                   |                                   |  | 0 4 76 20   |                   |  |  |
|  |   |            |         |      |            |                            |                    |   |    |              |     |                                    |                                     |                                   |  |   |                   |  |  |
| 188.3  |   |            | 3       | SS   | WH**       |                            |                    |   |    |              |     |                                    |                                     | ○                                 |  |   |                   |  |  |
| 1.8  | Silty clay, trace sand                          |            |         |      |            |                            |                    |   |    |              |     |                                    |                                     |                                   |  |   |                   |  |  |
|  | Firm Brown Wet                                  |            |         | FV   |            |                            |                    |   |    |              |     |                                    |                                     |                                   |  |   |                   |  |  |
| 187.4  |   |            |         |      |            |                            |                    |   |    |              |     |                                    |                                     |                                   |  |   |                   |  |  |
| 2.7  | Clay, trace sand<br>inclusions of silt          |            |         |      |            |                            |                    |   |    |              |     |                                    |                                     |                                   |  |   |                   |  |  |
|  | Firm Grey Moist<br>to wet                       |            | 4       | SS   | WH         |                            |                    |   |    |              |     |                                    |                                     | ○                                 |  |   |                   |  |  |
|  |   |            |         | FV   |            |                            |                    |   |    |              |     |                                    |                                     |                                   |  |   |                   |  |  |
| 185.9  |   |            |         |      |            |                            |                    |   |    |              |     |                                    |                                     |                                   |  |   |                   |  |  |
| 4.2  | Silt<br>some sand, some clay                    |            |         |      |            |                            |                    |   |    |              |     |                                    |                                     |                                   |  |   |                   |  |  |
|  | Very loose Grey Wet                             |            | 5       | SS   | WH         |                            |                    |   |    |              |     |                                    | ○                                   |                                   |  | 0 15 73 12  |                   |  |  |
| 184.7  |   |            |         |      |            |                            |                    |   |    |              |     |                                    |                                     |                                   |  |   |                   |  |  |
| 5.4  | End of borehole<br>Refusal on probable bedrock  |            |         |      |            |                            |                    |   |    |              |     |                                    |                                     |                                   |  |   |                   |  |  |
| <div>* 2006 11 21</div> <div>▽ Water level observed during drilling</div> <div>▼ Water level measured after drilling</div> <div>WH** denotes penetration due to weight of rods and hammer</div> <div>Note: High sensitivity values for field vane due to silt inclusions</div> |   |            |         |      |            |                            |                    |   |    |              |     |                                    |                                     |                                   |  |   |                   |  |  |

**METRIC**

| SOIL PROFILE   |   |            |        |      |            |
|--|---|------------|--------|------|------------|
| ELEV<br>DEPTH  | DESCRIPTION   | STRAT PLOT | NUMBER | TYPE | "N" VALUES |
| 189.1<br>0.0<br>0.2  | Ground Surface<br>Topsoil<br><br>Silty clay, trace sand layers of silt and clayey silt<br><br>Firm      Brown      Moist to wet |            | 1      | SS   | 5          |
| 186.4<br>2.7   | Clay, trace sand<br>Firm      Grey      Moist to wet<br><br>brown layering<br><br>thin layers of silt                           |            | 4      | SS   | WH         |
| 181.5<br>7.6   | End of borehole<br>Refusal on probable bedrock  |            |        |      |            |
| <div>*    2006   11   21</div> <div> Water level observed during drilling</div> <div> Water level measured after drilling</div> <div>WH** denotes penetration due to weight of rods and hammer</div> |   |            |        |      |            |

**RECORD OF BOREHOLE No 306-52**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+675, o/s 26.5m Lt. CL Med. ORIGINATED BY M.R.  
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
DATUM Geodetic DATE November 07, 2006 CHECKED BY C.N.

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |  |  |  |  | PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT |   |                | UNIT<br>WEIGHT<br><br>γ<br><br>kN/m³ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |  |  |  |  |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|--|--|--|--|---|---|----------------|--------------------------------------|---|--|--|--|--|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |  |  |  |  | W <sub>P</sub>  | W | W <sub>L</sub> |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
| 189.8         | Ground Surface  |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
| 0.0           | Topsoil   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
| 0.2           | Silty clay, trace sand<br>thin layers of silt                               |            | 1       | SS   | 6          |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               | Firm            Brown            Wet  |            | 2       | SS   | WH**       |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            | 3       | SS   | WH         |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         | FV   |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
| 187.1         |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
| 2.7           | Clay, trace sand  |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               | Soft to            Reddish            Wet<br>firm            brown/<br>grey |            | 4       | SS   | WH         |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         | FV   |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            | 5       | SS   | WH         |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               | thin layers of silt   |            |         | FV   |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
| 184.0         |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
| 5.8           | Clayey silt, trace sand   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               | Firm            Grey            Wet   |            | 6       | SS   | WH         |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         | FV   |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            | 7       | SS   | WH         |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
| 181.4         |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
| 8.4           | Silt, some clay<br>trace sand, trace gravel<br>thin layers of silty clay    |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               | Very loose Grey            Wet<br>to loose                                  |            | 8       | SS   | 4          |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
| 179.0         |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
| 10.8          | End of borehole<br>Refusal on probable bedrock                              |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |
|               |   |            |         |      |            |                            |                 |   |  |  |  |  |   |   |                |                                      |   |  |  |  |  |

\* 2006 11 07

Water level measured  
after drilling

WH\*\* denotes penetration due  
to weight of rods and  
hammer

## 1 of 1

METRIC

## Foundation Design

ON MOT VER3 SWAMP 306-1.GPJ ON MOT.GDT 12/15/2007 9:50:29 AM

$+$ <sup>7</sup>,  $\times$ <sup>5</sup>: Numbers refer to Sensitivity

(%) STRAIN AT FAILURE

## 1 of 1

METRIC

## Foundation Design

| SOIL PROFILE   |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT                      |  |  |  |  | PLASTIC LIMIT<br>NATURAL MOISTURE<br>CONTENT<br>LIQUID LIMIT |  |  | UNIT<br>WEIGHT<br><br>γ<br><br>kN/m³ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |    |    |    |
|--|---|------------|---------|------|------------|----------------------------|-----------------|--|--|--|--|--|--|--|--|--------------------------------------|---|----|----|----|
| ELEV<br>DEPTH  | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa   |  |  |  |  | WATER CONTENT (%)  |  |  |                                      | GR  | SA | SI | CL |
|  |   |            |         |      |            |                            |                 | ○ UNCONFINED      + FIELD VANE<br>● QUICK TRIAXIAL    × LAB VANE |  |  |  |  | W <sub>P</sub> W      W <sub>L</sub>                         |  |  |                                      |   |    |    |    |
| 190.7<br>0.0<br>0.1  | Ground Surface<br>Topsoil<br>Sandy silt, trace clay   |            | 1       | SS   | 4          |                            |                 |  |  |  |  |  |  |  |  |                                      |   |    |    |    |
| 190.0<br>0.7   | Loose Brown Wet<br>Clayey silt, some sand<br>Firm Brown Wet<br>thin layers of silty clay            |            | 2       | SS   | WH**       |                            |                 |  |  |  |  |  |  |  |  |                                      |   |    |    |    |
|  |   |            | 3       | SS   | 2          |                            |                 |  |  |  |  |  |  |  |  |                                      |   |    |    |    |
| 188.1<br>2.6   | Silty clay, trace sand<br>Firm Brown Wet  |            | 4       | SS   | 2          |                            |                 |  |  |  |  |  |  |  |  |                                      |   |    |    |    |
|  | thin layers of silt<br>Grey   |            |         | FV   |            |                            |                 |  |  |  |  |  |  |  |  |                                      |   |    |    |    |
|  |   |            | 5       | SS   | WH         |                            |                 |  |  |  |  |  |  |  |  |                                      |   |    |    |    |
| 185.1<br>5.6   | Silt, some sand<br>thin layers of silty clay<br>Very loose Grey Moist to wet<br>sandy, trace gravel |            | 6       | SS   | 3          |                            |                 |  |  |  |  |  |  |  |  |                                      |   |    |    |    |
| 183.7<br>7.0   | End of borehole<br>Refusal on probable bedrock  |            |         |      |            |                            |                 |  |  |  |  |  |  |  |  |                                      |   |    |    |    |
| <div>* 2006 11 08</div> <div> Water level measured after drilling</div> <div>WH** Denotes penetration due to weight of rods and hammer</div> |   |            |         |      |            |                            |                 |  |  |  |  |  |  |  |  |                                      |   |    |    |    |



RECORD OF BOREHOLE No 306-63

1 of 1

METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+775, o/s 48.5m Lt. CL Med. ORIGINATED BY M.R.  
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
DATUM Geodetic DATE November 09, 2006 CHECKED BY C.N.



| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>*<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT                      |    |    |    |     | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br><br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br><br>GR SA SI CL |                   |  |  |
|---------------|---|------------|---------|------|------------|---------------------------------|-----------------|--|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|--|--|-------------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                                 |                 | SHEAR STRENGTH kPa   |    |    |    |     |                                    |                                     |                                   |  |  | WATER CONTENT (%) |  |  |
|               |   |            |         |      |            |                                 |                 | ○ UNCONFINED      + FIELD VANE<br>● QUICK TRIAXIAL    × LAB VANE |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
| 191.6         | Ground Surface  |            |         |      |            |                                 |                 | 20   | 40 | 60 | 80 | 100 |                                    |                                     |                                   |  |  |                   |  |  |
| 0.0           | Topsoil   |            | 1       | SS   | 4          |                                 | 191             |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
| 0.1           | Clayey silt<br>with to trace sand<br>layers of silt and silty<br>clay |            | 2       | SS   | 4          |                                 | 190             |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               | Stiff to    Brown    Moist<br>firm                                    |            | 3       | SS   | 2          |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  | 0   1   70   29  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
| 189.2         | End of borehole   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
| 2.4           | Refusal on probable bedrock   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |   |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |

**RECORD OF BOREHOLE No 306-64**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+775, o/s 38.8m Lt. CL Med. ORIGINATED BY M.R.  
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
DATUM Geodetic DATE November 08, 2006 CHECKED BY C.N.

| SOIL PROFILE   |  |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |              |     |  | PLASTIC<br>LIMIT<br><br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br><br>w | LIQUID<br>LIMIT<br><br>w <sub>L</sub> | UNIT<br>WEIGHT<br><br>γ<br><br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br><br>GR SA SI CL |                   |  |            |
|--|--|------------|---------|------|------------|----------------------------|-----------------|---|----|--------------|-----|--|--|---|---------------------------------------|--|--|-------------------|--|------------|
| ELEV<br>DEPTH  | DESCRIPTION  | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |    |              |     |  |  |   |                                       |  |  | WATER CONTENT (%) |  |            |
|  |  |            |         |      |            |                            |                 | ○ UNCONFINED                                |    | + FIELD VANE |     |  |  |   |                                       |  |  | ● QUICK TRIAXIAL  |  | × LAB VANE |
| 191.8  | Ground Surface   |            |         |      |            |                            | 20              | 40  | 60 | 80           | 100 |  |  |   |                                       |  |  |                   |  |            |
| 0.0  | Topsoil  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |            |
| 0.1  | Clayey silt, trace sand<br>thin layers of silt and<br>silty clay |            | 1       | SS   | 4          |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |            |
|  | Firm      Brown      Moist                                       |            | 2       | SS   | 2          |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |            |
| 190.4  |  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |            |
| 1.4  | Silty clay, trace sand<br>thin layers of clayey silt             |            | 3       | SS   | 3          |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |            |
|  | Firm      Brown      Moist                                       |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |            |
|  |  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |            |
|  |  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |            |
|  |  |            | 4       | SS   | 4          |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |            |
|  |  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |            |
| 187.5  | End of borehole  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |            |
| 4.3  | Refusal on probable bedrock                                      |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |            |
| <div>*    2006   11   08</div> <div> Water level measured after drilling</div> <div> Penetrometer test</div> |  |            |         |      |            |                            |                 |   |    |              |     |  |  |   |                                       |  |  |                   |  |            |

\* 2006 11 08

▼ Water level measured  
after drilling

■ Penetrometer test

# RECORD OF BOREHOLE No 306-65

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+775, o/s 30.5m Lt. CL Med. ORIGINATED BY M.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
 DATUM Geodetic DATE November 08, 2006 CHECKED BY C.N.

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |              |    |                  | PLASTIC<br>LIMIT<br><br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br><br>w | LIQUID<br>LIMIT<br><br>w <sub>L</sub> | UNIT<br>WEIGHT<br><br>γ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |                   |  |  |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|----|--------------|----|------------------|--|---|---------------------------------------|-------------------------|---|-------------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION                               | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |    |              |    |                  |  |   |                                       |                         |   | WATER CONTENT (%) |  |  |
|               |   |            |         |      |            |                            |                 | ○ UNCONFINED                                |    | + FIELD VANE |    | ● QUICK TRIAXIAL |  |   |                                       |                         |   | × LAB VANE        |  |  |
| 192.0         | Ground Surface                            |            |         |      |            |                            |                 | 20  | 40 | 60           | 80 | 100              |  |   |                                       |                         |   |                   |  |  |
| 0.0           | Topsoil                                   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
| 0.1           | Clayey silt, trace sand<br>layers of silt |            | 1       | SS   | 6          |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               | Firm      Brown      Moist                |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            | 2       | SS   | 4          |                            | 191             |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
| 190.6         |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
| 1.4           | Silty clay, trace sand                    |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               | Firm      Brown      Moist                |            | 3       | SS   | 4          |                            | 190             |   |    | ■            |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
| 189.4         |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
| 2.6           | Silt, trace clay<br>thin layers of clay   |            |         |      |            |                            | 189             |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               | Loose      Brown      Moist               |            | 4       | SS   | 4          |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            | 188             |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
| 187.5         |   |            |         |      |            |                            | ▽t*             |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
| 4.5           | End of borehole                           |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               | Refusal on probable bedrock               |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |    |                  |  |   |                                       |                         |   |                   |  |  |

**RECORD OF BOREHOLE No 306-68**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+800, o/s 38.8m Lt. CL Med. ORIGINATED BY M.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
 DATUM Geodetic DATE November 09, 2006 CHECKED BY C.N.

| SOIL PROFILE  |  |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS<br>* | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT                      |    |    |    |     | PLASTIC<br>LIMIT<br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>w | LIQUID<br>LIMIT<br>w <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |                   |  |  |
|---------------|--|------------|---------|------|------------|---------------------------------|-----------------|--|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|--|--|-------------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION  | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                                 |                 | SHEAR STRENGTH kPa   |    |    |    |     |                                    |                                     |                                   |  |  | WATER CONTENT (%) |  |  |
|               |  |            |         |      |            |                                 |                 | ○ UNCONFINED      + FIELD VANE<br>● QUICK TRIAXIAL    × LAB VANE |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
| 192.2         | Ground Surface                                       |            |         |      |            |                                 |                 | 20   | 40 | 60 | 80 | 100 |                                    | 20                                  | 40                                | 60                                       |  |                   |  |  |
| 0.0           | Topsoil  |            |         |      |            |                                 | 192             |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
| 0.1           | Silty clay, trace sand<br>thin layers of clayey silt |            | 1       | SS   | 10         |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               | Stiff to Brown Moist<br>firm thin layers of silt     |            | 2       | SS   | 6          |                                 | 191             |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               |  |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
| 190.2         |  |            | 3       | SS   | 4          |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
| 2.0           | End of borehole<br>Refusal on probable bedrock       |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |
|               | * Borehole dry on<br>completion of drilling          |            |         |      |            |                                 |                 |  |    |    |    |     |                                    |                                     |                                   |  |  |                   |  |  |

1 of 1 **METRIC**

$+$ <sup>7</sup>,  $\times$ <sup>5</sup>: Numbers refer to Sensitivity


1 of 1 **METRIC**

$+$ <sup>7</sup>,  $\times$ <sup>5</sup>: Numbers refer to Sensitivity

RECORD OF PENETRATION TEST No 306-27

1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+475, o/s 58.5m Lt. CL Med. ORIGINATED BY M.R.  
DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY G.D.  
DATUM Geodetic DATE November 12, 2006 CHECKED BY C.N.

| SOIL PROFILE  |   |  | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |              | PLASTIC<br>LIMIT<br><br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br><br>w | LIQUID<br>LIMIT<br><br>w <sub>L</sub> | UNIT<br>WEIGHT<br><br>γ<br><br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br><br>GR SA SI CL |                   |            |
|---------------|---|--|---------|------|------------|----------------------------|-----------------|---|--------------|--|---|---------------------------------------|--|--|-------------------|------------|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT   | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |              |  |   |                                       |  |  | WATER CONTENT (%) |            |
|               |   |  |         |      |            |                            |                 | ○ UNCONFINED                                | + FIELD VANE |  |   |                                       |  |  | ● QUICK TRIAXIAL  | × LAB VANE |
| 189.2<br>0.0  | Ground Surface<br><br>Probable peat<br>Probable organic silty clay<br>Soft<br><br><br><br>Probable silty clay<br>Soft to firm |  |         |      |            |                            |                 |   |              |  |   |                                       |  |  |                   |            |
| 179.2<br>10.0 | End of dynamic cone<br>penetration test<br>Refusal on probable bedrock  |  |         |      |            |                            |                 |   |              |  |   |                                       |  |  |                   |            |

1 of 2 **METRIC**

$+$ <sup>7</sup>,  $\times$ <sup>5</sup>: Numbers refer to Sensitivity



**RECORD OF PENETRATION TEST No 306-34**

2 of 2 **METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+525, o/s 22.5m Lt. CL Med. ORIGINATED BY M.R.  
DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY G.D.  
DATUM Geodetic DATE November 15, 2006 CHECKED BY C.N.

| SOIL PROFILE  |  | SAMPLES    |        |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                 |                 |                 |                 | UNIT<br>WEIGHT<br>$\gamma$<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|---------------|--|------------|--------|------|------------|----------------------------|-----------------|---|-----------------|-----------------|-----------------|-----------------|---|--|
| ELEV<br>DEPTH | DESCRIPTION  | STRAT PLOT | NUMBER | TYPE | "N" VALUES |                            |                 | 20 40 60 80 100                             | 20 40 60 80 100 | 20 40 60 80 100 | 20 40 60 80 100 | 20 40 60 80 100 |   |  |
| 174.1         | Probable silt<br>Loose to compact                                      |            |        |      |            |                            | 174             |   |                 |                 |                 |                 |   |  |
|               |  |            |        |      |            |                            | 173             |   |                 |                 |                 |                 |   |  |
| 171.6         |  |            |        |      |            |                            | 172             |   |                 |                 |                 |                 |   |  |
| 17.5          | End of dynamic cone<br>penetration test<br>Refusal on probable bedrock |            |        |      |            |                            |                 |   |                 |                 |                 |                 |   |  |

## 1 of 1 METRIC

$+^7, \times^5$ : Numbers refer to Sensitivity

1 of 1 **METRIC**

20  
15 — 5 (%) STRAIN AT FAILURE  
10

RECORD OF PENETRATION TEST No 306-51

1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+675, o/s 52.5m Lt. CL Med. ORIGINATED BY M.R.  
DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY G.D.  
DATUM Geodetic DATE November 21, 2006 CHECKED BY C.N.

| SOIL PROFILE  |  |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |  | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|--|------------------------------------|-------------------------------------|-----------------------------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION  | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |  |                                    |                                     |                                   |  |  |
| 190.2<br>0.0  | Ground Surface<br>Probable topsoil —<br>Probable silty clay<br>Firm    |            |         |      |            |                            | 190             | 20 40 60 80 100                             |  |                                    |                                     |                                   |  |  |
|               |  |            |         |      |            |                            | 189             |   |  |                                    |                                     |                                   |  |  |
|               |  |            |         |      |            |                            | 188             |   |  |                                    |                                     |                                   |  |  |
|               | Probable clay — — —<br>Firm  |            |         |      |            |                            | 187             |   |  |                                    |                                     |                                   |  |  |
|               |  |            |         |      |            |                            | 186             |   |  |                                    |                                     |                                   |  |  |
|               |  |            |         |      |            |                            | 185             |   |  |                                    |                                     |                                   |  |  |
| 184.2<br>6.0  | End of dynamic cone<br>penetration test<br>Refusal on probable bedrock |            |         |      |            |                            |                 | 120/23cm                                    |  |                                    |                                     |                                   |  |  |

RECORD OF PENETRATION TEST No 306-58

1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+725, o/s 30.5m Lt. CL Med. ORIGINATED BY M.R.  
DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY G.D.  
DATUM Geodetic DATE November 08, 2006 CHECKED BY C.N.

| SOIL PROFILE  |  |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION<br>SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT |                |  | UNIT<br>WEIGHT<br>$\gamma$<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|---------------|--|------------|---------|------|------------|----------------------------|--------------------|---|----------------|---|----------------|--|---|--|
| ELEV<br>DEPTH | DESCRIPTION  | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                    | SHEAR STRENGTH kPa                          | W <sub>p</sub> | W   | W <sub>L</sub> |  |   |  |
| 190.0         | Ground Surface   |            |         |      |            |                            | 20 40 60 80 100    |   |                |   |                |  |   |  |
| 0.0           | Probable topsoil<br>Probable clayey silt<br>Soft to firm               |            |         |      |            |                            | 20 40 60 80 100    |   |                |   |                |  |   |  |
|               | Probable clay<br>Firm  |            |         |      |            |                            |                    |   |                |   |                |  |   |  |
|               | layers of silt   |            |         |      |            |                            |                    |   |                |   |                |  |   |  |
| 181.0         | End of dynamic cone<br>penetration test<br>Refusal on probable bedrock |            |         |      |            |                            | 181                |   |                |   |                |  |   |  |
| 9.0           |  |            |         |      |            |                            |                    |   |                |   |                |  |   |  |

**RECORD OF BOREHOLE No 307-19**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 14+425, o/s 38.8m Lt. CL Med. ORIGINATED BY N.R.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A + Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE March 02 and March 05, 2007 CHECKED BY G.D.

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |              |     |  | PLASTIC<br>LIMIT<br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>w | LIQUID<br>LIMIT<br>w <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|----|--------------|-----|--|------------------------------------|-------------------------------------|-----------------------------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 | ○ UNCONFINED                                |    | + FIELD VANE |     |  |                                    |                                     |                                   |  |  |
| 193.0         | Ground Surface  |            |         |      |            |                            | 20              | 40  | 60 | 80           | 100 |  |                                    |                                     |                                   |  |  |
| 0.0           | Peat, fine fibrous  |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
| 0.2           | Dark brown  |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
| 192.0         | Organic silt<br>trace sand, trace gravel                  |            | 1       | SS   | 2          |                            | 192             |   |    |              |     |  |                                    |                                     |                                   |  |  |
| 1.0           | Very loose Brown Wet                                      |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               | Clayey silt<br>trace sand, trace gravel<br>layers of silt |            | 2       | SS   | 7          |                            | 191             |   |    |              |     |  |                                    |                                     |                                   | 1 8 70 21                                |  |
|               | Soft to firm      Grey      Moist<br>to wet               |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            | 3       | SS   | 2          |                            | 190             |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            | 189             |   |    |              |     |  |                                    |                                     |                                   |  |  |
| 188.8         | Silt<br>some clay, trace sand                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
| 4.2           | Loose      Grey      Wet                                  |            | 4       | SS   | 5          |                            | 188             |   |    |              |     |  |                                    |                                     |                                   | 0 7 82 11                                |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
| 187.1         | End of borehole   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
| 5.9           | Refusal on probable bedrock                               |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |  |

## 1 of 1

METRIC

## Foundation Design

| SOIL PROFILE   |   |  |  |  |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                  |              |  |  | PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT |   |                | UNIT WEIGHT<br><br>γ | REMARKS &<br>GRAIN SIZE DISTRIBUTION (%) |    |    |    |    |
|--|---|--|--|--|------------|---------|------|------------|----------------------------|-----------------|---|------------------|--------------|--|--|---|---|----------------|----------------------|--|----|----|----|----|
| ELEV<br>DEPTH  | DESCRIPTION   |  |  |  | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 |   |                  |              |  |  | W <sub>P</sub>  | W | W <sub>L</sub> |                      | WATER CONTENT (%)                        | GR | SA | SI | CL |
| SHEAR STRENGTH kPa   |   |  |  |  |            |         |      |            |                            |                 |   |                  |              |  |  |   |   |                |                      |  |    |    |    |    |
|  |   |  |  |  |            |         |      |            |                            |                 |   | ○ UNCONFINED     | + FIELD VANE |  |  |   |   |                |                      |  |    |    |    |    |
|  |   |  |  |  |            |         |      |            |                            |                 |   | ● QUICK TRIAXIAL | x LAB VANE   |  |  |   |   |                |                      |  |    |    |    |    |
| 193.0<br>0.0   | Top of Ice<br>Ice/Snow  |  |  |  |            |         |      |            |                            |                 |   |                  |              |  |  |   |   |                |                      |  |    |    |    |    |
| 0.3  | Organic silt<br>Soft                  Dark brown                  Wet                             |  |  |  |            | 1       | SS   | 2          |                            | V*              | 192   |                  |              |  |  |   |   |                |                      |  |    |    |    |    |
| 191.1<br>1.9   | Silt, trace clay<br>Very loose Grey                  Wet to loose                                 |  |  |  |            | 2       | SS   | 2          |                            |                 | 191   |                  |              |  |  |   |   |                |                      |  |    |    |    |    |
| 189.6<br>3.4   | Clayey silt, trace sand<br>Stiff to firm                  Reddish brown/grey                  Wet |  |  |  |            | 3       | SS   | 4          |                            |                 | 190   |                  |              |  |  |   |   |                |                      |  |    |    |    |    |
|  |   |  |  |  |            |         | FV   |            |                            |                 | 189   |                  |              |  |  |   |   |                |                      |  |    |    |    |    |
|  |   |  |  |  |            | 4       | SS   | WH**       |                            |                 | 188   |                  |              |  |  |   |   |                |                      |  |    |    |    |    |
|  |   |  |  |  |            |         | FV   |            |                            |                 |   |                  |              |  |  |   |   |                |                      |  |    |    |    |    |
| 187.3<br>5.7   | End of borehole<br>Refusal on probable bedrock  |  |  |  |            |         |      |            |                            |                 |   |                  |              |  |  |   |   |                |                      |  |    |    |    |    |
| <div>*        2007   03   03</div> <div> Water level observed during drilling</div> <div>WH** Denotes penetration due to weight of rods and hammer</div> |   |  |  |  |            |         |      |            |                            |                 |   |                  |              |  |  |   |   |                |                      |  |    |    |    |    |

**RECORD OF BOREHOLE No 307-23**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 14+437.5, o/s 22.5m Lt. CL Med. ORIGINATED BY N.R.  
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
DATUM Geodetic DATE March 03, 2007 CHECKED BY G.D.

| SOIL PROFILE  |                             |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |              |     |  | PLASTIC<br>LIMIT<br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>w | LIQUID<br>LIMIT<br>w <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br><br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |                   |  |  |
|---------------|-----------------------------|------------|---------|------|------------|----------------------------|-----------------|---|----|--------------|-----|--|------------------------------------|-------------------------------------|-----------------------------------|--|---|-------------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION                 | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |    |              |     |  |                                    |                                     |                                   |  |   | WATER CONTENT (%) |  |  |
|               |                             |            |         |      |            |                            |                 | ○ UNCONFINED                                |    | + FIELD VANE |     |  |                                    |                                     |                                   |  |   | ○                 |  |  |
|               |                             |            |         |      |            |                            | 20              | 40  | 60 | 80           | 100 |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            | 20              | 40  | 60 | 80           | 100 |  |                                    |                                     |                                   |  |   |                   |  |  |
| 193.0         | Ground Surface              |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
| 0.0           | Organic silt                |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               | Very soft Dark Wet          |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               | to soft grey                |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            | 1       | SS   | 1          |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            | 2       | SS   | 2          |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
| 191.0         | Silt, trace clay            |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
| 2.0           | Very loose Grey Wet         |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               | to loose                    |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            | 3       | SS   | 6          |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
| 189.2         | Clayey silt, trace sand     |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
| 3.8           | Firm Grey Wet               |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            | 4       | SS   | 3          |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         | FV   |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            | 5       | SS   | 1          |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         | FV   |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            | 6       | SS   | 1          |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         | FV   |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
| 184.2         | End of borehole             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
| 8.8           | Refusal on probable bedrock |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |  |   |                   |  |  |
|               |                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     | </                                |  |   |                   |  |  |



**RECORD OF BOREHOLE No 307-27**

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**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 14+450, o/s 38.8m Lt. CL Med. ORIGINATED BY N.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 04, 2007 CHECKED BY G.D.

| SOIL PROFILE  |  |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT                      |  |  |                   |  | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br><br>γ<br><br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|--|--|--|-------------------|--|------------------------------------|-------------------------------------|-----------------------------------|--|---|
| ELEV<br>DEPTH | DESCRIPTION  | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa   |  |  |                   |  |                                    |                                     |                                   |  |   |
|               |  |            |         |      |            |                            |                 | ○ UNCONFINED      + FIELD VANE<br>● QUICK TRIAXIAL    × LAB VANE |  |  |                   |  |                                    |                                     |                                   |  |   |
|               |  |            |         |      |            |                            |                 | 20   40   60   80   100  |  |  |                   |  |                                    |                                     |                                   |  |   |
|               |  |            |         |      |            | 20   40   60   80   100    |                 |  |  |  | WATER CONTENT (%) |  |                                    |                                     |                                   |  |   |
| 193.0         | Top of Ice   |            |         |      |            |                            |                 |  |  |  |                   |  |                                    |                                     |                                   |  |   |
| 0.0           | Ice/Snow   |            |         |      |            |                            |                 |  |  |  |                   |  |                                    |                                     |                                   |  |   |
| 0.3           | Peat, fine fibrous                                 |            |         |      |            |                            |                 |  |  |  |                   |  |                                    |                                     |                                   |  |   |
|               | Dark brown      Wet                                |            |         |      |            |                            |                 |  |  |  |                   |  |                                    |                                     |                                   |  |   |
| 191.9         |  |            | 1       | SS   | 2          |                            | 192             |  |  |  |                   |  |                                    |                                     |                                   |  |   |
| 1.1           | Clayey silt, trace sand<br>peat inclusions to 2.2m |            |         |      |            |                            |                 |  |  |  |                   |  |                                    |                                     |                                   |  |   |
|               | Very soft   Grey      Wet<br>to soft               |            | 2       | SS   | 1          |                            | 191             |  |  |  |                   |  |                                    |                                     |                                   |  |   |
|               | _____  |            |         |      |            |                            |                 |  |  |  |                   |  |                                    |                                     |                                   |  |   |
|               | Firm to<br>stiff                                   |            |         |      |            |                            | 190             |  |  |  |                   |  |                                    |                                     |                                   |  |   |
|               |  |            | 3       | SS   | 8          |                            |                 |  |  |  |                   |  |                                    |                                     |                                   | 0   1   80   19                                  |   |
| 188.9         |  |            |         |      |            |                            | 189             |  |  |  |                   |  |                                    |                                     |                                   |  |   |
| 4.1           | Silty clay, trace sand                             |            |         |      |            |                            |                 |  |  |  |                   |  |                                    |                                     |                                   |  |   |
|               | Firm to      Grey      Wet<br>soft                 |            | 4       | SS   | 2          |                            | 188             |  |  |  |                   |  |                                    |                                     |                                   |  |   |
|               |  |            |         |      |            |                            |                 |  |  |  |                   |  |                                    |                                     |                                   |  |   |
|               |  |            |         | FV   |            |                            |                 |  |  |  |                   |  |                                    |                                     |                                   |  |   |
|               |  |            |         |      |            |                            | 187             |  |  |  |                   |  |                                    |                                     |                                   |  |   |
|               |  |            | 5       | TW   | PH         |                            |                 |  |  |  |                   |  |                                    |                                     | 16.5                              | 1   1   53   46                                  |   |
| 185.8         |  |            |         |      |            |                            | 186             |  |  |  |                   |  |                                    |                                     |                                   |  |   |
| 7.2           | Clay   |            |         |      |            |                            |                 |  |  |  |                   |  |                                    |                                     |                                   |  |   |
|               | Firm      Grey      Wet                            |            | 6       | SS   | 2          |                            | 185             |  |  |  |                   |  |                                    |                                     |                                   |  |   |
|               |  |            |         |      |            |                            |                 |  |  |  |                   |  |                                    |                                     |                                   |  |   |
|               |  |            |         | FV   |            |                            |                 |  |  |  |                   |  |                                    |                                     |                                   |  |   |
|               |  |            |         |      |            |                            | 184             |  |  |  |                   |  |                                    |                                     |                                   |  |   |
|               |  |            | 7       | SS   | 1          |                            |                 |  |  |  |                   |  |                                    |                                     |                                   | 0   0   37   63                                  |   |
|               |  |            |         |      |            |                            |                 |  |  |  |                   |  |                                    |                                     |                                   |  |   |
|               |  |            |         | FV   |            |                            | 183             |  |  |  |                   |  |                                    |                                     |                                   |  |   |
|               |  |            |         |      |            |                            |                 |  |  |  |                   |  |                                    |                                     |                                   |  |   |
|               |  |            | 8       | SS   | 1          |                            | 182             |  |  |  |                   |  |                                    |                                     |                                   |  |   |
|               |  |            |         |      |            |                            |                 |  |  |  |                   |  |                                    |                                     |                                   |  |   |
|               |  |            |         | FV   |            |                            |                 |  |  |  |                   |  |                                    |                                     |                                   |  |   |
|               |  |            |         |      |            |                            | 181             |  |  |  |                   |  |                                    |                                     |                                   |  |   |
|               |  |            |         |      |            |                            |                 |  |  |  |                   |  |                                    |                                     |                                   |  |   |
|               |  |            | 9       | SS   | 1          |                            |                 |  |  |  |                   |  |                                    |                                     |                                   |  |   |
|               |  |            |         |      |            |                            |                 |  |  |  |                   |  |                                    |                                     |                                   |  |   |
|               |  |            |         | FV   |            |                            | 180             |  |  |  |                   |  |                                    |                                     |                                   |  |   |
|               |  |            |         |      |            |                            |                 |  |  |  |                   |  |                                    |                                     |                                   |  |   |
| 179.3         |  |            |         |      |            |                            |                 |  |  |  |                   |  |                                    |                                     |                                   |  |   |
| 13.7          | Silt<br>some clay, trace sand                      |            | 10      | SS   | 8          |                            | 179             |  |  |  |                   |  |                                    |                                     |                                   | 0   2   86   12                                  |   |
|               | Loose      Grey      Wet                           |            |         |      |            |                            |                 |  |  |  |                   |  |                                    |                                     |                                   |  |   |
| 178.3         |  |            |         |      |            |                            |                 |  |  |  |                   |  |                                    |                                     |                                   |  |   |
| 14.7          | End of borehole                                    | Cont'd     |         |      |            |                            |                 |  |  |  |                   |  |                                    |                                     |                                   |  |   |

**RECORD OF BOREHOLE No 307-27**

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**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 14+450, o/s 38.8m Lt. CL Med. ORIGINATED BY N.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 04, 2007 CHECKED BY G.D.



















| SOIL PROFILE  |  |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |    |     | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT |   |                | UNIT<br>WEIGHT<br>$\gamma$<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|---------------|--|------------|---------|------|------------|----------------------------|-----------------|---|----|----|----|-----|---|---|----------------|---|--|
| ELEV<br>DEPTH | DESCRIPTION                            | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | 20  | 40 | 60 | 80 | 100 | W <sub>p</sub>                                      | W | W <sub>L</sub> |   |  |
| 178.0         | Refusal on probable bedrock            |            |         |      |            |                            |                 |   |    |    |    |     |   |   |                |   |  |
|               | * 2007 03 04                           |            |         |      |            |                            |                 |   |    |    |    |     |   |   |                |   |  |
|               | ▽ Water level observed during drilling |            |         |      |            |                            |                 |   |    |    |    |     |   |   |                |   |  |
|               | ▼ Water level measured after drilling  |            |         |      |            |                            |                 |   |    |    |    |     |   |   |                |   |  |

**RECORD OF BOREHOLE No 307-28**

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**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 14+450, o/s 22.5m Lt. CL Med. ORIGINATED BY N.R.  
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
DATUM Geodetic DATE March 06, 2007 CHECKED BY G.D.

| SOIL PROFILE  |                           |   | SAMPLES |      |            | GROUND WATER<br>CONDITIONS  | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |    |    |     | PLASTIC<br>LIMIT<br>W <sub>P</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br><br>γ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|---------------------------|---|---------|------|------------|---|-----------------|---|----|----|----|-----|------------------------------------|-------------------------------------|-----------------------------------|-------------------------|---|
| ELEV<br>DEPTH | DESCRIPTION               | STRAT PLOT  | NUMBER  | TYPE | "N" VALUES |   |                 | SHEAR STRENGTH kPa                          |    |    |    |     |                                    |                                     |                                   |                         |   |
| 193.0         | Top of Ice                |  |         |      |            |  |                 | 20  | 40 | 60 | 80 | 100 |                                    |                                     |                                   | kN/m³                   | GR SA SI CL                                       |
| 0.0           | Ice/Snow                  |   |         |      |            |   |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |
| 0.3           | Peat, fine fibrous        |  |         |      |            |   |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |
| 192.1         | Dark brown                |   |         |      |            |   |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |
| 0.9           | Organic silt              |  | 1       | SS   | 2          |   | 192             |   |    |    |    |     |                                    |                                     |                                   |                         |   |
|               | Soft Dark brown Wet       |   |         |      |            |   |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |
| 191.1         | Silt, trace clay          |  | 2       | SS   | 1          |   | 191             |   |    |    |    |     |                                    |                                     |                                   |                         |   |
| 1.9           | trace sand, organics      |   |         |      |            |   |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |
|               | Very loose Grey Wet       |  |         |      |            |   | 190             |   |    |    |    |     |                                    |                                     |                                   |                         |   |
|               | to loose                  |   |         |      |            |   |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |
|               |                           |  | 3       | SS   | 8          |   | 189             |   |    |    |    |     |                                    |                                     |                                   |                         |   |
|               |                           |   |         |      |            |   |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |
| 188.3         | Clay, trace sand          |  | 4       | SS   | 1          |   | 188             |   |    |    |    |     |                                    |                                     |                                   | 0 1 47 52               |   |
| 4.7           | thin layers of silty clay |   |         |      |            |   |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |
|               | Firm Grey Wet             |  |         | FV   |            |   | 187             |   |    |    |    |     |                                    |                                     |                                   |                         |   |
|               |                           |   |         |      |            |   |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |
|               |                           |  | 5       | SS   | 2          |   | 186             |   |    |    |    |     |                                    |                                     |                                   |                         |   |
|               |                           |   |         |      |            |   |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |
|               |                           |  |         | FV   |            |   | 185             |   |    |    |    |     |                                    |                                     |                                   | 0 1 37 62               |   |
|               |                           |   |         |      |            |   |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |
|               |                           |  | 6       | SS   | 2          |   | 184             |   |    |    |    |     |                                    |                                     |                                   |                         |   |
|               |                           |   |         |      |            |   |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |
|               |                           |  |         | FV   |            |   | 183             |   |    |    |    |     |                                    |                                     |                                   |                         |   |
|               |                           |   |         |      |            |   |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |
|               |                           |  | 7       | SS   | 2          |   | 182             |   |    |    |    |     |                                    |                                     |                                   |                         |   |
|               |                           |   |         |      |            |   |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |
|               |                           |  |         | FV   |            |   | 181             |   |    |    |    |     |                                    |                                     |                                   |                         |   |
|               |                           |   |         |      |            |   |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |
| 181.2         | Silt                      |  |         | FV   |            |   | 180             |   |    |    |    |     |                                    |                                     |                                   | 0 1 84 15               |   |
| 11.8          | some clay, trace sand     |   |         |      |            |   |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |
|               | Very loose Grey Wet       |  | 9       | SS   | 4          |   | 179             |   |    |    |    |     |                                    |                                     |                                   |                         |   |
|               | to loose                  |   |         |      |            |   |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |
|               |                           |  |         |      |            |   |                 |   |    |    |    |     |                                    |                                     |                                   |                         |   |

Cont'd

**RECORD OF BOREHOLE No 307-28**

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**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 14+450, o/s 22.5m Lt. CL Med. ORIGINATED BY N.R.  
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
DATUM Geodetic DATE March 06, 2007 CHECKED BY G.D.

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                  |   |   |            | PLASTIC<br>LIMIT<br><br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br><br>w | LIQUID<br>LIMIT<br><br>w <sub>L</sub> | UNIT<br>WEIGHT<br><br>γ<br><br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |  |  |  |    |    |    |    |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|------------------|---|---|------------|--|---|---------------------------------------|--|---|--|--|--|----|----|----|----|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |                  |   |   |            |  |   |                                       |  | WATER CONTENT (%)                                 |  |  |  | GR | SA | SI | CL |
|               |   |            |         |      |            |                            |                 | ○ UNCONFINED                                | ● QUICK TRIAXIAL | + | × | FIELD VANE |  |   |                                       |  | LAB VANE  |  |  |  |    |    |    |    |
| 178.0         |   |            |         |      |            |                            |                 |   |                  |   |   |            |  |   |                                       |  |   |  |  |  |    |    |    |    |
| 177.7         |   |            |         |      |            |                            |                 |   |                  |   |   |            |  |   |                                       |  |   |  |  |  |    |    |    |    |
| 15.3          | End of borehole<br><br>Refusal on probable bedrock<br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><br><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|            |         |      |            |                            |                 |   |                  |   |   |            |  |   |                                       |  |   |  |  |  |    |    |    |    |

**RECORD OF BOREHOLE No 307-34**

1 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 14+475, o/s 38.8m Lt. CL Med. ORIGINATED BY N.R.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A + Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE March 02 and March 05, 2007 CHECKED BY G.D.

| SOIL PROFILE  |  |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |              | PLASTIC<br>LIMIT<br>W <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|--|------------|---------|------|------------|----------------------------|---|--------------|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|
| ELEV<br>DEPTH | DESCRIPTION                            | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            | SHEAR STRENGTH kPa                          |              |                                    |                                     |                                   |                     |   |
|               |  |            |         |      |            |                            | ○ UNCONFINED                                | + FIELD VANE |                                    |                                     |                                   |                     |   |
|               |  |            |         |      |            |                            | ● QUICK TRIAXIAL                            | × LAB VANE   |                                    |                                     |                                   |                     |   |
|               |  |            |         |      |            | WATER CONTENT (%)          |   |              |                                    |                                     |                                   |                     |   |
| 193.0         | Top of Ice                             |            |         |      |            |                            | 20 40 60 80 100                             |              |                                    |                                     |                                   |                     |   |
| 0.0           | Ice/Snow                               |            |         |      |            |                            | 20 40 60 80 100                             |              |                                    |                                     |                                   |                     |   |
| 0.3           | Peat, fine fibrous<br>trace gravel     |            |         |      |            |                            |   |              |                                    |                                     |                                   |                     |   |
|               | Dark brown                             |            | 1       | SS   | 2          |                            |   |              |                                    |                                     |                                   |                     |   |
|               |  |            | 2       | SS   | 1          |                            |   |              |                                    |                                     |                                   |                     |   |
| 190.3         | Clayey silt, trace sand                |            |         |      |            |                            |   |              |                                    |                                     |                                   |                     |   |
| 2.7           | Firm to Grey Wet<br>stiff              |            | 3       | SS   | 8          |                            |   |              |                                    |                                     |                                   |                     |   |
| 188.4         | Clay, trace sand                       |            |         |      |            |                            |   |              |                                    |                                     |                                   |                     |   |
| 4.6           | Firm Grey Wet                          |            | 4       | SS   | 1          |                            |   |              |                                    |                                     |                                   |                     |   |
|               | fissured Blueish grey                  |            |         | FV   |            |                            |   |              |                                    |                                     |                                   |                     |   |
|               |  |            | 5       | SS   | 2          |                            |   |              |                                    |                                     |                                   |                     |   |
|               |  |            |         | FV   |            |                            |   |              |                                    |                                     |                                   |                     |   |
|               |  |            | 6       | SS   | 2          |                            |   |              |                                    |                                     |                                   |                     |   |
|               |  |            |         | FV   |            |                            |   |              |                                    |                                     |                                   |                     |   |
|               |  |            | 7       | SS   | 2          |                            |   |              |                                    |                                     |                                   |                     |   |
|               |  |            |         | FV   |            |                            |   |              |                                    |                                     |                                   |                     |   |
|               |  |            | 8       | SS   | 1          |                            |   |              |                                    |                                     |                                   |                     |   |
|               |  |            |         | FV   |            |                            |   |              |                                    |                                     |                                   |                     |   |
| 180.5         | Silt, trace to some clay<br>trace sand |            | 9       | SS   | 1          |                            |   |              |                                    |                                     |                                   |                     |   |
| 12.5          | Loose Grey Wet                         |            |         |      |            |                            |   |              |                                    |                                     |                                   |                     |   |
|               |  |            | 10      | SS   | 5          |                            |   |              |                                    |                                     |                                   |                     |   |
| 178.0         |  |            |         |      |            |                            |   |              |                                    |                                     |                                   |                     |   |

ON\_MOT VER3 SWAMP 307-MAR 6.GPJ ON\_MOT.GDT 12/7/2007 11:35:10 AM

+<sup>7</sup>, ×<sup>5</sup>: Numbers refer to  
Sensitivity

20  
15—○—5  
10








(%) STRAIN AT FAILURE

**RECORD OF BOREHOLE No 307-34**

2 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 14+475, o/s 38.8m Lt. CL Med. ORIGINATED BY N.R.  
DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A + Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE March 02 and March 05, 2007 CHECKED BY G.D.

| SOIL PROFILE  |  |   | SAMPLES |      |            | GROUND WATER | CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION RESISTANCE PLOT |    |              |     |                  | PLASTIC LIMIT<br>w <sub>p</sub> | NATURAL MOISTURE CONTENT<br>w | LIQUID LIMIT<br>w <sub>L</sub> | UNIT WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS & GRAIN SIZE DISTRIBUTION (%)<br>GR SA SI CL |                   |  |  |
|---------------|--|---|---------|------|------------|--------------|------------|-----------------|--|----|--------------|-----|------------------|---------------------------------|-------------------------------|--------------------------------|---------------------------------------|--|-------------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION  | STRAT PLOT  | NUMBER  | TYPE | "N" VALUES |              |            |                 | SHEAR STRENGTH kPa                       |    |              |     |                  |                                 |                               |                                |                                       |  | WATER CONTENT (%) |  |  |
|               |  |   |         |      |            |              |            |                 | ○ UNCONFINED                             |    | + FIELD VANE |     | ● QUICK TRIAXIAL |                                 |                               |                                |                                       |  | × LAB VANE        |  |  |
| 178.0         |  |   |         |      |            |              |            | 20              | 40                                       | 60 | 80           | 100 |                  |                                 |                               |                                |                                       |  |                   |  |  |
| 15.0          | thin sand layers   |  | 11      | SS   | 7          |              |            |                 |  |    |              |     |                  |                                 |                               |                                |                                       |  |                   |  |  |
| 177.1         | Sand with gravel, trace silt   |  |         |      |            |              |            |                 |  |    |              |     |                  |                                 |                               |                                |                                       |  |                   |  |  |
| 15.9          | Compact Brown Wet  |  | 12      | SS   | 20         |              |            |                 |  |    |              |     |                  |                                 |                               |                                |                                       |  |                   |  |  |
| 175.7         | End of borehole  |  |         |      |            |              |            |                 |  |    |              |     |                  |                                 |                               |                                |                                       |  |                   |  |  |
| 17.3          | Refusal on probable bedrock  |  |         |      |            |              |            |                 |  |    |              |     |                  |                                 |                               |                                |                                       |  |                   |  |  |
|               | Samples 4 and 5: Combined for lab testing  |   |         |      |            |              |            |                 |  |    |              |     |                  |                                 |                               |                                |                                       |  |                   |  |  |
|               | * 2007 03 05   |   |         |      |            |              |            |                 |  |    |              |     |                  |                                 |                               |                                |                                       |  |                   |  |  |
|               |  Water level observed during drilling |   |         |      |            |              |            |                 |  |    |              |     |                  |                                 |                               |                                |                                       |  |                   |  |  |
|               |  Water level measured after drilling  |   |         |      |            |              |            |                 |  |    |              |     |                  |                                 |                               |                                |                                       |  |                   |  |  |
|               | C.F.H.S.A - Denotes Continuous Flight Hollow Stem Augers   |   |         |      |            |              |            |                 |  |    |              |     |                  |                                 |                               |                                |                                       |  |                   |  |  |

# RECORD OF BOREHOLE No 307-36

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 14+487.5, o/s 58.5m Lt. CL Med. ORIGINATED BY M.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Manual Probing COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 29, 2007 CHECKED BY G.D.

| SOIL PROFILE  |                    |            |        | SAMPLES |            |                    | GROUND WATER<br>*<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |  |                   |  |  | PLASTIC<br>LIMIT<br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>w | LIQUID<br>LIMIT<br>w <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |    |    |    |
|---------------|--------------------|------------|--------|---------|------------|--------------------|---------------------------------|-----------------|---|--|-------------------|--|--|------------------------------------|-------------------------------------|-----------------------------------|--|---|----|----|----|
| ELEV<br>DEPTH | DESCRIPTION        | STRAT PLOT | NUMBER | TYPE    | "N" VALUES | SHEAR STRENGTH kPa |                                 |                 |   |  | WATER CONTENT (%) |  |  |                                    |                                     |                                   |  | GR  | SA | SI | CL |
| 193.0         | Ground Surface     |            |        |         |            |                    |                                 |                 |   |  |                   |  |  |                                    |                                     |                                   |  |   |    |    |    |
| 0.0           | Bedrock at surface |            |        |         |            |                    |                                 |                 |   |  |                   |  |  |                                    |                                     |                                   |  |   |    |    |    |
|               | * Borehole dry     |            |        |         |            |                    |                                 |                 |   |  |                   |  |  |                                    |                                     |                                   |  |   |    |    |    |

**RECORD OF BOREHOLE No 307-37**

1 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 14+487.5, o/s 20.5m Lt. CL Med. ORIGINATED BY N.R.  
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
DATUM Geodetic DATE March 01, 2007 CHECKED BY G.D.

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |              |     |  | PLASTIC<br>LIMIT<br>W <sub>P</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>W | LIQUID<br>LIMIT<br>W <sub>L</sub> | UNIT<br>WEIGHT<br>γ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |                   |  |  |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|----|--------------|-----|--|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|-------------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |    |              |     |  |                                    |                                     |                                   |                     |   | WATER CONTENT (%) |  |  |
|               |   |            |         |      |            |                            |                 | ○ UNCONFINED                                |    | + FIELD VANE |     |  |                                    |                                     |                                   |                     |   | ● QUICK TRIAXIAL  |  |  |
| 193.4         | Ground Surface  |            |         |      |            |                            | 20              | 40  | 60 | 80           | 100 |  |                                    |                                     |                                   |                     |   |                   |  |  |
| 0.0           | Peat  |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
| 0.1           | Dark brown  |            | 1       | SS   | 10         |                            |                 |   |    |              |     |  |                                    |                                     |                                   | 3.7%                |   |                   |  |  |
|               | Silt, some clay<br>trace to some sand                   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
|               | Compact Mottled Moist<br>to loose grey/ to wet<br>brown |            | 2       | SS   | 4          |                            |                 |   |    |              |     |  |                                    |                                     |                                   |                     | 0 10 77 13  |                   |  |  |
|               | Grey  |            | 3       | SS   | 8          |                            |                 |   |    |              |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
|               | sandy   |            | 4       | SS   | 4          |                            |                 |   |    |              |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
| 188.9         | Clay, trace sand  |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
| 4.5           | Firm Grey Wet   |            | 5       | SS   | 4          |                            |                 |   |    |              |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
|               |   |            | 6       | SS   | 1          |                            |                 |   |    |              |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
|               |   |            |         | FV   |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
|               |   |            | 7       | SS   | 2          |                            |                 |   |    |              |     |  |                                    |                                     |                                   |                     | 0 1 41 58   |                   |  |  |
|               |   |            |         | FV   |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
|               |   |            | 8       | SS   | 1          |                            |                 |   |    |              |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
|               |   |            |         | FV   |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
|               |   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
| 182.3         | Clayey silt   |            | 9       | SS   | 1          |                            |                 |   |    |              |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
| 11.1          | Firm Grey Wet   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
|               |   |            | 10      | SS   | WH**       |                            |                 |   |    |              |     |  |                                    |                                     |                                   |                     | 0 0 69 31   |                   |  |  |
|               |   |            |         | FV   |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
| 179.8         | Silt, trace clay  |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
| 13.6          | Loose Grey Wet  |            | 11      | SS   | 6          |                            |                 |   |    |              |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
| 178.9         | End of borehole   |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |                     |   |                   |  |  |
| 14.5          | Refusal on probable bedrock                             |            |         |      |            |                            |                 |   |    |              |     |  |                                    |                                     |                                   |                     |   |                   |  |  |



# RECORD OF BOREHOLE No 307-37

2 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 14+487.5, o/s 20.5m Lt. CL Med. ORIGINATED BY N.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 01, 2007 CHECKED BY G.D.

| SOIL PROFILE  |   |            |        | SAMPLES |            |                    | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |                   |              |                  | PLASTIC<br>LIMIT<br><br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br><br>w | LIQUID<br>LIMIT<br><br>w <sub>L</sub> | UNIT<br>WEIGHT<br><br>γ<br><br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |    |    |    |            |              |
|---------------|---|------------|--------|---------|------------|--------------------|----------------------------|-----------------|---|----|-------------------|--------------|------------------|--|---|---------------------------------------|--|---|----|----|----|------------|--------------|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER | TYPE    | "N" VALUES | SHEAR STRENGTH kPa |                            |                 |   |    | WATER CONTENT (%) |              |                  |  |   |                                       |  | GR  | SA | SI | CL |            |              |
| 20            |   |            |        |         |            | 40                 |                            |                 | 60  | 80 | 100               | ○ UNCONFINED | ● QUICK TRIAXIAL |  |   |                                       |  |   |    |    |    | ✕ LAB VANE | ✚ FIELD VANE |
| 178.4         |   |            |        |         |            |                    |                            |                 |   |    |                   |              |                  |  |   |                                       |  |   |    |    |    |            |              |
|               | <div>*20070301</div> <div>▽Water level observed during drilling</div> <div>WH**Denotes penetration due to weight of hammer and rods</div> |            |        |         |            |                    |                            |                 |   |    |                   |              |                  |  |   |                                       |  |   |    |    |    |            |              |

# RECORD OF BOREHOLE No 307-40

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 14+500, o/s 38.8m Lt. CL Med. ORIGINATED BY N.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Manual Probing COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 29, 2007 CHECKED BY G.D.

| SOIL PROFILE  |                    |            |        | SAMPLES |            |                    | GROUND WATER<br>*<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |   |                   |            |          | PLASTIC<br>LIMIT<br><br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br><br>w | LIQUID<br>LIMIT<br><br>w <sub>L</sub> | UNIT<br>WEIGHT<br><br>γ<br><br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |  |  |  |
|---------------|--------------------|------------|--------|---------|------------|--------------------|---------------------------------|-----------------|---|---|-------------------|------------|----------|--|---|---------------------------------------|--|---|--|--|--|
| ELEV<br>DEPTH | DESCRIPTION        | STRAT PLOT | NUMBER | TYPE    | "N" VALUES | SHEAR STRENGTH kPa |                                 |                 |   |   | WATER CONTENT (%) |            |          |  |   |                                       |  |   |  |  |  |
|               |                    |            |        |         |            | ○ UNCONFINED       |                                 |                 | ● QUICK TRIAXIAL                            | + | ×                 | FIELD VANE | LAB VANE |  |   |                                       |  |   |  |  |  |
| 198.5         | Ground Surface     |            |        |         |            |                    |                                 |                 |   |   |                   |            |          |  |   |                                       |  |   |  |  |  |
| 0.0           | Bedrock at surface |            |        |         |            |                    |                                 |                 |   |   |                   |            |          |  |   |                                       |  |   |  |  |  |
|               | * Borehole dry     |            |        |         |            |                    |                                 |                 |   |   |                   |            |          |  |   |                                       |  |   |  |  |  |

RECORD OF PENETRATION TEST No 307-22

1 of 1 METRIC

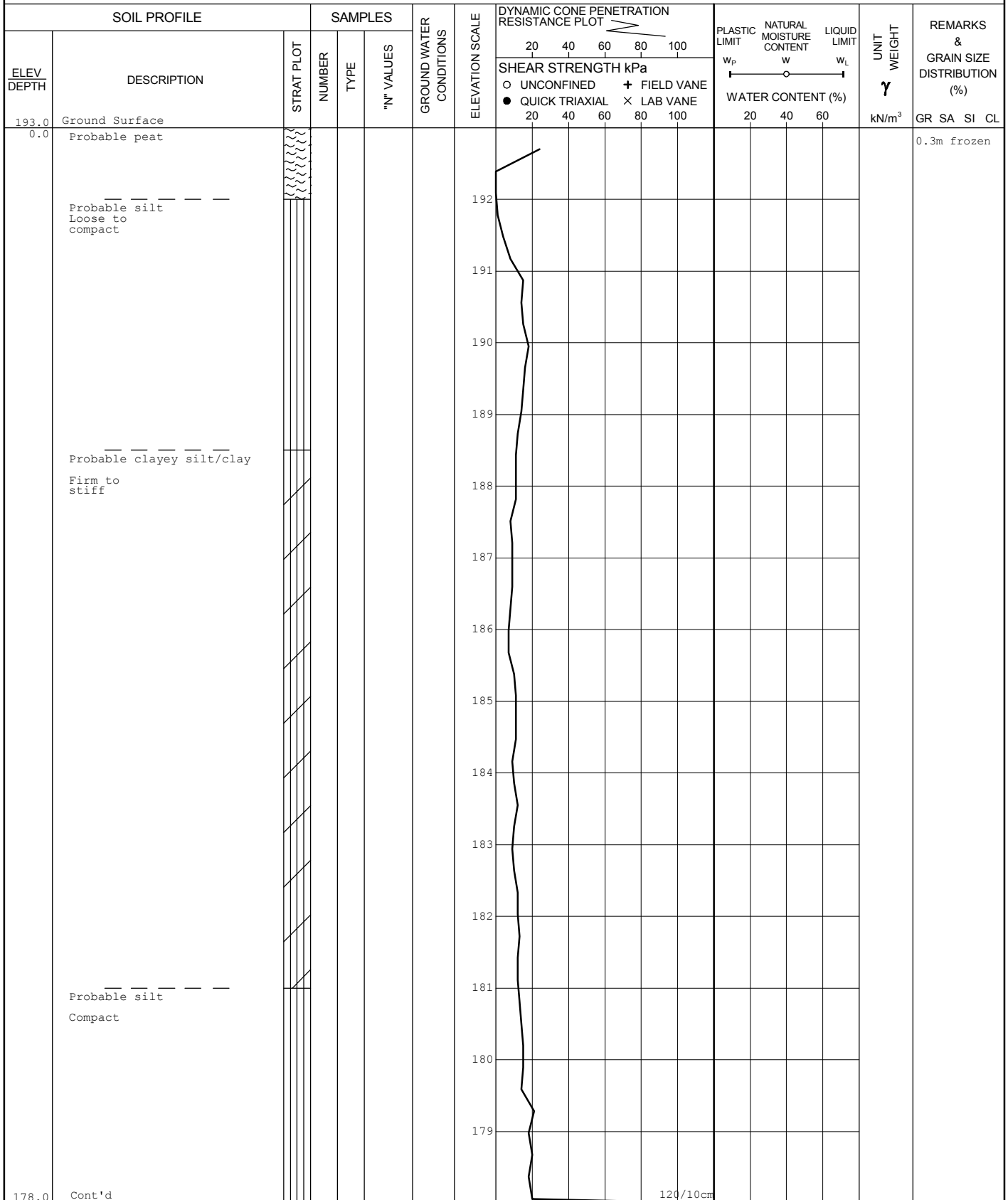
G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 14+437.5, o/s 38.8m Lt. CL Med. ORIGINATED BY N.R.  
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
DATUM Geodetic DATE March 05, 2007 CHECKED BY G.D.

| SOIL PROFILE  |  | SAMPLES    |        |      | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                 | PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT |                                 |                   | UNIT<br>WEIGHT<br>$\gamma$<br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%)<br>GR SA SI CL |
|---------------|--|------------|--------|------|----------------------------|-----------------|---|-----------------|---|---------------------------------|-------------------|---|--|
| ELEV<br>DEPTH | DESCRIPTION  | STRAT PLOT | NUMBER | TYPE |                            |                 | "N" VALUES                                  | 20 40 60 80 100 | 20 40 60 80 100                                     | W <sub>p</sub> W W <sub>L</sub> | WATER CONTENT (%) |   |  |
| 193.0<br>0.0  | Ground Surface<br>Probable organic silt                                |            |        |      |                            |                 |   |                 |   |                                 |                   |   | 0.3m frozen  |
|               | -----<br>Probable clayey silt<br>Soft to firm                          |            |        |      |                            |                 |   |                 |   |                                 |                   |   |  |
| 185.0<br>8.0  | End of dynamic cone<br>penetration test<br>Refusal on probable bedrock |            |        |      |                            |                 |   |                 |   |                                 |                   |   |  |

RECORD OF PENETRATION TEST No 307-26

1 of 2 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 14+450, o/s 56.5m Lt. CL Med. ORIGINATED BY N.R.  
DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE March 06, 2007 CHECKED BY G.D.



## RECORD OF PENETRATION TEST No 307-30

1 of 1 METRIC

|        |            |          |   |               |      |
|--------|------------|----------|---|---------------|------|
| G.W.P. | 5203-06-00 | LOCATION | Hwy 69(New), Sta. 14+462.5, o/s 56.5m Lt. CL Med. | ORIGINATED BY | N.R. |
|--------|------------|----------|---|---------------|------|

DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.

DATUM Geodetic DATE March 02, 2007 CHECKED BY G.D.

[illegible]

1 of 1 **METRIC**

AM  
+<sup>7</sup>, X<sup>5</sup>: Numbers refer to Sensitivity

20  
15 — ○ — 5  
10  
(%) STRAIN AT FAILURE

**RECORD OF BOREHOLE No 310-1**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 13+400, o/s 38.8m Lt. CL median ORIGINATED BY F.P.  
DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY N.S.B.  
DATUM Geodetic DATE March 04, 2007 CHECKED BY C.N.

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                  |              |            |    | PLASTIC<br>LIMIT<br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>w | LIQUID<br>LIMIT<br>w <sub>L</sub> | UNIT<br>WEIGHT<br>γ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |                   |  |  |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|------------------|--------------|------------|----|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|-------------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |                  |              |            |    |                                    |                                     |                                   |                     |   | WATER CONTENT (%) |  |  |
|               |   |            |         |      |            |                            |                 | ○ UNCONFINED                                | ● QUICK TRIAXIAL | + FIELD VANE | × LAB VANE |    |                                    |                                     |                                   |                     |   |                   |  |  |
| 195.0         | Ground Surface  |            |         |      |            |                            | 20              | 40  | 60               | 80           | 100        | 20 | 40                                 | 60                                  | kN/m <sup>3</sup>                 | GR SA SI CL         |   |                   |  |  |
| 0.0           | Peat, coarse fibrous<br>Dark brown<br>fine fibrous                      |            | 1       | AS   | -          | ▽*                         |                 |   |                  |              |            |    |                                    |                                     |                                   | 0.5m frozen         |   |                   |  |  |
|               |   |            | 2       | SS   | WH**       |                            | 194             |   |                  |              |            |    |                                    |                                     |                                   |                     | 547<br>Org.<br>58.0%                              |                   |  |  |
|               |   |            | 3       | SS   | WH         |                            | 193             |   |                  |              |            |    |                                    |                                     |                                   |                     |   |                   |  |  |
|               | amorphous<br>layers of organic silty clay                               |            | 4       | SS   | WH         |                            | 192             |   |                  |              |            |    |                                    |                                     |                                   |                     |   |                   |  |  |
| 191.5         |   |            | 5       | SS   | WH         |                            |                 |   |                  |              |            |    |                                    |                                     |                                   |                     |   |                   |  |  |
| 3.5           | Silty clay, varved<br>organics to 5.0m<br>Very soft Grey Wet<br>to soft |            |         | FV   |            | 191                        | +               | 3   |                  |              |            |    |                                    |                                     |                                   |                     |   |                   |  |  |
|               |   |            | 6       | SS   | WH         | 190                        |                 |   |                  |              |            |    |                                    |                                     |                                   |                     |   |                   |  |  |
|               |   |            |         | FV   |            |                            | +               | 4   |                  |              |            |    |                                    |                                     |                                   |                     |   |                   |  |  |
|               |   |            | 7       | SS   | WH         | 189                        |                 |   |                  |              |            |    |                                    |                                     |                                   |                     |   |                   |  |  |
|               |   |            |         | FV   |            | 188                        |                 | +   | 4                |              |            |    |                                    |                                     |                                   |                     |   |                   |  |  |
|               |   |            | 8       | SS   | WH         | 187                        |                 |   |                  |              |            |    |                                    |                                     |                                   |                     |   |                   |  |  |
|               |   |            |         | FV   |            |                            | +               | 3   |                  |              |            |    |                                    |                                     |                                   |                     |   |                   |  |  |
|               | layers of silt  |            |         |      |            | 186                        |                 |   |                  |              |            |    |                                    |                                     |                                   |                     |   |                   |  |  |
|               |   |            | 9       | SS   | 1          |                            |                 |   |                  |              |            |    |                                    |                                     |                                   |                     |   |                   |  |  |
| 184.3         | End of borehole   |            |         |      |            |                            |                 |   |                  |              |            |    |                                    |                                     |                                   |                     |   |                   |  |  |
| 10.7          | Refusal on probable bedrock   |            |         |      |            |                            |                 |   |                  |              |            |    |                                    |                                     |                                   |                     |   |                   |  |  |
|               | * 2007 03 04  |            |         |      |            |                            |                 |   |                  |              |            |    |                                    |                                     |                                   |                     |   |                   |  |  |
|               | ▽ Water level observed<br>during drilling                               |            |         |      |            |                            |                 |   |                  |              |            |    |                                    |                                     |                                   |                     |   |                   |  |  |
|               | ▼ Water level measured<br>after drilling                                |            |         |      |            |                            |                 |   |                  |              |            |    |                                    |                                     |                                   |                     |   |                   |  |  |
|               | WH** Denotes penetration due<br>to weight of hammer and<br>rods         |            |         |      |            |                            |                 |   |                  |              |            |    |                                    |                                     |                                   |                     |   |                   |  |  |

\* 2007 03 04

▽ Water level observed  
during drilling

▼ Water level measured  
after drilling

WH\*\* Denotes penetration due  
to weight of hammer and  
rods

**RECORD OF BOREHOLE No 310-4**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 13+412.5, o/s 26.5m Lt. CL median ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 05, 2007 CHECKED BY C.N.

| SOIL PROFILE  |  |            | SAMPLES |      |           | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                  |              |            |     | PLASTIC<br>LIMIT<br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>w | LIQUID<br>LIMIT<br>w <sub>L</sub> | UNIT<br>WEIGHT<br><br>γ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |                   |  |  |
|---------------|--|------------|---------|------|-----------|----------------------------|-----------------|---|------------------|--------------|------------|-----|------------------------------------|-------------------------------------|-----------------------------------|-------------------------|---|-------------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION  | STRAT PLOT | NUMBER  | TYPE | *N VALUES |                            |                 | SHEAR STRENGTH kPa                          |                  |              |            |     |                                    |                                     |                                   |                         |   | WATER CONTENT (%) |  |  |
|               |  |            |         |      |           |                            |                 | ○ UNCONFINED                                | ● QUICK TRIAXIAL | + FIELD VANE | × LAB VANE |     |                                    |                                     |                                   |                         |   |                   |  |  |
| 195.0         | Ground Surface   |            |         |      |           | ▼*                         |                 | 20  | 40               | 60           | 80         | 100 |                                    |                                     |                                   |                         | GR SA SI CL                                       |                   |  |  |
| 0.0           | Peat, coarse fibrous<br>Dark brown<br>fine fibrous   |            | 1       | AS   | -         | ▼*                         |                 |   |                  |              |            |     |                                    |                                     |                                   |                         | 0.5m frozen                                       |                   |  |  |
|               |  |            | 2       | SS   | WH**      |                            |                 |   |                  |              |            |     |                                    |                                     |                                   | 626                     | Org.<br>56.3%                                     |                   |  |  |
|               |  |            | 3       | SS   | WH        |                            |                 |   |                  |              |            |     |                                    |                                     |                                   | 988                     |   |                   |  |  |
|               | amorphous<br>layers of organic silty<br>clay   |            | 4       | SS   | WH        |                            |                 |   |                  |              |            |     |                                    |                                     |                                   | 184                     |   |                   |  |  |
| 191.9         |  |            |         |      |           |                            | 192             |   |                  |              |            |     |                                    |                                     |                                   |                         |   |                   |  |  |
| 3.1           | Silty clay, organics<br>layers of organic silty<br>clay, seashells to 4.5m<br><br>Very soft Grey Wet<br>to firm  |            | 5       | SS   | WH        |                            |                 |   |                  |              |            |     |                                    |                                     |                                   |                         |   |                   |  |  |
|               |  |            |         | FV   |           |                            | 191             | +   | 1                |              |            |     |                                    |                                     |                                   |                         |   |                   |  |  |
|               | trace sand<br>varved   |            | 6       | SS   | WH        |                            | 190             |   |                  |              |            |     |                                    |                                     |                                   |                         | 1 1 51 47   |                   |  |  |
|               |  |            |         | FV   |           |                            |                 | +   | 3                |              |            |     |                                    |                                     |                                   |                         |   |                   |  |  |
|               |  |            | 7       | SS   | WH        |                            | 189             |   |                  |              |            |     |                                    |                                     |                                   |                         |   |                   |  |  |
|               |  |            |         | FV   |           |                            | 188             | +   | 2                |              |            |     |                                    |                                     |                                   |                         |   |                   |  |  |
|               |  |            | 8       | SS   | WH        |                            | 187             |   |                  |              |            |     |                                    |                                     |                                   |                         | 0 1 54 45   |                   |  |  |
|               |  |            |         | FV   |           |                            |                 | +   | 2                |              |            |     |                                    |                                     |                                   |                         |   |                   |  |  |
|               | cobbles  |            | 9       | SS   | 10/5cm    |                            | 186             |   |                  |              |            |     |                                    |                                     |                                   |                         |   |                   |  |  |
| 185.4         |  |            |         |      |           |                            |                 |   |                  |              |            |     |                                    |                                     |                                   |                         |   |                   |  |  |
| 9.6           | End of borehole<br><br>Refusal on probable bedrock   |            |         |      |           |                            |                 |   |                  |              |            |     |                                    |                                     |                                   |                         |   |                   |  |  |
|               | Sample 9: sampler bouncing<br><br>* 2007 03 05<br><br>▽ Water level observed<br>during drilling<br><br>▼ Water level measured<br>after drilling<br><br>WH** Denotes penetration due<br>to weight of hammer and<br>rods |            |         |      |           |                            |                 |   |                  |              |            |     |                                    |                                     |                                   |                         |   |                   |  |  |










**RECORD OF BOREHOLE No 310-7**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 13+425, o/s 38.8m Lt. CL median ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 04, 2007 CHECKED BY C.N.

| SOIL PROFILE  |   |   | SAMPLES |      |           | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |                  |              |            |     | PLASTIC<br>LIMIT<br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>w | LIQUID<br>LIMIT<br>w <sub>L</sub> | UNIT<br>WEIGHT<br>γ<br><br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |                   |  |  |
|---------------|---|---|---------|------|-----------|----------------------------|-----------------|---|------------------|--------------|------------|-----|------------------------------------|-------------------------------------|-----------------------------------|--|---|-------------------|--|--|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT  | NUMBER  | TYPE | *N VALUES |                            |                 | SHEAR STRENGTH kPa                          |                  |              |            |     |                                    |                                     |                                   |  |   | WATER CONTENT (%) |  |  |
|               |   |   |         |      |           |                            |                 | ○ UNCONFINED                                | ● QUICK TRIAXIAL | + FIELD VANE | × LAB VANE |     |                                    |                                     |                                   |  |   |                   |  |  |
| 195.0         | Ground Surface  |   |         |      |           | ▼*                         |                 | 20  | 40               | 60           | 80         | 100 |                                    |                                     |                                   |  | GR SA SI CL                                       |                   |  |  |
| 0.0           | Peat, coarse fibrous<br><br>Dark brown                    |    | 1       | AS   | -         | ▼*                         |                 |   |                  |              |            |     |                                    |                                     |                                   |  | 0.5m frozen                                       |                   |  |  |
|               |   |   |         |      |           |                            |                 |   |                  |              |            |     |                                    |                                     |                                   |  |   |                   |  |  |
|               | amorphous layers of organic silty clay                    |    | 2       | SS   | WH**      |                            | 194             |   |                  |              |            |     |                                    |                                     |                                   |  | 944   |                   |  |  |
|               |   |   | 3       | SS   | WH        |                            | 193             |   |                  |              |            |     |                                    |                                     |                                   |  | 89  |                   |  |  |
| 192.4         |   |   | 4       | SS   | WH        |                            |                 |   |                  |              |            |     |                                    |                                     |                                   |  |   |                   |  |  |
| 2.6           | Clayey silt organics to 3.1m                              |    |         |      |           |                            |                 |   |                  |              |            |     |                                    |                                     |                                   |  |   |                   |  |  |
|               | Very soft Grey Wet to soft varved                         |    | 5       | SS   | WH        | 192                        |                 |   |                  |              |            |     |                                    |                                     |                                   |  | 0 0 68 32   |                   |  |  |
|               |   |   |         | FV   |           | 191                        | +               | 2   |                  |              |            |     |                                    |                                     |                                   |  |   |                   |  |  |
|               |   |   | 6       | SS   | 1         | 190                        |                 |   |                  |              |            |     |                                    |                                     |                                   |  |   |                   |  |  |
|               |   |   |         | FV   |           |                            | +               | 3   |                  |              |            |     |                                    |                                     |                                   |  |   |                   |  |  |
| 189.2         |   |   |         |      |           | 189                        |                 |   |                  |              |            |     |                                    |                                     |                                   |  |   |                   |  |  |
| 5.8           | Sand trace to some silt trace gravel, cobbles             |  | 7       | SS   | 10/7cm    |                            |                 |   |                  |              |            |     |                                    |                                     |                                   |  | 2 87 (11)   |                   |  |  |
| 188.4         | Compact Grey Wet  |  |         |      |           |                            |                 |   |                  |              |            |     |                                    |                                     |                                   |  |   |                   |  |  |
| 6.6           | End of borehole<br>Refusal on probable bedrock            |  |         |      |           |                            |                 |   |                  |              |            |     |                                    |                                     |                                   |  |   |                   |  |  |
|               | Sample 7: sampler bouncing                                |   |         |      |           |                            |                 |   |                  |              |            |     |                                    |                                     |                                   |  |   |                   |  |  |
|               | * 2007 03 04  |   |         |      |           |                            |                 |   |                  |              |            |     |                                    |                                     |                                   |  |   |                   |  |  |
|               | ▽ Water level observed during drilling                    |   |         |      |           |                            |                 |   |                  |              |            |     |                                    |                                     |                                   |  |   |                   |  |  |
|               | ▼ Water level measured after drilling                     |   |         |      |           |                            |                 |   |                  |              |            |     |                                    |                                     |                                   |  |   |                   |  |  |
|               | WH** Denotes penetration due to weight of hammer and rods |   |         |      |           |                            |                 |   |                  |              |            |     |                                    |                                     |                                   |  |   |                   |  |  |

**RECORD OF BOREHOLE No 310-9**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 13+437.5, o/s 52.5m Lt. CL median ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 05, 2007 CHECKED BY C.N.

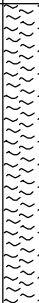

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT              |    |    |     |  | PLASTIC LIMIT<br>NATURAL MOISTURE<br>CONTENT LIQUID LIMIT |  |     | UNIT<br>WEIGHT<br>$\gamma$ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|--|----|----|-----|--|---|--|-----|----------------------------|---|
| ELEV<br>DEPTH | DESCRIPTION   | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                                       |    |    |     |  | WATER CONTENT (%)   |  |     |                            |   |
|               |   |            |         |      |            |                            |                 | ○ UNCONFINED + FIELD VANE<br>● QUICK TRIAXIAL x LAB VANE |    |    |     |  |   |  |     |                            |   |
| 195.0         | Top of Ice/snow   |            |         |      |            |                            | 20              | 40   | 60 | 80 | 100 |  |   |  |     |                            |   |
| 0.0           | Ice/Snow  |            |         |      |            |                            |                 |  |    |    |     |  |   |  |     |                            |   |
| 0.3           | Peat, coarse fibrous<br>Dark brown<br>fine fibrous                    |            | 1       | AS   | -          |                            |                 |  |    |    |     |  |   |  |     |                            |   |
|               |   |            | 2       | SS   | WH**       | 194                        |                 |  |    |    |     |  |   |  | 166 | Org.<br>9.5%               |   |
| 193.5         |   |            |         |      |            |                            |                 |  |    |    |     |  |   |  |     |                            |   |
| 1.5           | Silty clay<br>organics to 3.0m<br>varved<br>Firm Grey Moist<br>to wet |            | 3       | SS   | 2          | 193                        |                 |  |    |    |     |  | ○   |  |     |                            |   |
|               |   |            |         | FV   |            |                            |                 |  |    |    |     |  |   |  |     |                            |   |
|               | layers of silt  |            |         |      |            | 192                        |                 |  |    |    |     |  |   |  | ○   |                            |   |
|               |   |            | 4       | SS   | 2          |                            |                 |  |    |    |     |  |   |  |     |                            |   |
|               |   |            | 5       | TW   | PH         | 191                        |                 |  |    |    |     |  | ○   |  |     |                            |   |
|               |   |            |         |      |            |                            |                 |  |    |    |     |  |   |  |     |                            |   |
| 190.1         | layers of sandy silt<br>trace gravel, cobbles                         |            | 6       | SS   | 10/10cm    |                            |                 |  |    |    |     |  |   |  |     |                            |   |
| 4.9           | End of borehole   |            |         |      |            |                            |                 |  |    |    |     |  |   |  |     |                            |   |
|               | Refusal on probable bedrock   |            |         |      |            |                            |                 |  |    |    |     |  |   |  |     |                            |   |
|               | Sample 6: Sampler bouncing  |            |         |      |            |                            |                 |  |    |    |     |  |   |  |     |                            |   |
|               | * 2007 03 05  |            |         |      |            |                            |                 |  |    |    |     |  |   |  |     |                            |   |
|               | ▽ Water level observed<br>during drilling                             |            |         |      |            |                            |                 |  |    |    |     |  |   |  |     |                            |   |
|               | ▼ Water level measured<br>after drilling                              |            |         |      |            |                            |                 |  |    |    |     |  |   |  |     |                            |   |
|               | WH** Denotes penetration due<br>to weight of hammer and<br>rods       |            |         |      |            |                            |                 |  |    |    |     |  |   |  |     |                            |   |



RECORD OF PENETRATION TEST No 310-3

1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 13+412.5, o/s 52.5m Lt. CL median ORIGINATED BY F.P.  
DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE March 05, 2007 CHECKED BY C.N.

| SOIL PROFILE  |   |  | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |              |  | PLASTIC<br>LIMIT<br><br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br><br>w | LIQUID<br>LIMIT<br><br>w <sub>L</sub> | UNIT<br>WEIGHT<br><br>γ<br><br>kN/m <sup>3</sup> | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |
|---------------|---|--|---------|------|------------|----------------------------|-----------------|---|--------------|--|--|---|---------------------------------------|--|---|
| ELEV<br>DEPTH | DESCRIPTION                             | STRAT PLOT   | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |              |  |  |   |                                       |  |   |
| 195.0         | Ground Surface                          |  |         |      |            |                            |                 | ○ UNCONFINED                                | + FIELD VANE |  |  |   |                                       |  | GR SA SI CL                                       |
| 0.0           | Probable peat                           |   |         |      |            |                            |                 | ● QUICK TRIAXIAL                            | × LAB VANE   |  |  |   |                                       |  | 0.5m frozen                                       |
|               | Probable silty clay                     |  |         |      |            |                            |                 |   |              |  |  |   |                                       |  |   |
|               | Very soft<br>to soft                    |  |         |      |            |                            |                 |   |              |  |  |   |                                       |  |   |
| 186.3         | End of dynamic cone<br>penetration test |  |         |      |            |                            |                 |   |              |  |  |   |                                       |  |   |
| 8.7           | Refusal on probable bedrock             |  |         |      |            |                            |                 |   |              |  |  |   |                                       |  |   |

RECORD OF PENETRATION TEST No 310-10

1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 13+437.5, o/s 26.5m Lt. CL median ORIGINATED BY F.P.  
DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
DATUM Geodetic DATE March 05, 2007 CHECKED BY C.N.

| SOIL PROFILE  |   |            | SAMPLES |      |            | GROUND WATER<br>CONDITIONS | ELEVATION SCALE | DYNAMIC CONE PENETRATION<br>RESISTANCE PLOT |    |            | PLASTIC<br>LIMIT<br>w <sub>p</sub> | NATURAL<br>MOISTURE<br>CONTENT<br>w | LIQUID<br>LIMIT<br>w <sub>L</sub> | UNIT<br>WEIGHT<br>γ | REMARKS<br>&<br>GRAIN SIZE<br>DISTRIBUTION<br>(%) |  |  |
|---------------|---|------------|---------|------|------------|----------------------------|-----------------|---|----|------------|------------------------------------|-------------------------------------|-----------------------------------|---------------------|---|--|--|
| ELEV<br>DEPTH | DESCRIPTION                             | STRAT PLOT | NUMBER  | TYPE | "N" VALUES |                            |                 | SHEAR STRENGTH kPa                          |    |            |                                    |                                     |                                   |                     |   |  |  |
| 195.0         | Ground Surface                          |            |         |      |            |                            |                 | 20  | 40 | 60         | 80                                 | 100                                 |                                   |                     |   |  |  |
| 0.0           | Probable peat                           |            |         |      |            |                            |                 | ○ UNCONFINED                                | +  | FIELD VANE |                                    |                                     |                                   |                     |   |  |  |
|               | Probable silty clay                     |            |         |      |            |                            |                 | ● QUICK TRIAXIAL                            | ×  | LAB VANE   |                                    |                                     |                                   |                     |   |  |  |
|               | Very soft<br>to soft                    |            |         |      |            |                            |                 | 20  | 40 | 60         | 80                                 | 100                                 |                                   |                     |   |  |  |
| 190.0         | End of dynamic cone<br>penetration test |            |         |      |            |                            |                 |   |    |            |                                    |                                     |                                   |                     |   |  |  |
| 5.0           | Refusal on probable bedrock             |            |         |      |            |                            |                 |   |    |            |                                    |                                     |                                   |                     |   |  |  |



# **APPENDIX G**

## **Non-Standard Special Provisions and Operational Constraints**

## **EXCAVATION OF ORGANICS AND COMPRESSIBLE SOILS – Item No.**

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### **Non-Standard Special Provision**

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#### **Scope**

This non-standard special provision outlines the procedures(s) to be used for excavating organic and/or soft compressible deposits at the following areas:

- Highway 69 SBL – STA 17+750 to 18+125 (Swamp 302 SBL)
- Highway 69 NBL – STA 17+750 to 18+100 (Swamp 302 NBL)
- Highway 69 SBL – STA 16+075 to 16+325 (Swamp 305 SBL)
- Highway 69 SBL – STA 15+360 to 15+750 (Swamp 306 SBL)
- Highway 69 SBL – STA 14+425 to 14+490 (Swamp 307 SBL)

Where there is restriction in space due to the proximity to an existing roadway and if a temporary protection system is not employed, staged excavation in strips of limited width shall be carried out to maintain stability and to protect the existing roadway during subexcavation and replacement operations. The staged excavation procedures to be followed are:

- Work may be carried out simultaneously starting from both ends of the swamp and progressing towards the centre along the embankment footprint;
- The crest of the excavation shall start no closer than 2 m from the edge of the existing pavement;
- The excavation shall be carried out such that the base of the excavation is maintained outside a zone defined by a line drawn downward at 1H:1V from the crest of the existing roadway embankments to the base of the excavation;
- Removal of the organic and, where applicable, soft compressible deposits within the proposed wick drain treatment footprint and backfilling of the excavation shall be carried out simultaneously in accordance with OPSS 209.
- Temporary excavation side slopes or back slopes through the organic and soft compressible deposits shall be no steeper than 1.25H:1V adjacent to the existing roadway. Temporary excavations through the existing highway fill shall be no steeper than 1H:1V;
- Provisions for traffic control measures shall be available on site to maintain the safe operation of Highway 69 during the excavation and backfilling operations in the event that distress to the existing roadway occurs during the staged excavation.

**Basis of Payment**

Payment at the lump sum contract price for this tender item shall be full compensation for all labour, equipment and materials for completion of the work.



## **DRAINAGE BLANKET – Item No.**

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### **Non-Standard Special Provision**

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#### **1.0 SCOPE**

This non-standard special provision specifies the requirements for the surface preparation, supply, placement and compaction of the Drainage Blanket (Blanket) in connection with the installation of the prefabricated wick drains.

#### **2.0 MATERIALS**

The Drainage Blanket shall be pit run Granular 'B' Type I and shall satisfy the physical and gradation requirements as specified in SP 110S13 except that:

- 100 % shall pass the 26.5 mm sieve; and,
- no more than 5 % shall pass the 0.075 mm sieve.

#### **3.0 CONSTRUCTION**

3.1 The Blanket shall be placed and compacted to the limits and grades shown on the Contract Drawing or as directed by the Contract Administrator.

3.2 The Blanket shall be placed, subsequent to the required stripping/sub-excavation of organic deposits, to an elevation meeting the following requirements:

- at least 0.5 m above the groundwater table during the installation of the wick drains;
- a minimum thickness of 0.5 m; and,
- at least 0.3 m above the original grade.

3.3 The Blanket shall be end-dumped for placement below water.

3.4 The Blanket shall be placed and compacted in lift thicknesses not exceeding 250 mm except below water as described in Item 3.3.

#### **4.0 PAYMENT**

4.1 Measurement for Payment

Measurement for payment shall be by the tonne. The method of determining the mass of materials for payment shall conform to OPSS 102.

#### 4.2 Basis of Payment

Payment at the contract price for the above item shall be full compensation for all labour, equipment and materials to do the required work.

## **WICK DRAINS – Item No.**

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### **Non-Standard Special Provision**

---

#### **1.0 GENERAL**

##### **1.1 Scope**

This non-standard special provision specifies the requirements for the supply and installation of wick drains in accordance with the details shown on the plans and profiles/cross-sections drawings and with the requirements of this specification.

##### **1.2 Qualifications**

The work shall be undertaken by a recognized specialist subcontractor who has proven satisfactory experience in work of this type and magnitude and has completed a minimum of five wick drain installation projects in the last five years, each project with the following characteristics:

- Minimum installation depth: not less than 15 m; and,
- Total length of wick drains: not less than 100,000 m.

The specialist subcontractor's qualifications shall be submitted to the Contract Administrator not later than 15 working days in advance of commencing the installation of wick drains.

##### **1.3 Definitions**

**Quality Verification Engineer (QVE):** means an Engineer who has a minimum of five (5) years experience related to the design and installation of wick drains or alternatively has demonstrated expertise by providing satisfactory quality verification services for the work at a minimum of two (2) projects of similar scope to the Contract. The Quality Verification Engineer shall be retained by the Contractor to certify that the work is in general conformance with the Contract Documents and to issue Certificate(s) of Conformance.

##### **1.4 Submission and Design Requirements**

###### **1.4.1 Certificate of Conformance – Material**

The Contractor shall submit a sample of the wick drain to the Quality Verification Engineer for review prior to the installation of the wick drains on the Contract. The Contractor shall submit to the Contract Administrator a Certificate of Conformance sealed and signed by the Quality Verification Engineer a minimum of one (1) week prior to commencement of work under this item. The Certificate shall state that the wick drain material is in conformance with the requirements and specifications of the Contract Documents.

#### 1.4.2 Certificate of Conformance – Installation Method

The Contractor shall submit to the Contract Administrator a Certificate of Conformance sealed and signed by the Quality Verification Engineer a minimum of one (1) week prior to commencement of work under this item. The Certificate shall state that the installation procedures are in conformance with the requirements and specifications of the Contract Documents.

#### 1.4.3 Certificate of Conformance – Final

Upon completion of the wick drain installation, the Contractor shall submit to the Contract Administrator a final Certificate of Conformance sealed and signed by the Quality Verification Engineer. The certificate shall state that the work has been carried out in general conformance with the installation procedure and specifications of the Contract Documents.

### 2.0 SITE CONDITIONS

The Contractor shall refer to the Foundation Investigation Reports in the Contract Documents for a description of subsurface conditions at this site. The Record of Borehole sheets are not represented as a complete description of the subsurface conditions, but only present what was found in borings at the indicated locations on the date boreholes were drilled. The subsurface conditions may be variable between the borehole locations. The Contractor should verify existing subsurface and surface conditions.

### 3.0 MATERIALS

- 3.1 The prefabricated wick drain shall consist of a continuous plastic drainage core wrapped in a non-woven geotextile. The core configuration should be ‘Studded’ or ‘Grooved’ (‘Filament’ or ‘Cusped’ are not acceptable).

The prefabricated wick drain material shall meet the minimum requirements specified in Table 1.

- 3.2 The Contractor shall submit a 1 m long, full width, sample of the wick drain material to the Contract Administrator for information at least one (1) month prior to commencement of work under this item. The sample shall be stamped or labeled by the manufacturer as being representative of the wick drain material having the specified trade name. Documentation indicating the source and the physical and mechanical properties of the wick drain shall be provided.
- 3.3 Manufacturer certification shall be provided for all wick drain material delivered to the project. Quality test certificates for each production lot supplied, showing compliance with all requirements of this special provision shall be obtained by the Contractor and submitted to the Contract Administrator prior to installation.
- 3.4 All wick drains supplied shall be free of defects, rips, holes or flaws. During shipment the wick drain shall be protected from damage. During on-site storage the storage area shall be such that the wick drain is protected from sunlight, dirt, dust, mud, debris and any other detrimental substances and construction equipment.

## **4.0 EQUIPMENT**

- 4.1 Wick drains shall be installed vertical, with equipment which will minimize disturbance to the drainage blanket or the native subsoil during the installation operation. Static or vibratory methods are considered acceptable. Falling weight impact hammers will not be allowed.
- 4.2 The Contractor is advised that the site is considered as an environmentally sensitive area and therefore the control of any water effluent needs to be carefully planned and organized. Jetting techniques to install the wick drains, therefore, shall be subjected to the approval of the Contract Administrator.
- 4.3 The Contractor shall be permitted to use augering equipment to predrill or to loosen the native soils and the drainage blanket if required to facilitate the installation of the wick drains.
- 4.4 Each prefabricated wick drain shall be installed using a mandrel or sleeve that shall be advanced through the drainage blanket and the underlying soil. The mandrel shall protect the prefabricated wick drain material from tears, cuts and abrasions during installation and shall be withdrawn after the installation of the wick drain. The mandrel shall be provided with an "anchor" rod or plate at the bottom to prevent the soil from entering the bottom of the mandrel during installation of the wick drain and to anchor the bottom of the wick drain at the required depth at the time of mandrel removal. The projected cross-sectional area of the mandrel and anchor combination shall not exceed 7,700 mm<sup>2</sup>.

## **5.0 INSTALLATION**

### **5.1 Installation Method Proposal Submission**

At least three (3) weeks prior to the installation of the wick drains, the Contractor shall submit to the Quality Verification Engineer, details of the sequence and method of installation. The submittals shall satisfy the specifications and at a minimum contain the following specific information:

- Size, type, weight, maximum pushing force, and configuration of the installation rig;
- Dimensions and length of mandrel;
- Details of wick drain anchorage;
- Detailed description of proposed installation procedures;
- Proposed methods for overcoming obstructions; and,
- Proposed methods for splicing wick drains.

### **5.2 Construction Sequence**

Wick drains shall be installed vertical, subsequent to the construction of the drainage blanket and prior to installation of monitoring instruments and placement of the embankment material.

### **5.3 Trial Wick Drains**

Prior to the installation of prefabricated wick drains within the areas designated on the plans, the Contractor shall demonstrate that the proposed materials, equipment and installation method produces a satisfactory wick drain installation in accordance with this specification. The Contractor will be required to install a total of ten (10) trial wick drains at locations within the work area as designated

by the Contractor Administrator.

Should the ten (10) trial wick drains be installed to the satisfaction of the Quality Verification Engineer, the trial wick drains can be incorporated as part of the permanent installation. The Contractor will be compensated for each trial wick drain if the installation satisfies the requirements of this specification, at the same unit price as the production wick drains. The Contractor shall not be compensated for unsatisfactory trial wick drains.

Full time monitoring of the Contractor's method of installation will be required by the Contractor's Quality Verification Engineer. If, at any time, the Quality Verification Engineer considers that the method of installation does not produce a wick drain that satisfies the project requirements, the Contractor shall alter the method and/or equipment as necessary to comply with this specification.

#### 5.4 Layout

The layout of the prefabricated wick drains locations/pattern shall be staked by the Contractor. The location of the drains shall not vary by more than 150 mm from the locations indicated on the Contract Drawings.

#### 5.5 Plumbness

Wick drains shall be installed vertically, within a tolerance of not more than 10 mm per 500 mm. The equipment shall be carefully checked for plumbness and the Contractor shall provide the Contract Administrator with a suitable means of verifying the plumbness of the mandrel and of determining the depth of the drain at any time.

#### 5.6 Splices

Splices or connections in the wick drain material shall be done in a manner that ensures continuity and avoids any reduction of the flow characteristics of the wick material. Splices shall overlap by a minimum length of 150 mm.

#### 5.7 Cut-off

The wick drain shall be cut above the ground surface such that at least a 150 mm length protrudes above the top of the granular blanket at each wick drain location.

#### 5.8 Tip Elevation

The wick drains shall be installed to the elevations as summarized in Table 2.

#### 5.9 Obstructions

Where obstructions are encountered below the working surface that cannot be penetrated by the wick drain installation equipment, the Contractor shall complete the wick drain from the elevation of the obstruction to the working surface and notify the Contract Administrator. At the direction of the Contract Administrator, the Contractor shall attempt to install a new drain within a 500 mm radius of the obstructed drain. A maximum of two (2) attempts shall be made as directed by the Contract Administrator. The Contractor will be compensated for each obstructed wick drain unless the wick

drain is improperly completed, in which case no compensation will be allowed.

5.10 Pre-augering

It may be necessary to pre-auger through the native soils and the drainage blanket at some locations to facilitate the installation of the prefabricated wick drain. Pre-augering shall not extend more than 1 m into the cohesive soils at the site. Any additional cost for preaugering shall be incorporated into the unit price.

5.11 Rejected Drains

Wick drains that are installed beyond the plan location by more than 150 mm, or that are damaged or are not installed in accordance with this specification shall be rejected. Rejected wick drains may be removed at the Contractor's own expense and time. The Contractor shall not be compensated for the materials and work associated with rejected wick drains.

Replacement wick drains shall be installed within a 500 mm radius from the location of the rejected drain as directed by the Contract Administrator.

5.12 Geotechnical Instrumentation

Installation of the wick drains should be coordinated with the placement of geotechnical instrumentation as shown on the Contract Drawings. Special care shall be taken to install wick drains in such a manner so as not to disturb instrumentation already in place. The replacement of instrumentation damaged as a result of the Contractor's activities will be the responsibility of the Contractor.

**6.0 PAYMENT**

6.1 Measurement for Payment

Measurement of the item "WICK DRAINS", as may be revised by Adjusted Plan Quantity shall be by the linear metre for all accepted drains installed including the 150 mm length, protruding above the ground surface. Properly completed obstructed wick drains and properly installed replacement wick drains and accepted trial wick drains will be measured for payment.

6.2 Basis of Payment

Item – Wick Drains

Payment at the Contract unit price per linear metre for the above item shall be full compensation for all labour, materials and equipment to complete the work in accordance with the Plans and Specifications.

No payment shall be made for unacceptable wick drains or delays or expenses incurred by the Contractor as a result of improper or unacceptable material or installation.

**Table 1 – Wick Drain Material Specification**

| Property                     | Test Method | Units             | Specification                      |
|------------------------------|-------------|-------------------|------------------------------------|
| <b>Physical</b>              |             |                   |                                    |
| Drain Body Material          | --          | --                | Polypropylene – Studded or Grooved |
| Filter Material              | --          | --                | Polypropylene – Non Woven          |
| Width                        | --          | mm                | ≥ 100                              |
| Core Thickness               | ASTM D-5199 | mm                | ≥ 2                                |
| Composite Thickness          | ASTM D-5199 | mm                | ≥ 3                                |
| Mass of Core                 | ASTM D-3776 | g/m               | ≥ 40                               |
| Mass of Filter               | ASTM D-5261 | g/m <sup>2</sup>  | ≥ 130                              |
| <b>Mechanical</b>            |             |                   |                                    |
| Tensile Strength Core        | ASTM D-638  | N                 | ≥ 800                              |
| Grab Tensile Strength Filter | ASTM D-4632 | N                 | ≥ 600                              |
| Puncture Strength            | ASTM D-4533 | N                 | ≥ 200                              |
| Filter Trapezoidal Tear      | ASTM D-4833 | N                 | ≥ 200                              |
| Apparent Opening Size (AOS)  | ASTM D-4751 | µm                | ≥ 40                               |
| Discharge Capacity @ 10 kPa  | ASTM D-4716 | m <sup>3</sup> /s | ≥ 1.2 x 10 <sup>-4</sup>           |
| Discharge Capacity @ 240 kPa | ASTM D-4716 | m <sup>3</sup> /s | ≥ 1.0 x 10 <sup>-4</sup>           |
| Permittivity                 | ASTM D-4491 | sec <sup>-1</sup> | ≥ 0.25                             |



**Table 2 – Tip Elevations for Wick Drain Installations**

| <b>Anticipated Tip Elevations<sup>1</sup> (m)</b> |                           |                             |                              |                             |                           |
|---|---------------------------|-----------------------------|------------------------------|-----------------------------|---------------------------|
| <b>Station</b>                                    | <b>SBL –<br/>West Toe</b> | <b>SBL –<br/>Centreline</b> | <b>Median<br/>Centreline</b> | <b>NBL –<br/>Centreline</b> | <b>NBL – East<br/>Toe</b> |
| <i>Swamp 302 – STA 17+750 to 18+125</i>           |                           |                             |                              |                             |                           |
| 17+750  | 184.2                     | 181.6                       | 175.9                        | 178.0                       | 179.3                     |
| 17+760  | 183.2                     | 180.7                       | 175.9                        | 177.6                       | 178.8                     |
| 17+770  | 182.3                     | 179.7                       | 176.0                        | 177.2                       | 178.3                     |
| 17+780  | 181.3                     | 178.8                       | 176.0                        | 176.9                       | 177.7                     |
| 17+790  | 180.4                     | 177.8                       | 176.1                        | 176.5                       | 177.2                     |
| 17+800  | 179.5                     | 176.9                       | 176.2                        | 176.1                       | 176.7                     |
| 17+810  | 178.5                     | 176.5                       | 176.2                        | 176.0                       | 176.2                     |
| 17+820  | 177.1                     | 176.1                       | 176.3                        | 175.9                       | 175.2                     |
| 17+830  | 177.1                     | 175.8                       | 176.3                        | 175.8                       | 175.6                     |
| 17+840  | 177.2                     | 175.4                       | 176.3                        | 175.7                       | 175.9                     |
| 17+850  | 177.3                     | 175.0                       | 176.3                        | 175.6                       | 176.3                     |
| 17+860  | 177.4                     | 175.3                       | 176.3                        | 175.8                       | 176.7                     |
| 17+870  | 177.5                     | 175.7                       | 176.3                        | 176.0                       | 177.0                     |
| 17+880  | 177.4                     | 176.0                       | 176.4                        | 176.3                       | 177.4                     |
| 17+890  | 177.3                     | 176.4                       | 176.5                        | 176.5                       | 177.9                     |
| 17+900  | 177.2                     | 176.7                       | 176.7                        | 176.7                       | 178.3                     |
| 17+910  | 177.1                     | 176.9                       | 176.9                        | 177.3                       | 178.7                     |
| 17+920  | 177.0                     | 177.2                       | 177.0                        | 177.9                       | 179.2                     |
| 17+930  | 177.0                     | 177.4                       | 177.4                        | 178.5                       | 179.5                     |
| 17+940  | 177.2                     | 177.7                       | 177.9                        | 179.1                       | 179.6                     |
| 17+950  | 177.5                     | 177.9                       | 178.4                        | 179.7                       | 179.7                     |
| 17+960  | 177.7                     | 178.0                       | 178.9                        | 179.4                       | 179.8                     |
| 17+970  | 177.9                     | 178.0                       | 179.4                        | 179.1                       | 179.9                     |
| 17+980  | 177.9                     | 178.1                       | 179.6                        | 178.8                       | 180.0                     |
| 17+990  | 177.6                     | 178.1                       | 179.3                        | 178.5                       | 179.9                     |
| 18+000  | 177.4                     | 178.2                       | 179.0                        | 178.2                       | 179.9                     |
| 18+010  | 177.1                     | 178.2                       | 178.7                        | 178.3                       | 179.8                     |
| 18+020  | 176.8                     | 178.2                       | 178.4                        | 178.3                       | 179.7                     |
| 18+030  | 177.0                     | 178.2                       | 178.2                        | 178.4                       | 179.6                     |
| 18+040  | 177.7                     | 178.2                       | 178.3                        | 178.4                       | 179.3                     |
| 18+050  | 178.4                     | 178.2                       | 178.4                        | 178.5                       | 179.0                     |
| 18+060  | 179.0                     | 178.5                       | 178.5                        | 178.6                       | 178.7                     |
| 18+070  | 179.7                     | 178.8                       | 178.6                        | 178.6                       | 178.4                     |
| 18+080  | 180.0                     | 179.0                       | 178.7                        | 178.7                       | 178.1                     |
| 18+090  | 179.9                     | 179.3                       | 178.8                        | 178.7                       | 177.8                     |

| Anticipated Tip Elevations <sup>1</sup> (m) |                |                  |                   |                  |                |
|---|----------------|------------------|-------------------|------------------|----------------|
| Station                                     | SBL – West Toe | SBL – Centreline | Median Centreline | NBL – Centreline | NBL – East Toe |
| 18+100                                      | 179.9          | 179.6            | 178.9             | 178.8            | 177.5          |
| 18+110                                      | 179.8          | 179.9            | 179.0             | N/R              | N/R            |
| 18+120                                      | 179.7          | 180.2            | 179.1             | N/R              | N/R            |
| 18+125                                      | 179.7          | 180.3            | 179.1             | N/R              | N/R            |
| <b>Swamp 305 – STA 16+075 to 16+325</b>     |                |                  |                   |                  |                |
| 16+075                                      | N/R            | N/R              | N/R               | N/A              | N/A            |
| 16+080                                      | N/R            | N/R              | N/R               | N/A              | N/A            |
| 16+090                                      | N/R            | N/R              | N/R               | N/A              | N/A            |
| 16+100                                      | N/R            | N/R              | N/R               | N/A              | N/A            |
| 16+110                                      | N/R            | 177.1            | 168.5             | N/A              | N/A            |
| 16+120                                      | 177.8          | 173.4            | 166.9             | N/A              | N/A            |
| 16+130                                      | 175.7          | 169.6            | 165.7             | N/A              | N/A            |
| 16+140                                      | 173.0          | 165.9            | 164.9             | N/A              | N/A            |
| 16+150                                      | 170.3          | 162.2            | 164.2             | N/A              | N/A            |
| 16+160                                      | 167.5          | 162.1            | 163.4             | N/A              | N/A            |
| 16+170                                      | 164.8          | 161.9            | 162.6             | N/A              | N/A            |
| 16+180                                      | 163.4          | 161.8            | 162.9             | N/A              | N/A            |
| 16+190                                      | 163.3          | 161.6            | 164.4             | N/A              | N/A            |
| 16+200                                      | 163.1          | 161.5            | 165.9             | N/A              | N/A            |
| 16+210                                      | 162.9          | 162.5            | 167.4             | N/A              | N/A            |
| 16+220                                      | 162.8          | 163.5            | 168.9             | N/A              | N/A            |
| 16+230                                      | 163.0          | 164.4            | 170.3             | N/A              | N/A            |
| 16+240                                      | 163.6          | 165.4            | 171.8             | N/A              | N/A            |
| 16+250                                      | 164.3          | 166.4            | 173.3             | N/A              | N/A            |
| 16+260                                      | 164.9          | 167.9            | 174.8             | N/A              | N/A            |
| 16+270                                      | 165.5          | 169.4            | 176.3             | N/A              | N/A            |
| 16+280                                      | 166.1          | 171.0            | 177.7             | N/A              | N/A            |
| 16+290                                      | 166.7          | 172.5            | 179.2             | N/A              | N/A            |
| 16+300                                      | 167.4          | 174.0            | 180.7             | N/A              | N/A            |
| 16+310                                      | 168.0          | 175.5            | 182.2             | N/A              | N/A            |
| 16+320                                      | 168.6          | 177.0            | 183.7             | N/A              | N/A            |
| 16+325                                      | 168.9          | 177.8            | 184.4             | N/A              | N/A            |
| <b>Swamp 306 – STA 15+360 to 15+750</b>     |                |                  |                   |                  |                |
| 15+360                                      | 189.1          | 180.9            | 176.2             | N/A              | N/A            |
| 15+370                                      | 189.1          | 180.4            | 176.1             | N/A              | N/A            |
| 15+380                                      | 188.7          | 180.0            | 176.1             | N/A              | N/A            |
| 15+390                                      | 187.8          | 179.5            | 176.0             | N/A              | N/A            |
| 15+400                                      | 186.9          | 179.0            | 175.9             | N/A              | N/A            |

| Anticipated Tip Elevations <sup>1</sup> (m) |                   |                     |                      |                     |                   |
|---|-------------------|---------------------|----------------------|---------------------|-------------------|
| Station                                     | SBL –<br>West Toe | SBL –<br>Centreline | Median<br>Centreline | NBL –<br>Centreline | NBL – East<br>Toe |
| 15+410                                      | 186.0             | 178.5               | 175.8                | N/A                 | N/A               |
| 15+420                                      | 185.1             | 178.0               | 175.7                | N/A                 | N/A               |
| 15+430                                      | 184.0             | 177.6               | 175.7                | N/A                 | N/A               |
| 15+440                                      | 182.7             | 177.1               | 175.6                | N/A                 | N/A               |
| 15+450                                      | 181.4             | 176.6               | 175.5                | N/A                 | N/A               |
| 15+460                                      | 180.1             | 176.5               | 175.4                | N/A                 | N/A               |
| 15+470                                      | 178.8             | 176.5               | 175.3                | N/A                 | N/A               |
| 15+480                                      | 177.7             | 176.4               | 175.2                | N/A                 | N/A               |
| 15+490                                      | 176.7             | 176.4               | 175.1                | N/A                 | N/A               |
| 15+500                                      | 175.7             | 176.3               | 175.0                | N/A                 | N/A               |
| 15+510                                      | 174.7             | 176.0               | 174.9                | N/A                 | N/A               |
| 15+520                                      | 173.7             | 175.7               | 174.8                | N/A                 | N/A               |
| 15+530                                      | 173.6             | 175.5               | 173.8                | N/A                 | N/A               |
| 15+540                                      | 174.4             | 175.2               | 175.1                | N/A                 | N/A               |
| 15+550                                      | 175.2             | 174.9               | 176.4                | N/A                 | N/A               |
| 15+560                                      | 176.0             | 175.9               | 177.7                | N/A                 | N/A               |
| 15+570                                      | 176.8             | 176.9               | 179.0                | N/A                 | N/A               |
| 15+580                                      | 178.0             | 177.8               | 179.6                | N/A                 | N/A               |
| 15+590                                      | 179.5             | 178.8               | 179.5                | N/A                 | N/A               |
| 15+600                                      | 181.1             | 179.8               | 179.4                | N/A                 | N/A               |
| 15+610                                      | 182.6             | 179.9               | 179.3                | N/A                 | N/A               |
| 15+620                                      | 184.1             | 180.1               | 179.2                | N/A                 | N/A               |
| 15+630                                      | 184.7             | 180.2               | 179.2                | N/A                 | N/A               |
| 15+640                                      | 184.4             | 180.4               | 179.5                | N/A                 | N/A               |
| 15+650                                      | 184.1             | 180.5               | 179.8                | N/A                 | N/A               |
| 15+660                                      | 183.7             | 180.7               | 180.0                | N/A                 | N/A               |
| 15+670                                      | 183.4             | 181.0               | 180.3                | N/A                 | N/A               |
| 15+680                                      | 183.3             | 181.2               | 180.4                | N/A                 | N/A               |
| 15+690                                      | 183.4             | 181.5               | 180.3                | N/A                 | N/A               |
| 15+700                                      | 183.5             | 181.7               | 180.2                | N/A                 | N/A               |
| 15+710                                      | 183.6             | 182.2               | 180.1                | N/A                 | N/A               |
| 15+720                                      | 183.7             | 182.7               | 180.0                | N/A                 | N/A               |
| 15+730                                      | 183.9             | 183.1               | 180.0                | N/A                 | N/A               |
| 15+740                                      | 184.0             | 183.6               | 179.9                | N/A                 | N/A               |
| 15+750                                      | 184.1             | 184.1               | 179.8                | N/A                 | N/A               |
| <b>Swamp 307 – STA 14+425 to 14+490</b>     |                   |                     |                      |                     |                   |
| 14+425                                      | 186.3             | 187.8               | 183.2                | N/A                 | N/A               |
| 14+430                                      | 186.3             | 185.9               | 183.2                | N/A                 | N/A               |

| <b>Anticipated Tip Elevations<sup>1</sup> (m)</b> |                       |                         |                          |                         |                       |
|---|-----------------------|-------------------------|--------------------------|-------------------------|-----------------------|
| <b>Station</b>                                    | <b>SBL – West Toe</b> | <b>SBL – Centreline</b> | <b>Median Centreline</b> | <b>NBL – Centreline</b> | <b>NBL – East Toe</b> |
| 14+435  | 186.3                 | 184.0                   | 183.2                    | N/A                     | N/A                   |
| 14+440  | 184.8                 | 182.1                   | 182.5                    | N/A                     | N/A                   |
| 14+445  | 182.4                 | 180.2                   | 181.4                    | N/A                     | N/A                   |
| 14+450  | 180.0                 | 178.3                   | 180.2                    | N/A                     | N/A                   |
| 14+455  | 181.1                 | 178.5                   | 180.1                    | N/A                     | N/A                   |
| 14+460  | 182.3                 | 178.8                   | 179.9                    | N/A                     | N/A                   |
| 14+465  | 183.8                 | 179.0                   | 179.8                    | N/A                     | N/A                   |
| 14+470  | 185.7                 | 179.3                   | 179.6                    | N/A                     | N/A                   |
| 14+475  | 187.5                 | 179.5                   | 179.5                    | N/A                     | N/A                   |
| 14+480  | 189.4                 | 179.2                   | 179.2                    | N/A                     | N/A                   |
| 14+485  | 191.3                 | 178.9                   | 178.9                    | N/A                     | N/A                   |
| 14+490  | 193.1                 | 178.6                   | 178.6                    | N/A                     | N/A                   |

Notes: 1. The anticipated termination elevations have been interpreted from the available borehole information assuming the wick drains will either terminate at either the top of bedrock or penetrate about 1 m into the cohesionless deposit underlying the compressible cohesive deposit. The wick drain tip elevations between and beyond the borehole locations were estimated by interpolation and extrapolation of the available data, respectively, and as such, the actual tip elevations may vary during wick drain installation. The lateral extent of the wick drain installation should be at least two (2) times the wick drain spacing beyond the proposed embankment toe.

N/A Wick drain installation is not applicable to the NBL embankment.

N/R Wick drain installation is not required at this location.

**SUPPLY AND INSTALLATION OF EMBANKMENT MONITORING EQUIPMENT –**  
**Item No.**

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Non-Standard Special Provision

---

**1.0 GENERAL**

1.0.1 Scope

This non-standard special provision contains the requirements for the supply and installation of the following geotechnical instruments:

- Survey Benchmarks (BM);
- Settlement Plates (SP);
- Vibrating Wire Piezometers (VWP);
- Standpipe Piezometers (SPP);
- Settlement Pins (S); and,
- Nail Pins (NP).

1.0.2 Purpose

The purpose of these instruments is to monitor settlements and pore water pressures in the foundation soils during construction of Highway 69 embankments over the following swamps:

- Highway 69 SBL – STA 17+750 to 18+125 (Swamp 302 SBL)
- Highway 69 NBL – STA 17+750 to 18+100 (Swamp 302 NBL)
- Highway 69 SBL – STA 16+075 to 16+325 (Swamp 305 SBL)
- Highway 69 SBL – STA 15+360 to 15+750 (Swamp 306 SBL)
- Highway 69 SBL – STA 14+425 to 14+490 (Swamp 307 SBL)

The rate of fill placement and the timing for the removal of surcharge at temporary culvert locations shall be controlled by the instrumentation readings.

1.0.3 Personnel

The Contractor shall retain a Geotechnical Consultant with MTO classification of Geotechnical (Structures and Embankments) – High Complexity, to undertake the supply and installation of geotechnical instruments.

The Contractor shall be understood to refer to the Contractor and their Geotechnical Consultant.

1.0.4 Or Equal

The term, “or equal” shall be understood to indicate that the equal product is the same or better than the specified product in function, performance, reliability, quality and general

configuration. Only one supplier should be selected for the supply of the data acquisition system and vibrating wire piezometers.

#### 1.0.5 Notification

The Contract Administrator shall be notified a minimum of 15 working days in advance of commencing the installation of instruments.

#### 1.0.6 Submission Requirements

The Contractor shall submit details of the proposed installation methods including locations and types of the data acquisition system, monitoring enclosure, survey benchmarks and installation schedule, to the Contract Administrator, a minimum of 15 working days before the start of instrument installation.

#### 1.0.7 Drawings

Reference shall be made to the following drawings that are contained elsewhere in the Contract:

- Monitoring Section Location Plans;
- Embankment Monitoring Program Plan and Section Types A, B and C;
- and,
- Typical Instrument Installation Details.

#### 1.0.8 Subsurface Conditions

The subsurface conditions at the site are described in Foundation Investigation Reports as specified elsewhere in the Contract Documents.

#### 1.0.9 Equipment Operation and Weather Conditions

All installation and monitoring equipment and associated materials shall be capable of withstanding the range of temperatures possible for their location within the ground or on the surface. The instruments shall be capable of operating within the manufacturer's stated accuracy throughout the temperature range. Monitoring shall be conducted year round.

### **1.1 INSTALLATION**

The quantity and location of instruments are presented in Table 1A and shown on the Contract Drawings.

**Table 1A – Instrument Quantities and Locations**

| Monitoring Section    |                |             | Quantities |            |            |           |           |
|-----------------------|----------------|-------------|------------|------------|------------|-----------|-----------|
| <i>Swamp Crossing</i> | <i>Station</i> | <i>Type</i> | <i>SP</i>  | <i>VWP</i> | <i>SPP</i> | <i>S</i>  | <i>NP</i> |
| Swamp 302<br>SBL      | 17+800         | C           | 4          | 2          | 0          | 3         | 2         |
|                       | 17+920         | A           | 2          | 4          | 1          | 3         | 0         |
|                       | 17+985         | B           | 2          | 2          | 0          | 3         | 0         |
|                       | 18+050         | A           | 2          | 4          | 1          | 3         | 0         |
| Swamp 302<br>NBL      | 17+800         | C           | 4          | 2          | 0          | 3         | 2         |
|                       | 17+850         | A           | 2          | 4          | 1          | 3         | 0         |
|                       | 17+915         | B           | 2          | 2          | 0          | 3         | 0         |
|                       | 17+980         | B           | 2          | 2          | 0          | 3         | 0         |
|                       | 18+050         | A           | 2          | 4          | 1          | 3         | 0         |
| Swamp 305<br>SBL      | 16+140         | B           | 2          | 2          | 0          | 3         | 0         |
|                       | 16+200         | A           | 2          | 4          | 1          | 3         | 0         |
|                       | 16+232         | C           | 4          | 2          | 0          | 3         | 2         |
|                       | 16+293         | C           | 4          | 2          | 0          | 3         | 2         |
| Swamp 306<br>SBL      | 15+400         | A           | 2          | 4          | 1          | 3         | 0         |
|                       | 15+450         | B           | 2          | 2          | 0          | 3         | 0         |
|                       | 15+500         | B           | 2          | 2          | 0          | 3         | 0         |
|                       | 15+550         | A           | 2          | 4          | 1          | 3         | 0         |
|                       | 15+600         | B           | 2          | 2          | 0          | 3         | 0         |
|                       | 15+654         | C           | 4          | 2          | 0          | 3         | 2         |
| Swamp 307<br>SBL      | 14+460         | A           | 2          | 4          | 1          | 3         | 0         |
| <b>TOTAL</b>          |                |             | <b>50</b>  | <b>56</b>  | <b>8</b>   | <b>60</b> | <b>10</b> |

1.1.1 Instrument Location

Prior to the installation of instruments, the Contractor shall accurately survey and stake the location of each instrument and obtain a ground elevation at each instrument location.

1.1.2 Survey Benchmarks (BM)

The Contractor shall provide a minimum of two (2) non-yielding deep seated survey Benchmarks in each swamp crossing, as specified below, and shall establish the geodetic elevation of each such Benchmark.

The number and locations of bench marks shall be such that direct sighting is possible from all geotechnical instruments to at least one (1) Benchmark.

1.1.3 Accuracy of Surveying for Elevations

Elevations shall be surveyed to an accuracy of  $\pm 2$  mm or better.

#### 1.1.4 Materials and Equipment

The Contractor shall supply all materials and equipment required for the installation of instrumentation unless otherwise noted.

#### 1.1.5 Underground Utilities/Wick Drains

The Contractor shall be responsible for locating and protecting all underground utilities and existing wick drains prior to drilling boreholes for installing instruments. Any damage to underground utilities and/or existing wick drains caused by the Contractor's work shall be repaired by the Contractor at no cost to the Owner or Contract Administrator.

#### 1.1.6 Marking and Labelling

The location of any above-ground monitoring fixture shall be made clearly visible to nearby traffic before, during and after embankment construction. Marking shall be of sufficient size to be visible from a reversing vehicle and after heavy snow falls.

Instruments and their data cables shall be clearly labelled in the field, each instrument having a unique identifier. The labelling shall remain legible for at least 3 years.

#### 1.1.7 Protection of Instruments

The Contractor shall adequately protect all instruments such that they are not damaged during construction. Any instrument damaged by the Contractor's work shall be immediately replaced at no cost to the Owner or Contract Administrator.

#### 1.1.8 Boreholes

The Contractor shall make a basic stratigraphic log of boreholes as they are being drilled. In situ or laboratory testing is not required.

Boreholes shall be advanced using conventional drilling methods and shall be as straight and vertical as practical.

#### 1.1.9 Installation Program

Instrument installation shall commence immediately after wick drain installation and before any embankment construction. Table 1B gives a summary of the installation schedule requirements.

**Table 1B – Installation Program**

| Type | Start of Installation         | Completion of Installation               |
|------|-------------------------------|--|
| SP   | After wick drain installation | At completion of embankment construction |
| VWP  | After wick drain installation | Before embankment construction           |



|     |   |  |
|-----|---|--|
| SPP | After wick drain installation           | Before embankment construction           |
| S   | After Placement of Surcharge            | At completion of embankment construction |
| NP  | After Construction of Temporary Culvert | Before embankment construction           |

## 2.0 SURVEY BENCHMARKS (BM) – SUPPLY AND INSTALLATION

### 2.1 GENERAL

#### 2.1.1 Scope

This Section contains the requirements for the supply and installation of Benchmarks (BM).

The purpose of the benchmarks is to provide non-settling references for the surveying of the Settlement Plates (SP).

#### 2.1.2 General Procedure

The Benchmarks shall be installed prior to embankment construction. The Benchmark shall consist of a steel rod anchored to the bottom of a borehole.

#### 2.1.3 Number and Location

The minimum number and approximate locations of the Benchmarks are shown on the Contract Drawings and are given in Table 2. The number and locations of Benchmarks shall be adjusted in the field such that direct sighting is possible from all Settlement Plates to at least one Benchmark.

**Table 2 – Benchmark Locations**

| Swamp Crossing       | Station | Offset <sup>1</sup> | Approximate Elevation of the Bottom of Rod Anchor <sup>2</sup><br>(m) | Estimated Length of Steel Rod including 1 m Stickup <sup>2</sup><br>(m) |
|----------------------|---------|---------------------|---|---|
| Swamp 302<br>SBL/NBL | 17+735  | 62.0 m Lt           | 185.0   | 5 m   |
|                      | 18+145  | 50.0 m Lt           | On Bedrock  | Less than 5 m<br>(Est.)   |
| Swamp 305 SBL        | 16+130  | 63.0 m Lt           | On Bedrock  | Less than 5 m<br>(Est.)   |
|                      | 16+310  | 74.0 m Lt           | On Bedrock  | Less than 5 m<br>(Est.)   |

|               |        |           |            |                      |
|---------------|--------|-----------|------------|----------------------|
| Swamp 306 SBL | 15+355 | 67.0 m Lt | On Bedrock | Less than 5 m (Est.) |
|               | 15+655 | 75.0 m Lt | 187.2      | 6 m                  |
| Swamp 307 SBL | 14+420 | 72.0 m Lt | 185.3      | 9 m                  |
|               | 14+485 | 65.0 m Lt | On Bedrock | Less than 5 m (Est.) |

NOTE: 1. Offset from median centreline.  
2. The rod anchor elevations shown are approximate and should be adjusted in the field so that the rod anchor is installed a minimum of 2 m into the bedrock.

## 2.2 MATERIALS

### 2.2.1 General

The Contractor shall supply all materials and equipment required for the installation of the Benchmarks.

### 2.2.2 Rod

The Contractor shall supply a steel pipe Schedule 40 with an outside diameter not less than 25.4 mm, supplied in lengths as required to complete the installation as described in Section 2.3.

The top end of each length of rod shall be threaded to receive a cap. A rounded cap shall be installed at the top of the rod in such a way that a single survey point can be clearly identified and returned to.

### 2.2.3 Sand

The Contractor shall supply clean, washed sand. The sand shall be Sakcrete washed general-purpose sand – or equal.

### 2.2.4 Grout

The Contractor shall supply cement-bentonite grout. A suitable grout mix design consists of 23 kg of bentonite (OPSS 1205), 143 litres of water and 40 kg of cement (Type GU – OPSS 1301).

### 2.2.5 Rod Anchor Grout

The Contractor shall supply cement-bentonite grout. A suitable grout mix design consists of 14 kg of bentonite (OPSS 1205), 49 litres of water and 40 kg of cement (Type GU – OPSS 1301).

### 2.2.6 Friction Reducing Sleeve

The Contractor shall supply a friction reducing sleeve consisting of Schedule 40 – 50.8 mm (2") O.D. PVC pipe cut perpendicular to the axis of the pipe.

## **2.3 INSTALLATION**

### **2.3.2 General**

The Contractor shall install Benchmarks as shown on the Contract Drawings and in accordance with the information below.

### **2.3.2 Borehole Installation**

The borehole shall be advanced to the rod anchor elevations provided in Table 2 using suitable drilling techniques. The diameter of the borehole shall be sufficient to fit the rod, friction reducing sleeve and rod anchor. The sides of the borehole shall be stable and the borehole shall be free of drilling mud and debris.

### **2.3.3 Rod**

The coupling of the rods shall be such that all sections have the same axis and no separation or contraction will occur at the couplings.

### **2.3.4 Rod Anchor**

The rod shall be installed vertically in the borehole with its bottom end resting at the bottom of the borehole. The bottom portion of the rod shall be fixed against the surrounding native soil by grouting the bottom 0.5 m of the borehole to form a concrete/soil anchor.

Once grouting is completed and the rod anchor grout has set, the contractor shall pour clean sand in the lower 0.5 m length of the borehole above the concrete/soil anchor to create a base for the end of the friction reducing sleeve to rest on.

The elevation of the bottom of the rod anchor shall be determined by measuring the length of the rod to the ground surface elevation.

### **2.3.5 Friction Reducing Sleeve**

The friction reducing sleeve shall be over the entire length of the rod above the rod anchor and sand.

### **2.3.6 Installation Details**

The elevation, easting and northing of the top of the Benchmark rod shall be surveyed.

## **2.4 COORDINATION WITH MONITORING**

### **2.4.2 Notification**

The Contractor shall notify the Contract Administrator no later than three (3) working days after installing a benchmark. At this time the Contractor shall also supply the following information to the Contract Administrator.

- BM Northings and Eastings in MTM NAD 83 coordinates;
- Elevation of the rod anchor and top of rod in Geodetic datum;
- Dates of installation;
- Stratigraphic log of subsurface conditions at the BMs, including drilling method notes;
- Installation notes / sketches; and,
- Description of BM, sleeve and rod anchor.

#### 2.4.3 Monitoring

Monitoring of settlements with reference to the Benchmarks shall be done by others. Monitoring shall be conducted during the embankment construction. The Contractor shall provide installation information as specified above and provide access to the Benchmarks for monitoring including, but not limited, to snow clearing in the winter. The Contractor shall provide electric power and general area lighting as needed.

### 2.5 **REPORTING**

The Contractor shall record and report relevant installation details to the Contract Administrator. These include, but are not limited to:

- BM Northings and Eastings in MTM NAD 83 coordinates;
- Elevation of the rod anchor and top of rod in Geodetic datum;
- Dates of installation;
- Stratigraphic log of subsurface conditions at the benchmarks, including drilling method notes;
- Installation notes / sketches; and,
- Description of BM, sleeve and rod anchor.

### 3.0 SETTLEMENT PLATES (SP) – SUPPLY AND INSTALLATION

#### 3.1 GENERAL

##### 3.1.1 Scope

This section contains the requirements for the supply and installation of Settlement Plates (SP).

The purpose of the Settlement Plates is to monitor settlements of the embankment base. The settlement readings shall help to establish the timing for the removal of the surcharge. Settlement is measured by survey of the top of the rod with reference to stable, non-settling Benchmarks.

##### 3.1.2 General Procedure

The Settlement Plates shall be attached to a plate at the ground surface (i.e. top of the sand blanket). As embankment construction proceeds the rods shall be extended above the new top of embankment.

Sleeves around the rods shall be installed to reduce friction and allow uninhibited movement of the rod with the plate.

A protective surround shall be extended with the rods as embankment construction proceeds.

##### 3.1.3 Location

The locations of the settlement plates are shown on the Contract Drawings and are given in Table 3.

**Table 3 – Settlement Plates Locations**

| Swamp Crossing | Monitoring Section Type | Station | Offset <sup>1</sup> | Approximate Elevation of Existing Ground Surface (m) | Estimated Thickness of Embankment <sup>2</sup> (m) |
|----------------|-------------------------|---------|---------------------|--|--|
| Swamp 302 SBL  | C                       | 17+800  | 11.5 m Lt           | 189.0  | 1.75   |
|                | C                       | 17+800  | 3 m Lt              | 189.0  | 3.5  |
|                | C                       | 17+800  | 3 m Rt              | 189.0  | 3.5  |
|                | C                       | 17+800  | 11.5 m Rt           | 189.0  | 1.75   |
|                | A                       | 17+920  | 3 m Lt              | 186.5  | 5.0  |
|                | A                       | 17+920  | 3 m Rt              | 186.5  | 5.0  |
|                | B                       | 17+985  | 3 m Lt              | 186.5  | 5.0  |
|                | B                       | 17+985  | 3 m Rt              | 186.5  | 5.0  |
|                | A                       | 18+050  | 3 m Lt              | 186.5  | 4.0  |

|                  |                |          |           |       |      |
|------------------|----------------|----------|-----------|-------|------|
|                  | A              | 18+050   | 3 m Rt    | 186.5 | 4.0  |
| Swamp 302<br>NBL | C              | 17+800   | 12.5 m Lt | 188.0 | 2.25 |
|                  | C              | 17+800   | 3 m Lt    | 188.0 | 4.5  |
|                  | C              | 17+800   | 3 m Rt    | 188.0 | 4.5  |
|                  | C              | 17+800   | 12.5 m Rt | 188.0 | 2.25 |
|                  | A              | 17+850   | 3 m Lt    | 186.5 | 4.5  |
|                  | A              | 17+850   | 3 m Rt    | 186.5 | 4.5  |
|                  | B              | 17+915   | 3 m Lt    | 186.5 | 5.0  |
|                  | B              | 17+915   | 3 m Rt    | 186.5 | 5.0  |
|                  | B              | 17+980   | 3 m Lt    | 186.5 | 4.5  |
|                  | B              | 17+980   | 3 m Rt    | 186.5 | 4.5  |
|                  | A              | 18+050   | 3 m Lt    | 186.5 | 4.0  |
|                  | A              | 18+050   | 3 m Rt    | 186.5 | 4.0  |
|                  |                |          |           |       |      |
| Swamp 305<br>SBL | B              | 16+140   | 3 m Lt    | 186.9 | 3.0  |
|                  | B              | 16+140   | 3 m Rt    | 186.9 | 3.0  |
|                  | A              | 16+200   | 3 m Lt    | 187.2 | 3.0  |
|                  | A              | 16+200   | 3 m Rt    | 187.2 | 3.0  |
|                  | C              | 16+232   | 11.5 m Lt | 186.9 | 1.75 |
|                  | C              | 16+232   | 3 m Lt    | 186.9 | 3.5  |
|                  | C              | 16+232   | 3 m Rt    | 186.9 | 3.5  |
|                  | C              | 16+232   | 11.5 m Rt | 186.9 | 1.75 |
|                  | C <sup>3</sup> | 16+286.5 | 11.5 m Rt | 187.5 | 1.75 |
|                  | C <sup>3</sup> | 16+289.5 | 3 m Rt    | 187.5 | 3.5  |
|                  | C <sup>3</sup> | 16+294.5 | 3 m Lt    | 187.5 | 3.5  |
|                  | C <sup>3</sup> | 16+297.5 | 11.5 m Lt | 187.5 | 1.75 |
|                  |                |          |           |       |      |
| Swamp 306<br>SBL | A              | 15+400   | 3 m Lt    | 189.1 | 3.0  |
|                  | A              | 15+400   | 3 m Rt    | 189.1 | 3.0  |
|                  | B              | 15+450   | 3 m Lt    | 189.5 | 3.0  |
|                  | B              | 15+450   | 3 m Rt    | 189.5 | 3.0  |
|                  | B              | 15+500   | 3 m Lt    | 189.2 | 2.5  |
|                  | B              | 15+500   | 3 m Rt    | 189.2 | 2.5  |
|                  | A              | 15+550   | 3 m Lt    | 189.2 | 2.0  |
|                  | A              | 15+550   | 3 m Rt    | 189.2 | 2.0  |
|                  | B              | 15+600   | 3 m Lt    | 189.5 | 1.5  |
|                  | B              | 15+600   | 3 m Rt    | 189.5 | 1.5  |
|                  | C <sup>4</sup> | 15+648.5 | 10.5 m Rt | 189.1 | 1.0  |
|                  | C <sup>4</sup> | 15+651.5 | 3 m Rt    | 189.1 | 2.0  |
|                  | C <sup>4</sup> | 15+656.5 | 3 m Lt    | 189.1 | 2.0  |
|                  | C <sup>4</sup> | 15+659.5 | 10.5 m Lt | 189.1 | 1.0  |
|                  |                |          |           |       |      |
| Swamp 307<br>SBL | A              | 14+460   | 3 m Lt    | 192.3 | 3.0  |
|                  | A              | 14+460   | 3 m Rt    | 192.3 | 3.0  |

NOTE: 1. Offset from centreline of specified lane.

2. Embankment thickness does not include surcharge.
3. Culvert at centreline of roadway embankment at STA 16+293.
4. Culvert at centreline of roadway embankment at STA 15+654.

## **3.2 MATERIALS**

### **3.2.1 General**

The Contractor shall supply all materials and equipment required for the installation of the Settlement Plates (SP).

### **3.2.2 Plate**

The Contractor shall supply a steel plate with thickness of at least 6.35 mm. The plate shall be at least 0.5 m wide by 0.5 m long.

### **3.2.3 Rod**

The Contractor shall supply a steel pipe Schedule 40 with an outside diameter not less than 25.4 mm, supplied in lengths as required to complete the installation as described in Section 3.3.

The top end of each length of rod shall be threaded to receive a cap. A rounded cap shall be installed at the top of the rod in such a way that a single survey point can be clearly identified and returned to.

### **3.2.4 Friction Reducing Sleeve**

The Contractor shall supply a friction reducing sleeve consisting of Schedule 40 – 50.8 mm O.D. PVC pipe cut perpendicular to the axis of the pipe.

### **3.2.5 Protective Surround**

The Contractor shall supply a protective surround for the portion of the rod within the embankment.

The surround shall consist of 300 mm diameter corrugated steel pipe (CSP – OPSS 1801) with the ends cut perpendicular to the axis of the pipe and free of burrs and sharp edges. The space between the CSP and the Friction Reduction Sleeve (PVC pipe) shall be filled with medium to coarse sand.

## **3.3 INSTALLATION**

### **3.3.1 General**

The Contractor shall install Settlement Plates as shown on the Contract Drawings in addition to what is stated or emphasized below.

### **3.3.2 Settlement Plate**

For Monitoring Sections A and B specified in the Contract, the settlement plate shall be installed horizontally on undisturbed native soil just below the existing ground surface or on the sand blanket. For Monitoring Section C, the settlement plate shall be installed on top of the temporary culvert.

The elevation of the base of the plate shall be surveyed before backfilling.

### 3.3.3 Rod

The Settlement Plate rod shall be fixed to the centre of the plate and perpendicular to the plate.

The coupling of the rods shall be such that all sections have the same axis and no separation or contraction will occur at the couplings.

### 3.3.4 Friction Reducing Sleeve

The friction reducing sleeve shall be over the entire length of the rod that is below ground and within the embankment fill except that the cap on top of the Settlement Plate rod shall extend 25 mm above the top of the friction sleeve at all times

### 3.3.5 Extension of Rod

The Settlement Plate rods shall be extended upwards as the embankment are constructed so that the top of the rod is always at least 0.3 m but not more than 2 m above the surrounding fill.

### 3.3.6 Protective Surround

The CSP, Friction Reducing Sleeve and sand protective surround shall be extended with the rods.

The Settlement Plate rod shall be in the centre of the CSP and friction-reducing sleeve.

The annulus between the CSP and the friction-reducing sleeve shall be filled with sand to a level not higher than the top of the sleeve.

### 3.3.7 Installation Details

The elevation, easting and northing of the centre of the base of the plate shall be surveyed.

The elevation, easting and northing of the top of the rod shall be surveyed.

The total distance from the base of the plate to the top of the rod shall be measured to an accuracy of  $\pm 2$  mm or better.

## 3.4 **COORDINATION WITH MONITORING**

### 3.4.1 Notification



The Contractor shall notify the Contract Administrator no later than three (3) working days after installing a Settlement Plates. At this time the Contractor shall also supply the following information to the Contract Administrator:

- SP Northings and Eastings in MTM NAD 83 coordinates;
- Elevation of plate and rod in Geodetic datum;
- Dates of installation;
- Installation notes / sketches; and,
- Description of settlement plate rods, sleeve, plate.

Adjustments in the length of any Settlement Plate rod shall be coordinated with the Contract Administrator to allow surveying by others of the elevation of the top of the rod immediately before and immediately after adjustment. This surveying is necessary to accurately track the settlement data.

#### 3.4.2 Monitoring

Monitoring of the Settlement Plates shall be done by others. Monitoring shall be conducted during the embankment and surcharge construction. The Contractor shall provide installation information as specified above and provide access to the Settlement Plates for monitoring including, but not limited to a scaffolding platform and ladder if required and snow clearing in the winter. The Contractor shall provide electric power and general area lighting as needed for reading the instruments.

### 3.5 **REPORTING**

The Contractor shall record and report relevant installation details to the Contract Administrator. These include, but are not limited to:

- SP Northings and Eastings in MTM NAD 83 coordinates;
- Elevation of plate and rod in Geodetic datum;
- Dates of installation;
- Installation notes / sketches; and,
- Description of settlement plates rods, sleeve, plate.

## 4.0 **VIBRATING WIRE PIEZOMETER (VWP) – SUPPLY AND INSTALLATION**

### 4.1 **GENERAL**

#### 4.1.1 Scope

This Section contains the requirements for the supply and installation of Vibrating Wire Piezometers (VWP).

The purpose of the piezometers is to monitor piezometric head at depth within the foundation soil. The piezometer readings shall help to establish the timing for the fill placement and the removal of surcharge where required.

#### 4.1.2 General Procedure

The piezometers shall be installed in boreholes after wick drain installation but prior to any embankment construction.

The VWP signal cables shall be extended out of the embankment footprint area through a metal or plastic conduit buried in trenches, as shown on the Contract Drawings.

#### 4.1.3 Locations

The Contractor shall install VWP sensors at the centre of the triangular wick drain grid at the locations and depths given in Table 4.

**Table 4 – Vibrating Wire Piezometer Locations and Elevations**

| <b>Swamp Crossing</b> | <b>Monitoring Section Type</b> | <b>Station</b> | <b>Offset <sup>1</sup></b> | <b>Approximate Elevation of Existing Ground Surface (m)</b> | <b>Tip Elevation (m)</b> |
|-----------------------|--------------------------------|----------------|----------------------------|---|--------------------------|
| Swamp 302 SBL         | C                              | 17+798         | 0 m                        | 189.0   | 180.0                    |
|                       | C                              | 17+799         | 0 m                        | 189.0   | 181.4                    |
|                       | A                              | 17+919         | 0 m                        | 189.0   | 180.0                    |
|                       | A                              | 17+920         | 13.2 m Lt                  | 189.0   | 181.4                    |
|                       | A                              | 17+920         | 0 m                        | 189.0   | 181.4                    |
|                       | A                              | 17+920         | 13.2 m Rt                  | 189.0   | 181.4                    |
|                       | B                              | 17+984         | 0 m                        | 185.8   | 179.3                    |
|                       | B                              | 17+985         | 0 m                        | 185.8   | 181.3                    |
|                       | A                              | 18+049         | 0 m                        | 186.5   | 181.5                    |
|                       | A                              | 18+050         | 14.9 m Lt                  | 186.5   | 183.5                    |
|                       | A                              | 18+050         | 0 m                        | 186.5   | 183.5                    |
|                       | A                              | 18+050         | 14.9 m Rt                  | 186.5   | 183.5                    |
| Swamp 302 NBL         | C                              | 17+798         | 0 m                        | 188.0   | 180.3                    |
|                       | C                              | 17+799         | 0 m                        | 188.0   | 181.4                    |
|                       | A                              | 17+849         | 0 m                        | 186.5   | 181.4                    |
|                       | A                              | 17+850         | 14.4 m Lt                  | 186.5   | 183.3                    |
|                       | A                              | 17+850         | 0 m                        | 186.5   | 183.3                    |
|                       | A                              | 17+850         | 14.4 m Rt                  | 186.5   | 183.3                    |
|                       | B                              | 17+914         | 0 m                        | 186.5   | 180.1                    |
|                       | B                              | 17+915         | 0 m                        | 186.5   | 182.4                    |
|                       | A                              | 18+049         | 0 m                        | 186.5   | 181.4                    |
|                       | A                              | 18+050         | 14.4 m Lt                  | 186.5   | 183.3                    |
|                       | A                              | 18+050         | 0 m                        | 186.5   | 183.3                    |
|                       | A                              | 18+050         | 14.4 m Rt                  | 186.5   | 183.3                    |
| Swamp 305 SBL         | B                              | 16+139         | 0 m                        | 186.9   | 171.0                    |
|                       | B                              | 16+140         | 0 m                        | 186.9   | 176.7                    |

|                  |   |        |           |       |       |
|------------------|---|--------|-----------|-------|-------|
|                  | A | 16+199 | 0 m       | 187.2 | 171.4 |
|                  | A | 16+200 | 12.6 m Lt | 187.2 | 178.2 |
|                  | A | 16+200 | 0 m       | 187.2 | 178.2 |
|                  | A | 16+200 | 12.6 m Rt | 187.2 | 178.2 |
|                  | C | 16+230 | 0 m       | 185.7 | 170.3 |
|                  | C | 16+231 | 0 m       | 185.7 | 176.4 |
|                  | C | 16+290 | 0 m       | 185.8 | 178.6 |
|                  | C | 16+291 | 0 m       | 185.8 | 181.0 |
| Swamp 306<br>SBL | A | 15+399 | 0 m       | 189.1 | 183.4 |
|                  | A | 15+400 | 11.4 m Lt | 189.1 | 184.7 |
|                  | A | 15+400 | 0 m       | 189.1 | 184.7 |
|                  | A | 15+400 | 11.4 m Rt | 189.1 | 184.7 |
|                  | B | 15+448 | 0 m       | 189.4 | 182.7 |
|                  | B | 15+449 | 0 m       | 189.4 | 185.3 |
|                  | B | 15+498 | 0 m       | 189.2 | 182.4 |
|                  | B | 15+499 | 0 m       | 189.2 | 185.4 |
|                  | A | 15+549 | 0 m       | 189.3 | 181.8 |
|                  | A | 15+550 | 10.4 m Lt | 189.3 | 185.6 |
|                  | A | 15+550 | 0 m       | 189.3 | 185.6 |
|                  | A | 15+550 | 10.4 m Rt | 189.3 | 185.6 |
|                  | B | 15+598 | 0 m       | 189.5 | 184.4 |
|                  | B | 15+599 | 0 m       | 189.5 | 186.0 |
|                  | C | 15+652 | 0 m       | 189.1 | 184.6 |
|                  | C | 15+653 | 0 m       | 189.1 | 185.6 |
| Swamp 307<br>SBL | A | 14+459 | 0 m       | 192.3 | 184.6 |
|                  | A | 14+460 | 12.1 m Lt | 192.3 | 188.2 |
|                  | A | 14+460 | 0 m       | 192.3 | 188.2 |
|                  | A | 14+460 | 12.1 m Rt | 192.3 | 188.2 |

NOTE: 1. Offset from centreline of specified lane.

## 4.2 MATERIALS

### 4.2.1 VW Piezometers

The Contractor shall supply VW borehole piezometers by Slope Indicator model 52611020 (-5 psi to 50 psi), RST model VW2100-0.35 – or equal; compatible with the Slope Indicator model CR1000 data-logger, RST model ELGL1200 – or equal. All VW piezometers shall be of the same make/supplier.

All piezometers shall be calibrated prior to installation and the calibration data for each piezometer shall be provided to the Contract Administrator.

#### 4.2.2 Signal Cable

The Contractor shall supply Slope Indicator model 50613524 cable, RST model EL380004 cable – or equal. The length of cable for each piezometer shall be carefully estimated from the Contract Drawings to ensure that there is sufficient length of signal cable for each piezometer to provide enough slack in the borehole and along the trenches until each cable is out of the embankment footprint area where it shall be protected from earthmoving equipment.

#### 4.2.3 Bentonite

The Contractor shall supply bentonite (OPSS 1205) in pellet form in sufficient quantity to form borehole plugs as required.

#### 4.2.4 Filter Sand

The Contractor shall supply clean washed sand for filter around VW sensors. The sand shall be Sakcrete washed general-purpose sand – or equal.

#### 4.2.5 Grout

The Contractor shall supply cement-bentonite grout. A suitable grout mix design consists of 23 kg of bentonite (OPSS 1205), 143 litres of water and 40 kg of cement (Type GU – OPSS 1301)

#### 4.2.6 Trench Burial and Conduit

The signal cable for each piezometer shall be buried in a shallow trench as shown in the Contract Drawings, and taken out of the embankment footprint area. The Contractor shall supply suitable conduits (e.g. Schedule 40 – 75 mm – steel pipe or Schedule 80 – 75mm rigid PVC pipe) to protect the signal cables in the trenches and above ground surface. If appropriate, several signal cables may be housed in a single conduit and laid in a common trench.

#### 4.2.7 Data Acquisition System (Data-Logger)

The signal cables from the vibrating wire piezometers shall be connected to the nearest data-logger, Slope Indicator model 56701000 (CR1000), RST model ELGL1200 – or equal. The data-logger shall consist of the following:

- ENC 16/18 Water-proof Enclosure model 56705020, model ELF0638 – or equal;
- SC32A Serial Interface (with RS232 transfer cable) model 56704010, model CS-SC32A – or equal;
- VW Interface model 56701510 or 56701500, model CS-AVW200 – or equal;
- AM16/32 Multiplexer model 56702110, model ELGL2042 – or equal;
- A suitable power supply which shall be able to last for 10 years for long term settlement monitoring (i.e. large capacity rechargeable battery coupled with solar panel);
- LoggerNet Software model 56708020, model CS-Loggernet – or equal.

A minimum of four (4) CR1000 data-loggers shall be installed as specified in the Monitoring Section Location Plan. The Contractor shall submit a detailed proposal on the setup of the data-logging system (i.e. numbers and locations of the data-logging unit(s)) to the Contract Administrator for review, prior to ordering the data-logger(s). The Contractor shall program the data-loggers according to the following:

- Recording Software: VWP data shall be recorded two (2) times a day (i.e. one (1) reading every 12 hours); and,
- Test Software: once this program is transferred to the data-logger, the system shall be able to be tested and record data manually on site.

The real-time data shall be retrieved on site by direct wire (i.e. RS232 Cable) with a portable laptop computer as specified in the next section.

#### 4.2.8 Portable Laptop Computer

For the purposes of monitoring the VWPs the Contractor shall supply:

- A new Portable Laptop Computer (with a three (3) year warranty): Intel Core i5 or equivalent (2.4 GHz or higher) with Windows 7 (English), 4 GB memory, a minimum of 250 GB hard drive storage, a DVD+/-RW and Microsoft Office 2010, to retrieve, read and store the VW piezometer readings.
- An extra battery for the above portable laptop computer and a cigarette lighter adaptor for computer charger.

The portable laptop computer will become property of the MTO and shall be handed to the Contract Administrator after the installation of instruments for the monitoring program.

The calibration factors for all vibrating wire piezometers shall be entered in the portable laptop computer by the Contractor for initialization of the instruments.

#### 4.2.9 Wooden Posts

Wooden posts for the support of the data acquisition system enclosures shall be 100 mm by 100 mm (4" by 4"), minimum 3 m (10') long pressure treated lumber.

### 4.3 **INSTALLATION**

#### 4.3.1 General

Installation of the VWPs shall be in accordance with the manufacturer's recommendations in addition to what is stated or emphasised below.

#### 4.3.2 Borehole Installation

The borehole shall be advanced to 300 mm below the lowest tip elevation using suitable drilling techniques. The sides of the borehole shall be stable and the borehole shall be free of drilling mud and debris.

The exact borehole location shall be at the centre of the triangular wick drain grid and shall be determined in the field, after the wick drain installation.

#### 4.3.3 Protection for Long-Term Monitoring (Monitoring Shed)

The data-logger shall be installed in a walk-in Monitoring Shed to prevent vandalism and prolonged wear-out of the data-loggers against extreme weather. The Monitoring Shed shall be lockable and weathered proof surrounded by 2 m high chainlink fence and a lockable gate. The Monitoring Shed shall also be seating on a gravel pad and securely tied down to ground. The location of the Monitoring Shed shall not be susceptible to ground settlement. The Contractor shall submit a detailed proposal of the Monitoring Shed (i.e. materials and location(s) etc.) to the Contract Administrator for review, prior to construction.

The Contractor shall ensure access to the Monitoring Shed at all times, including but not limited to snow clearing in the winter.

#### 4.3.4 Completion of Installation

It is known that the process of installing VWP's can temporarily alter the pore water pressure acting on the piezometer tip. The installation of a VWP shall not be considered to be complete until the pore pressure acting on the piezometer has returned to and stabilized at the value prevailing in the surrounding, unaffected soil mass. The Contractor shall take daily reading of the pore pressures until the value has stabilized. Stabilization shall be deemed to have occurred:

- a) When no change in the measured value has occurred over a period of five (5) consecutive days and the measured value is within 10 percent of the anticipated hydrostatic value; and,
- b) When the daily rate of change is less than four (4) kPa per day for three (3) consecutive days and the measured value is within 5 percent of the anticipated hydrostatic value.

The Contractor should be prepared to wait for a period of 10 to 15 days after completion of installation of instruments for the baseline readings to stabilize.

### **4.4 COORDINATION WITH MONITORING**

#### 4.4.1 Notification

The Contractor shall notify the Contract Administrator no later than three (3) working days after the installation of a VWP. At this time, the Contractor shall also supply the following information to the Contract Administrator.

- VWP Northings and Eastings in MTM NAD 83 coordinates;
- Elevations of VW sensors in Geodetic datum;
- Dates of installation;
- Stratigraphic log of subsurface conditions, including drilling method notes;
- Installation notes / sketches;
- Model, make and serial numbers of VW sensors, readout unit and signal cable;

- and,
- Calibration details of VW sensors.

#### 4.4.2 Monitoring

Monitoring of the VW piezometers shall be done by others. Monitoring shall be conducted during and after the embankment and surcharge construction. The Contractor shall provide installation information as specified above and provide access to the data-loggers for monitoring.

The Contractor shall transfer the Portable Laptop Computer to the Contract Administrator, including all the data-logging software and hardware, operation instructions and calibration constants. The contractor shall also transfer the keys for the locks of the Monitoring Shed(s). The Contractor shall be available for one site meeting with the Contract Administrator to transfer and explain about any questions from the Contract Administrator regarding the data-logging system.

### 4.5 **REPORTING**

The Contractor shall record and report relevant installation details to the Contract Administrator. These include, but are not limited to:

- VWP Northings and Eastings in MTM NAD 83 coordinates;
- Elevations of VW sensors in Geodetic datum;
- Dates of installation;
- Stratigraphic log of subsurface conditions, including drilling method notes;
- Installation notes / sketches;
- Model, make and serial numbers of VW sensors, readout unit and signal cable;
- and,
- Calibration details of VW sensors.

### 5.0 **STANDPIPE PIEZOMETER (SPP) – SUPPLY AND INSTALLATION**

#### 5.1 **GENERAL**

##### 5.1.1 Scope

This Section contains the requirements for the supply and installation of Standpipe Piezometers.

The purpose of the Standpipe Piezometer is to monitor the hydrostatic piezometric head within the compressible clay deposits.

##### 5.1.2 General Procedure

The Standpipe Piezometers shall be installed after completion of wick drain installation but prior to embankment construction.

Standpipe Piezometers shall be installed in vertical boreholes.

### 5.1.3 Location

The locations and depths of the Standpipe Piezometers are given in Table 5.

**Table 5 – Standpipe Piezometer Locations and Elevations**

| <b>Swamp Crossing</b> | <b>Monitoring Section Type</b> | <b>Station</b> | <b>Offset <sup>1</sup></b> | <b>Approximate Elevation of Existing Ground Surface (m)</b> | <b>Tip Elevation (m)</b> |
|-----------------------|--------------------------------|----------------|----------------------------|---|--------------------------|
| Swamp 302 SBL         | A                              | 17+920         | 27.0 m Lt                  | 189.5   | 176.0                    |
|                       | A                              | 18+050         | 24.0 m Lt                  | 186.5   | 175.5                    |
| Swamp 302 NBL         | A                              | 17+850         | 26.5 m Rt                  | 186.5   | 174.5                    |
|                       | A                              | 18+050         | 22.5 m Rt                  | 186.5   | 178.5                    |
| Swamp 305 SBL         | A                              | 16+200         | 34.0 m Lt                  | 186.9   | 162.5                    |
| Swamp 306 SBL         | A                              | 15+475         | 18.0 m Lt                  | 190.2   | 175.0                    |
|                       | A                              | 15+550         | 32.0 m Lt                  | 189.2   | 172.0                    |
| Swamp 307 SBL         | A                              | 14+460         | 27.5 m Lt                  | 192.7   | 178.5                    |

NOTE: 1. Offset from centreline of specified lane.

## 5.2 MATERIALS

### 5.2.1 General

The Contractor shall supply material and equipment, required for installation of the Standpipe Piezometers.

### 5.2.2 Pipe and Couplings

The Contractor shall supply Schedule 40 flush jointed – 19mm PVC pipe (e.g. 75 x 5R or 75 x 10R – Canadian Pipe Supply Ltd.).

### 5.2.3 Perforated Section

The Contractor shall supply one (1) 1.5 m long slotted Schedule 40 flush jointed – 19 mm PVC slotted pipe (e.g. 75 x 5S Slot 10 Schedule 40 – F/J – PVC – Canadian Pipe Supply Ltd.) for each SPP.

### 5.2.4 Bottom Cap

The Contractor shall supply bottom caps Schedule 40 flush jointed – 19 mm PVC (e.g. 448-007FJ – Canadian Pipe Supply Ltd.) to fit the perforated section.



#### 5.2.5 Top Caps

The Contractor shall supply vented top caps Schedule 40 – 19 mm PVC (e.g. 448-007FJ-perforated – Canadian Pipe Supply Ltd.) to fit the pipe.

#### 5.2.6 Filter Sand

The Contractor shall supply clean washed sand for backfilling around perforated section. The sand shall be Sakrete washed general purpose sand – or equal.

#### 5.2.7 Bentonite

The Contractor shall supply bentonite (OPSS 1205) in pellet form for backfilling above the filter sand.

#### 5.2.8 Grout

The Contractor shall supply cement-bentonite grout for general backfilling. A suitable grout mix design consists of 23 kg of bentonite (OPSS 1205), 143 litres of water and 40 kg of cement (Type GU – OPSS 1301).

#### 5.2.9 Protective Housing

The Contractor shall supply a protective housing consisting of 100 mm minimum diameter galvanized steel pipe with a locking cap.

### 5.3 **INSTALLATION**

#### 5.3.1 General

Installation of the Standpipe Piezometers shall be as shown on the Contract Drawings in addition to what is stated or emphasised below.

The borehole shall be advanced to 300 mm below the tip elevation using suitable drilling techniques. The sides of the borehole shall be stable and the borehole shall be free of debris.

The Standpipe Piezometers must be of sufficient length above the ground surface to accommodate the piezometric head and to allow for snow accumulation.

### 5.4 **COORDINATION WITH MONITORING**

#### 5.4.1 Notification

The Contractor shall notify the Contract Administrator no later than three (3) days after installing a Standpipe Piezometer. At this time the Contractor shall also supply the following information to the Contract Administrator.

- SPP Northings and Eastings in MTM NAD 83 coordinates;
- Elevation of ground surface in Geodetic datum;
- Dates of installation;

- Stratigraphic log of subsurface conditions at the SPPs, including drilling method notes;
- Installation notes / backfilling notes;
- Depth of SPP screen, stick up above grounds surface; and,
- Description of screen and pipe.

#### 5.4.2 Monitoring

Monitoring of the Standpipe Piezometers shall be done by others. Monitoring shall be conducted during and after the embankment and surcharge construction. The Contractor shall provide installation information as specified above and provide access to the Standpipe Piezometers for monitoring including, but not necessarily limited to snow clearing in the winter. The contractor shall provide general area lighting as needed for reading the instruments.

### 5.5 COORDINATION WITH MONITORING

The Contractor shall record and report relevant installation details to the Contract Administrator. These include, but are not limited to:

- SPP Northings and Eastings in MTM NAD 83 coordinates;
- Elevation of ground surface in Geodetic datum;
- Dates of installation;
- Stratigraphic log of subsurface conditions at the SPPs, including drilling method notes;
- Installation notes / backfilling notes;
- Depth of SPP screen, stick up above grounds surface; and,
- Description of screen and pipe.

## 6.0 SETTLEMENT PINS (S) – SUPPLY AND INSTALLATION

### 6.1 GENERAL

#### 6.1.1 Scope

This Section contains the requirements for the supply and installation of Settlement Pins.

The purpose of the Settlement Pin is to directly monitor settlement of the embankment. Settlement is measured by survey of the top of the pin with reference to stable non-settling benchmarks.

#### 6.1.2 General Procedure

The Settlement Pins shall be cast into concrete at the top of the embankments, as shown on the Contract Drawings.

The concrete will be cast in situ in a hole dug at the locations of the Settlement Pins.

#### 6.1.3 Location

The locations of the Settlement Pins are given in Table 6.

**Table 6 – Settlement Pins Locations and Elevation**

| Swamp Crossing | Monitoring Section Type | Station | Left Settlement Pin Offset <sup>1, 2</sup> | Centre Settlement Pin Offset <sup>1</sup> | Right Settlement Pin Offset <sup>1, 2</sup> |
|----------------|-------------------------|---------|--|---|---|
| Swamp 302 SBL  | C                       | 17+801  | 6.0 m Lt                                   | 0 m                                       | 6.0 m Rt                                    |
|                | A                       | 17+921  | 6.0 m Lt                                   | 0 m                                       | 6.0 m Rt                                    |
|                | B                       | 17+986  | 6.0 m Lt                                   | 0 m                                       | 6.0 m Rt                                    |
|                | A                       | 18+051  | 6.0 m Lt                                   | 0 m                                       | 6.0 m Rt                                    |
| Swamp 302 NBL  | C                       | 17+801  | 6.0 m Lt                                   | 0 m                                       | 6.0 m Rt                                    |
|                | A                       | 17+851  | 6.0 m Lt                                   | 0 m                                       | 6.0 m Rt                                    |
|                | B                       | 17+916  | 6.0 m Lt                                   | 0 m                                       | 6.0 m Rt                                    |
|                | B                       | 17+981  | 6.0 m Lt                                   | 0 m                                       | 6.0 m Rt                                    |
|                | A                       | 18+051  | 6.0 m Lt                                   | 0 m                                       | 6.0 m Rt                                    |
| Swamp 305 SBL  | B                       | 16+141  | 6.0 m Lt                                   | 0 m                                       | 6.0 m Rt                                    |
|                | A                       | 16+201  | 6.0 m Lt                                   | 0 m                                       | 6.0 m Rt                                    |
|                | C                       | 16+233  | 6.0 m Lt                                   | 0 m                                       | 6.0 m Rt                                    |
|                | C                       | 16+290  | --   | --  | 6.0 m Rt                                    |
|                | C                       | 16+293  | --   | 0 m                                       | --  |
|                | C                       | 16+296  | 6.0 m Lt                                   | --  | --  |
| Swamp 306 SBL  | A                       | 15+401  | 6.0 m Lt                                   | 0 m                                       | 6.0 m Rt                                    |
|                | B                       | 15+451  | 6.0 m Lt                                   | 0 m                                       | 6.0 m Rt                                    |
|                | B                       | 15+501  | 6.0 m Lt                                   | 0 m                                       | 6.0 m Rt                                    |
|                | A                       | 15+551  | 6.0 m Lt                                   | 0 m                                       | 6.0 m Rt                                    |
|                | B                       | 15+601  | 6.0 m Lt                                   | 0 m                                       | 6.0 m Rt                                    |
|                | C                       | 15+652  | --   | --  | 6.0 m Rt                                    |
|                | C                       | 15+655  | --   | 0 m                                       | --  |
|                | C                       | 15+658  | 6.0 m Lt                                   | --  | --  |
| Swamp 307 SBL  | A                       | 14+461  | 6.0 m Lt                                   | 0 m                                       | 6.0 m Rt                                    |

NOTE: 1. Offset from centreline of specified lane.  
2. Offset for Left and Right Settlement Pins are approximate. Left and Right Settlement Pins should be installed at the crest of the surcharge fill.

## 6.2 MATERIALS

### 6.2.1 General

The Contractor shall supply material and equipment, required for installation of the Settlement Pins.

#### 6.2.2 Pin

The Contractor shall supply a 25.4 mm minimum diameter reinforcing steel bar (OPSS 905) cut 0.4 m long.

The top of the reinforcing steel bar shall be angled or rounded in such a way that a single survey point can be clearly identified and repeated.

#### 6.2.3 Concrete

The Contractor shall supply concrete (OPSS 1350) of minimum 25 MPa compressive strength and set time sufficient to secure the Settlement Pins within two (2) days of pouring.

### **6.3 INSTALLATION**

#### 6.3.1 General

The contractor shall install Settlement Pins as shown on the Contract Drawings.

### **6.4 COORDINATION WITH MONITORING**

#### 6.4.1 Notification

The Contractor shall notify the Contract Administrator no later than three (3) working days after installing a Settlement Pin. At this time the Contractor shall also supply the following information to the Contract Administrator.

- S Nothings and Eastings in MTM NAD 83 coordinates;
- Elevation of top of pin in Geodetic datum;
- Dates of installation; and,
- Installation notes / sketches.

#### 6.4.2 Monitoring

Monitoring of the Settlement Pins shall be done by others. Monitoring shall be conducted after the embankment and surcharge construction. The Contractor shall provide installation information as specified above and provide access to the Settlement Pins for monitoring.

### **6.5 REPORTING**

The Contractor shall record and report relevant installation details to the Contract Administrator. These include, but are not limited to:

- S Nothings and Eastings in MTM NAD 83 coordinates;
- Elevation of top of pin in Geodetic datum;
- Dates of installation; and,
- Installation notes / sketches.

## **7.0 NAIL PIN (NP) – SUPPLY AND INSTALLATION**

## 7.1 GENERAL

### 7.1.1 Scope

This Section contains the requirements for the supply and installation of Nail Pins.

The purpose of the Nail Pins is to monitor settlement of the temporary culverts. Settlement is measured by survey of the top of the Pin with reference to stable non-settling benchmarks.

### 7.1.2 General Procedure

For Monitoring Section Type C specified in the Contract, two (2) Nail Pins (NPs) shall be installed on the top of each temporary culvert, one (1) at each end of the culvert. The exact location shall be 0.5 m from each end and on the centreline of the culvert.

### 7.1.3 Location

The locations of the Nail Pins monitoring sections are given in Table 7.

**Table 7 – Nail Pin Locations**

| Swamp Crossing | Monitoring Section Type | Culvert Designation | Culvert Station <sup>1</sup> | Nail Pin Location                                |
|----------------|-------------------------|---------------------|------------------------------|--|
| Swamp 302 SBL  | C                       | C5A                 | 17+800                       | 0.5 m from the West end of the temporary culvert |
|                | C                       | C5A                 | 17+800                       | 0.5 m from the East end of the temporary culvert |
| Swamp 302 NBL  | C                       | C5A                 | 17+800                       | 0.5 m from the West end of the temporary culvert |
|                | C                       | C5A                 | 17+800                       | 0.5 m from the East end of the temporary culvert |
| Swamp 305 SBL  | C                       | C4                  | 16+232                       | 0.5 m from the West end of the temporary culvert |
|                | C                       | C4                  | 16+232                       | 0.5 m from the East end of the temporary culvert |
|                | C                       | C4A                 | 16+293                       | 0.5 m from the West end of the temporary culvert |
|                | C                       | C4A                 | 16+293                       | 0.5 m from the East end of the temporary culvert |
| Swamp 306 SBL  | C                       | C3                  | 15+654                       | 0.5 m from the West end of the temporary culvert |
|                | C                       | C3                  | 15+654                       | 0.5 m from the East end of the temporary culvert |

NOTE: 1. Stations for the nail pins are approximate. All nail pins shall be installed on the top of the temporary culverts on the culvert's centreline based on the locations above.

## 7.2 MATERIALS

### 7.2.1 General

The Contractor shall supply all materials and equipment required for the installation of the Nail Pins.

#### 7.2.2 Pin

The Contractor shall supply a 25.4 mm minimum diameter reinforcing steel bar (OPSS 905) cut 0.15 m long or equivalent.

The top of the reinforcing steel bar shall be angled or rounded in such a way that a single survey point can be clearly identified and repeated.

#### 7.2.3 Concrete

The Contractor shall supply concrete (OPSS 1350) of minimum 25 MPa compressive strength and set time sufficient to secure the Nail Pin within two (2) days of pouring.

### **7.3 INSTALLATION**

#### 7.3.1 General

The Contractor shall install nail pins as shown on the Contract Drawings.

### **7.4 COORDINATION WITH MONITORING**

#### 7.4.1 Notification

The Contractor shall notify the Contract Administrator no later than three (3) working days after installing a Nail Pin. At this time, the Contractor shall also supply the following information to the Contract Administrator:

- NP Northings and Eastings in MTM NAD 83 coordinates;
- Elevation of pin in Geodetic datum;
- Dates of installation; and,
- Installation notes / sketches.

#### 7.4.2 Monitoring

Monitoring of the Nail Pins shall be done by others. Monitoring shall be conducted during the embankment fill construction and surcharge period. The Contractor shall provide installation information as specified above and provide access to the Nail Pins for monitoring.

### **7.5 REPORTING**

The Contractor shall record and report relevant installation details to the Contract Administrator. These include, but are not limited to:

- NP Northings and Eastings in MTM NAD 83 coordinates;
- Elevation of pin in Geodetic datum;
- Dates of installation; and,

- Installation notes / sketches.

## **8.0 DECOMMISSIONING OF INSTRUMENTS**

### **8.1 GENERAL**

The Contractor shall decommission all the temporary Benchmarks (BM), Settlement Plates (SPs), Settlement Pins (Ss) and Nail Pins (NPs) at the end of the monitoring program unless advised otherwise by the Contract Administrator. The Vibrating Wire Piezometers (VWPs) and Standpipe Piezometers (SPPs) shall be kept for and protected long-term monitoring and shall not be decommissioned. Decommissioning of instrumentation shall be carried out according to the Ontario Water Resources Act, R.R.O. 1990, Regulation 903.

## **9.0 MEASUREMENT FOR PAYMENT**

Measurement for Payment will be made on the basis of the number of units of survey Benchmarks (BMs), Settlement Plates (SPs), Vibrating Wire Piezometers (VWPs), Standpipe Piezometers (SPPs), Settlement Pins (Ss) and Nail Pins (NPs) installed.

## **10.0 BASIS OF PAYMENTS**

Payment at the Lump Sum price for this tender item shall be full compensation for all labour, monitoring equipment and material to do the work.

## **EMBANKMENT CONSTRUCTION IN WICK DRAIN AREAS – Item No.**

---

### Operational Constraint

---

#### **Scope**

Fill placement for embankment construction shall not commence sooner than five (5) working days following completion of installation of all monitoring instrumentation, including notification and submission of required information (to the Contract Administrator) for all instrumentation. In any case, fill placement shall not commence before establishment of baseline readings. Baseline readings shall be conducted no sooner than three (3) days following notification of completion of installation of instrumentation and receipt of required installation information. If the baseline monitoring shows that the baseline has been established (i.e. consistent readings reflecting initial conditions obtained over the three (3) day period), embankment construction may commence. If the baseline is not established within a three (3) day period, additional daily readings will be completed until three (3) consistent readings on consecutive days have been obtained prior to commencement of embankment construction.

The Contractor shall confirm that the elevation of the top of the surcharge is within 300 mm of the design top of surcharge. Elevations shall be provided to the Contract Administrator within five (5) working days of placement of the surcharge. The Contractor shall keep records of the thickness of each layer of fill placed and provide these records to the Contract Administrator within five (5) working days of reaching the top of the layer.

#### **Embankment Construction – Highway 69 SBL STA 17+750 to 18+125 and Highway 69 NBL STA 17+750 to 18+100 (Swamp 302 SBL/NBL)**

After the wick drains and required instrumentation has been installed and baselined, embankment construction may proceed in the following manner:

| Layer Thickness            | Construction Time | Delay Time After Completion of Layer (before proceeding to the next layer) |
|----------------------------|-------------------|--|
| 0 m to 1.5 m               | 7 days            | No Delay   |
| 1.5 m to 3.0 m             | 7 days            | No Delay   |
| 3.0 m to 4.5 m             | 7 days            | No Delay   |
| 4.5 m to 6.0 m             | 7 days            | No Delay   |
| 6.0 m to 6.5 m             | 2.5 days          | 14.5 days  |
| 6.5 m to 8.5 m (Surcharge) | 7 days            | See Below  |

The delay times after completion of each layer, and surcharge period given above are estimated based on the detailed wick drain foundation analysis and design and are intended to be a guideline for bidding purposes only. The actual construction schedule will be determined by the results of the foundation monitoring program in place during construction. The contractor shall not begin placement of a new layer until permission is given by the Contract Administrator.

#### **Embankment Construction – Highway 69 SBL STA 16+075 to 16+325 (Swamp 305 SBL)**

After the wick drains and required instrumentation has been installed and baselined, embankment construction may proceed in the following manner:



| Layer Thickness            | Construction Time | Delay Time After Completion of Layer (before proceeding to the next layer) |
|----------------------------|-------------------|--|
| 0 m to 1.5 m               | 7 days            | No Delay   |
| 1.5 m to 3.0 m             | 7 days            | No Delay   |
| 3.0 m to 4.0 m             | 5 days            | No Delay   |
| 4.0 m to 6.0 m (Surcharge) | 7 days            | See Below  |

The delay times after completion of each layer, and surcharge period given above are estimated based on the detailed wick drain foundation analysis and design and are intended to be a guideline for bidding purposes only. The actual construction schedule will be determined by the results of the foundation monitoring program in place during construction. The contractor shall not begin placement of a new layer until permission is given by the Contract Administrator.

**Embankment Construction – Highway 69 SBL STA 15+360 to 15+750 (Swamp 306 SBL)**

After the wick drains and required instrumentation has been installed and baselined, embankment construction may proceed in the following manner:

| Layer Thickness            | Construction Time | Delay Time After Completion of Layer (before proceeding to the next layer) |
|----------------------------|-------------------|--|
| 0 m to 1.5 m               | 7 days            | No Delay   |
| 1.5 m to 3.0 m             | 7 days            | No Delay   |
| 3.0 m to 5.0 m (Surcharge) | 7 days            | See Below  |

The delay times after completion of each layer, and surcharge period given above are estimated based on the detailed wick drain foundation analysis and design and are intended to be a guideline for bidding purposes only. The actual construction schedule will be determined by the results of the foundation monitoring program in place during construction. The contractor shall not begin placement of a new layer until permission is given by the Contract Administrator.

**Embankment Construction – Highway 69 SBL STA 14+425 to 14+490 (Swamp 307 SBL)**

After the wick drains and required instrumentation has been installed and baselined, embankment construction may proceed in the following manner:

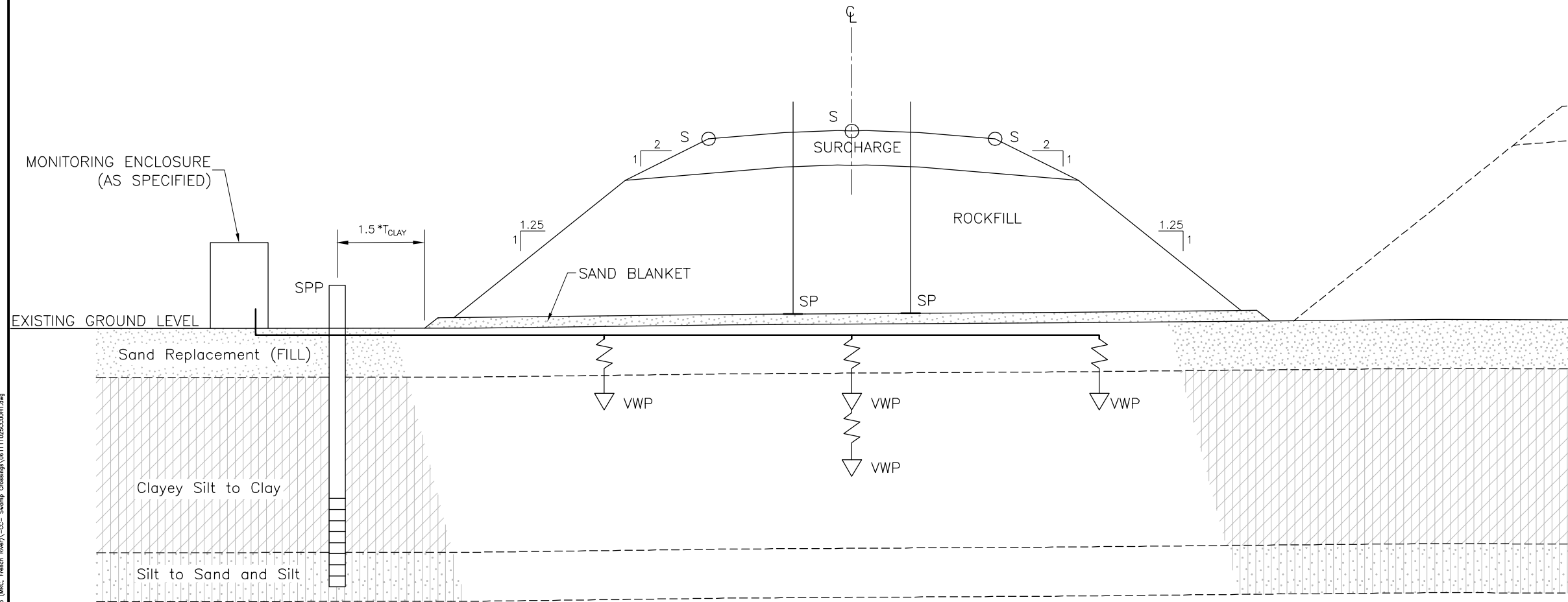
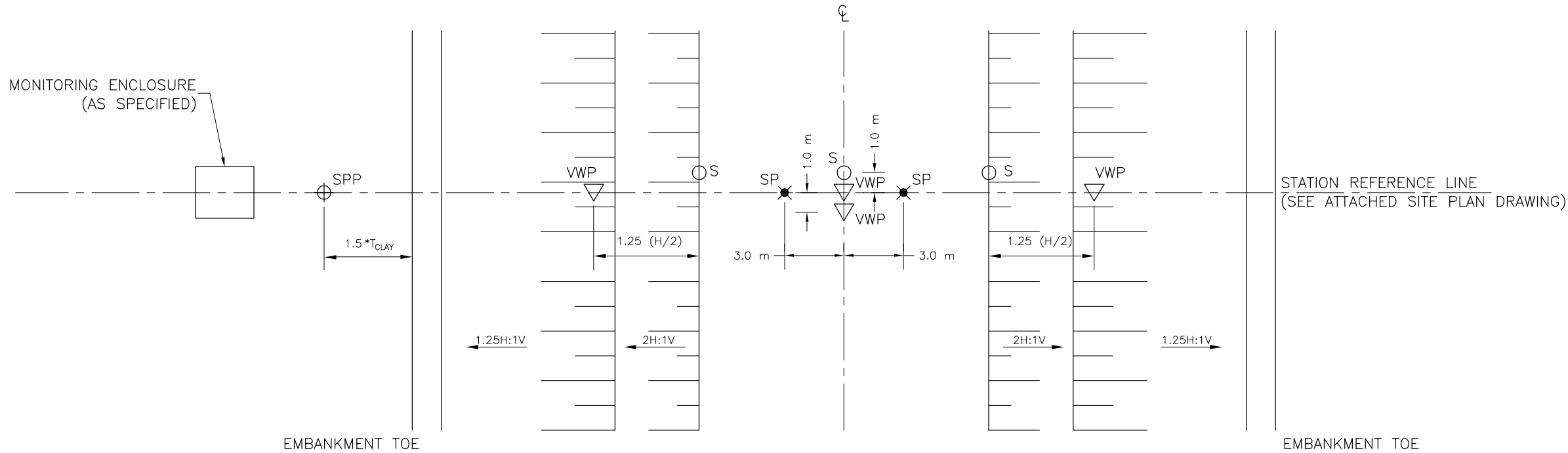
| Layer Thickness            | Construction Time | Delay Time After Completion of Layer (before proceeding to the next layer) |
|----------------------------|-------------------|--|
| 0 m to 1.5 m               | 7 days            | No Delay   |
| 1.5 m to 3.0 m             | 7 days            | No Delay   |
| 3.0 m to 5.0 m (Surcharge) | 7 days            | See Below  |

The delay times after completion of each layer, and surcharge period given above are estimated based on the detailed wick drain foundation analysis and design and are intended to be a guideline for bidding purposes only. The actual construction schedule will be determined by the results of the foundation monitoring program in place during construction. The contractor shall not begin placement of a new layer until permission is given by the Contract Administrator.



# **APPENDIX H**

## **Monitoring Instrumentation Specifications**



CONT No.  
WP No. 5203-06-00

HIGHWAY 69  
WICK DRAIN SWAMPS  
EMBANKMENT MONITORING PROGRAM  
PLAN AND SECTION – TYPE A

**Golder Associates Ltd.**  
MISSISSAUGA, ONTARIO, CANADA

SHEET

LEGEND

SP

SETTLEMENT ROD (PLAN)

SP

SETTLEMENT ROD (SECTION)

S

SETTLEMENT PIN

VWP

VIBRATING WIRE PIEZOMETER (PLAN)

VWP

VIBRATING WIRE PIEZOMETER (SECTION)

SPP

STANDPIPE PIEZOMETER (PLAN)

SPP

STANDPIPE PIEZOMETER (SECTION)

NOTES

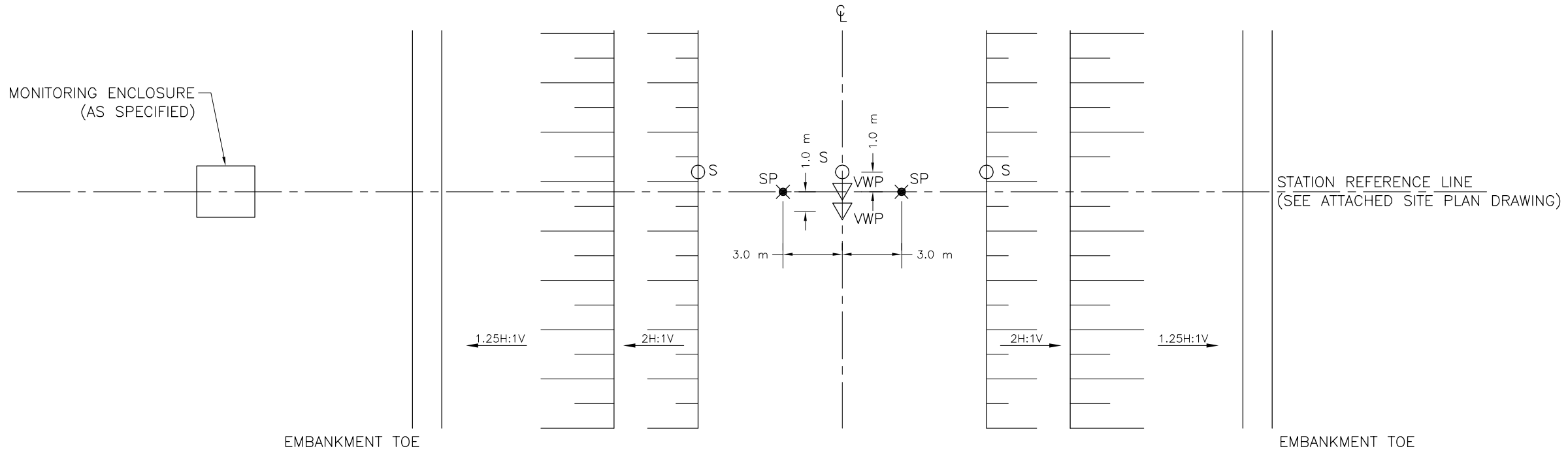
1. SEE SPECIFICATIONS FOR EXACT LOCATION, DEPTH AND NUMBER OF INSTRUMENTS.

2. "T<sub>CLAY</sub>" REFERS TO THE THICKNESS OF THE CLAYEY SILT TO CLAY DEPOSIT AT THE MONITORING SECTION.

3. "H" REFERS TO THE HEIGHT OF THE EMBANKMENT AT THE MONITORING SECTION.




|                     |                         |                 |          |
|---------------------|-------------------------|-----------------|----------|
|                     |                         |                 |          |
| NO.                 | DATE                    | BY              | REVISION |
| Geocres No. 41H-106 |                         |                 |          |
| HWY. 69             | PROJECT NO. 06-1111-025 |                 | DIST.    |
| SUBM'D. MWK         | CHKD. MWK               | DATE: Feb, 2012 | SITE:    |
| DRAWN: JFC/RJ       | CHKD. VA/CN             | APPD. JPD/JMAC  | DWG. H1  |



CONT No.  
WP No. 5203-06-00

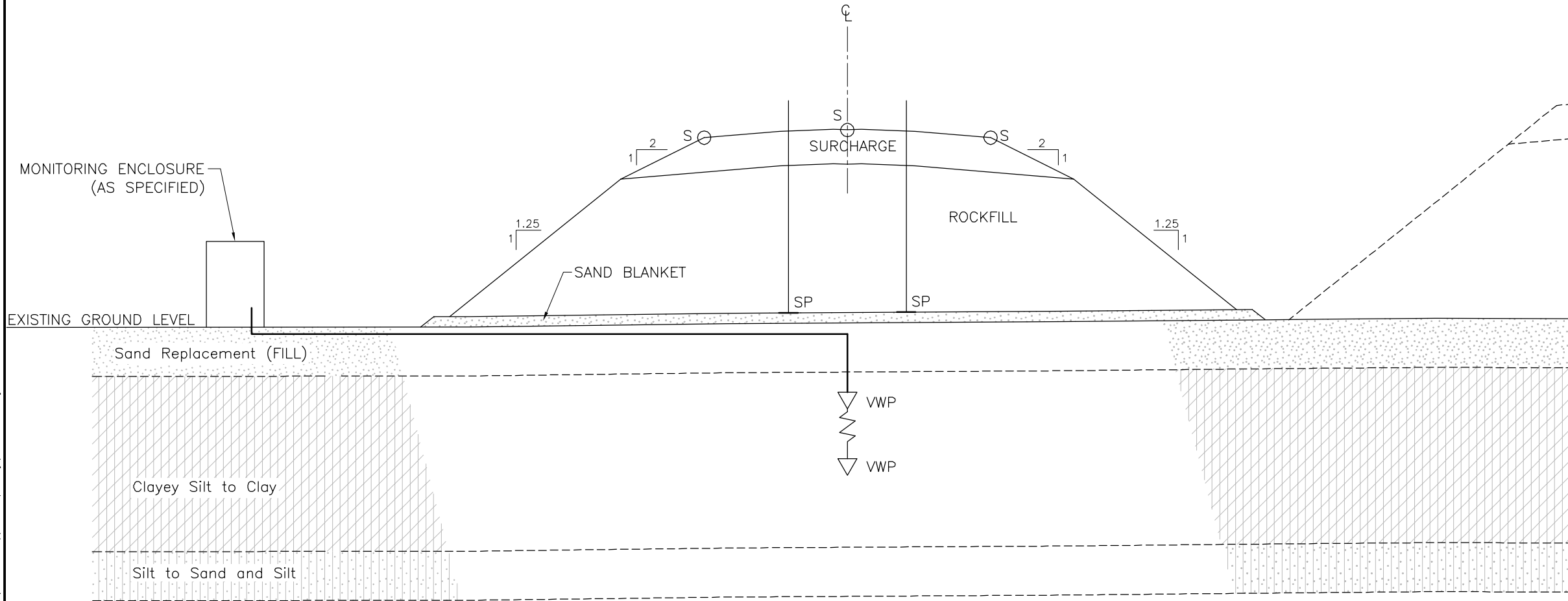
SHEET

HIGHWAY 69  
WICK DRAIN SWAMPS  
EMBANKMENT MONITORING PROGRAM  
PLAN AND SECTION - TYPE B



**Golder Associates Ltd.**  
MISSISSAUGA, ONTARIO, CANADA

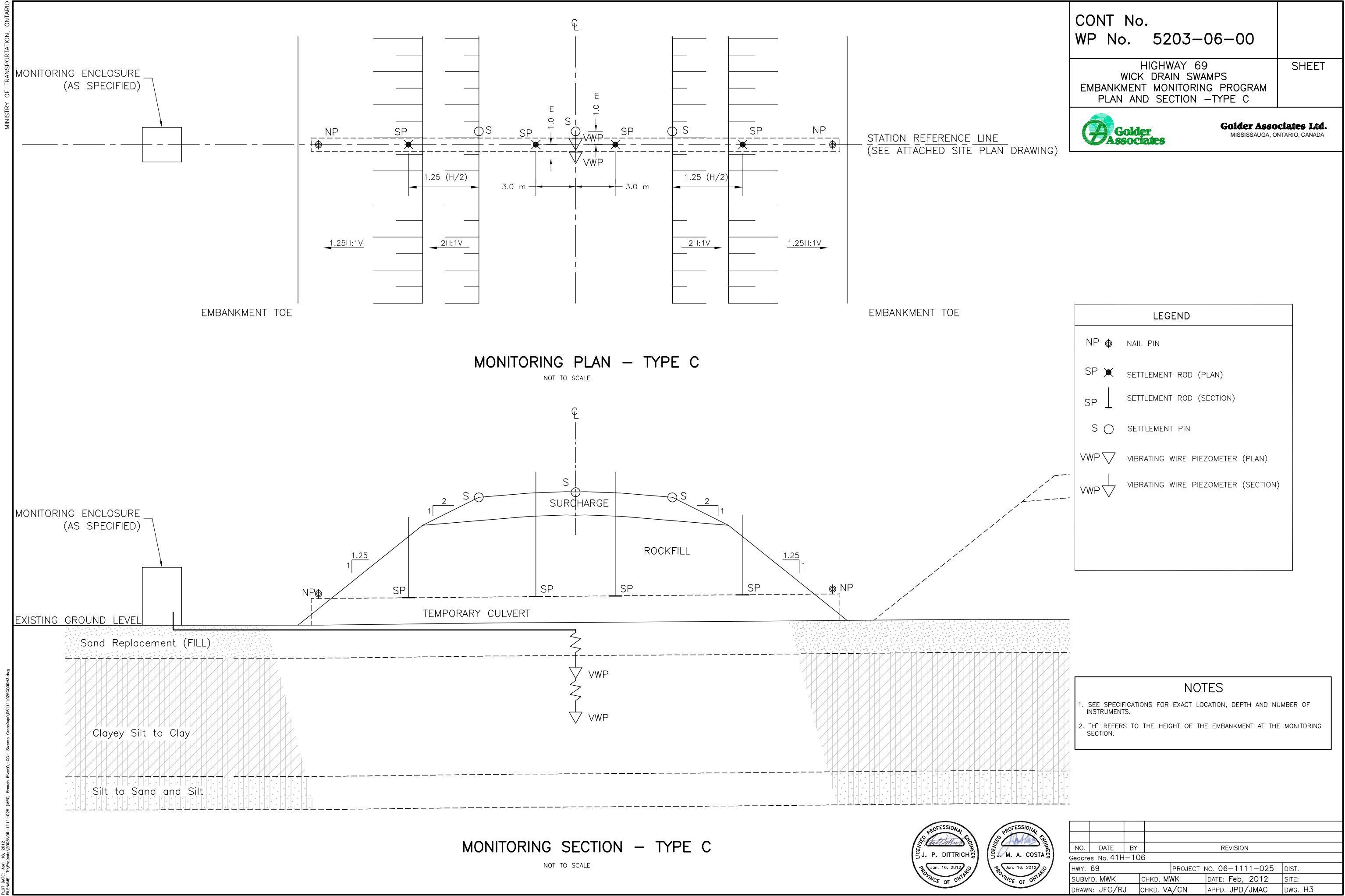
| LEGEND |                                     |
|--------|-------------------------------------|
| SP ✖   | SETTLEMENT ROD (PLAN)               |
| SP     | SETTLEMENT ROD (SECTION)            |
| S ○    | SETTLEMENT PIN                      |
| VWP ▽  | VIBRATING WIRE PIEZOMETER (PLAN)    |
| VWP ▽  | VIBRATING WIRE PIEZOMETER (SECTION) |



| NOTES  |  |
|--|--|
| 1. SEE SPECIFICATIONS FOR EXACT LOCATION, DEPTH AND NUMBER OF INSTRUMENTS. |  |



|                     |                         |                 |          |
|---------------------|-------------------------|-----------------|----------|
|                     |                         |                 |          |
| NO.                 | DATE                    | BY              | REVISION |
| Geocres No. 41H-106 |                         |                 |          |
| HWY. 69             | PROJECT NO. 06-1111-025 |                 | DIST.    |
| SUBM'D. MWK         | CHKD. MWK               | DATE: Feb, 2012 | SITE:    |
| DRAWN: JFC/RJ       | CHKD. VA/CN             | APPD. JPD/JMAC  | DWG. H2  |



MONITORING SECTION – TYPE C

NOT TO SCALE

LEGEND

NP

SP

SP

S

VWP

VWP

NAIL PIN

SETTLEMENT ROD (PLAN)

SETTLEMENT ROD (SECTION)

SETTLEMENT PIN

VIBRATING WIRE PIEZOMETER (PLAN)

VIBRATING WIRE PIEZOMETER (SECTION)

NOTES

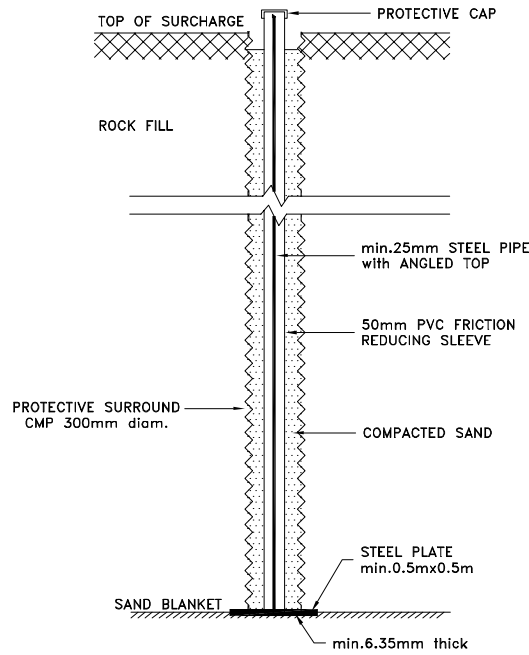
1. SEE SPECIFICATIONS FOR EXACT LOCATION, DEPTH AND NUMBER OF INSTRUMENTS.

2. "H" REFERS TO THE HEIGHT OF THE EMBANKMENT AT THE MONITORING SECTION.

PROFESSIONAL ENGINEER  
J. P. DITTRICH  
Jan. 16, 2012  
PROVINCE OF ONTARIO

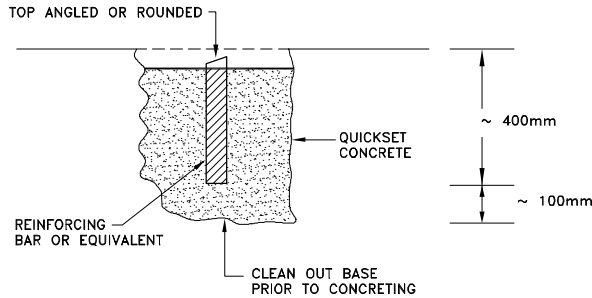
PROFESSIONAL ENGINEER  
J. M. A. COSTA  
Jan. 16, 2012  
PROVINCE OF ONTARIO

|                     |             |                         |          |
|---------------------|-------------|-------------------------|----------|
| NO.                 | DATE        | BY                      | REVISION |
| Geocres No. 41H-106 |             |                         |          |
| HWY. 69             |             | PROJECT NO. 06-1111-025 | DIST.    |
| SUBM'D. MWK         | CHKD. MWK   | DATE: Feb, 2012         | SITE:    |
| DRAWN: JFC/RJ       | CHKD. VA/CN | APPD. JPD/JMAC          | DWG. H3  |



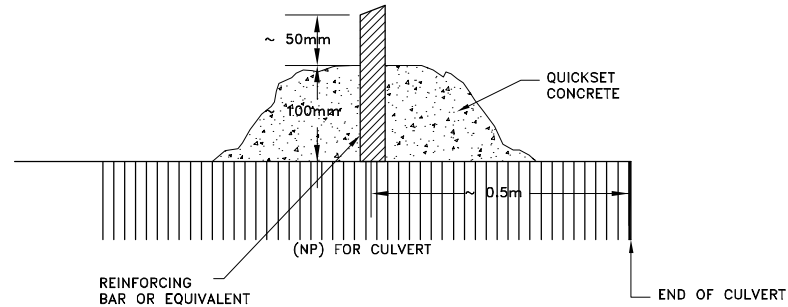
SETTLEMENT PLATE (SP)

NOT TO SCALE



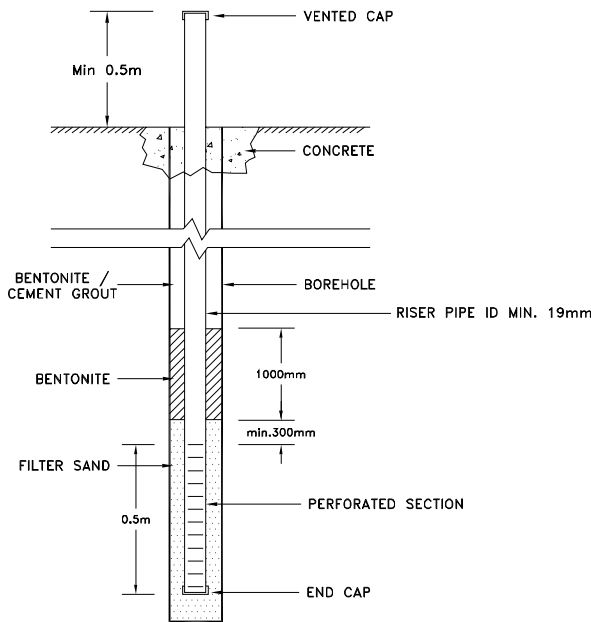
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NOT TO SCALE



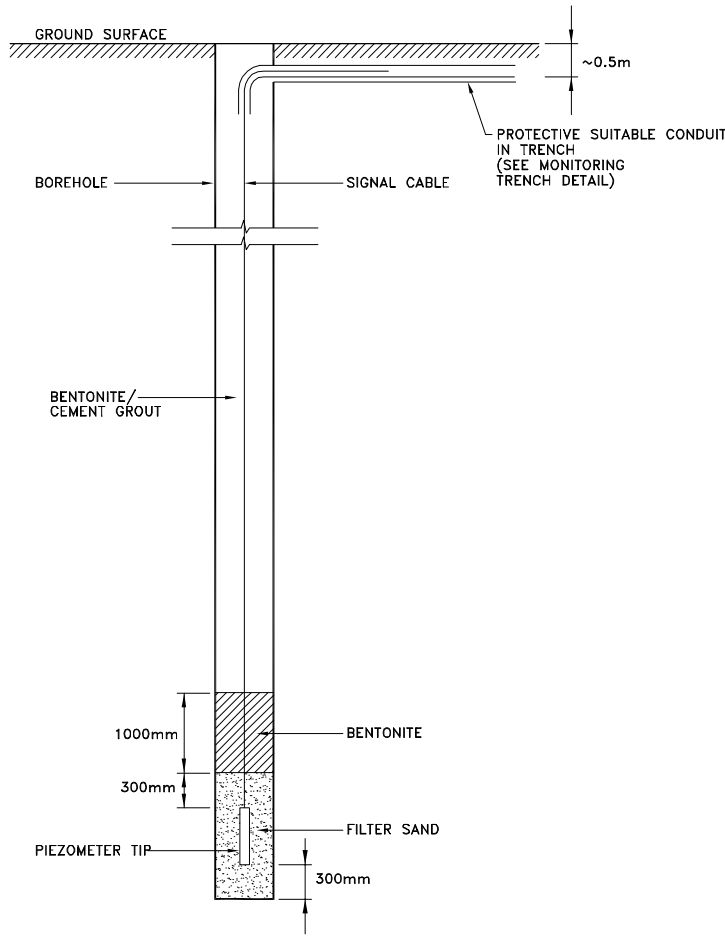
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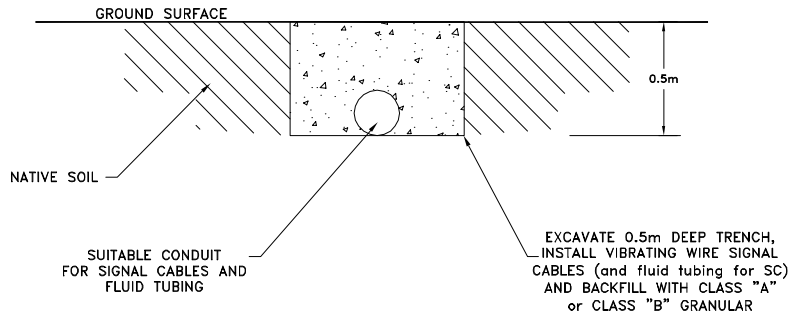
STANDPIPE PIEZOMETER (SPP)

NOT TO SCALE



VIBRATING WIRE PIEZOMETER (VWP)

NOT TO SCALE



MONITORING TRENCH

NOT TO SCALE



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

CONT No.  
GWP No. 5203-06-00

HIGHWAY 69  
WICK DRAIN SWAMPS  
TYPICAL INSTRUMENT  
INSTALLATION DETAILS

**Golder Associates Ltd.**  
MISSISSAUGA, ONTARIO, CANADA

|                     |                         |                 |          |
|---------------------|-------------------------|-----------------|----------|
| NO.                 | DATE                    | BY              | REVISION |
| Geocres No. 41H-106 |                         |                 |          |
| HWY. 69             | PROJECT NO. 06-1111-025 | DIST.           |          |
| SUBM'D. MWK         | CHKD. MWK               | DATE: Feb, 2012 | SITE:    |
| DRAWN: JFC/RJ       | CHKD. VA/CN             | APPD. JPD/JMAC  | DWG. H4  |

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

CONT No.  
GWP No. 5203-06-00

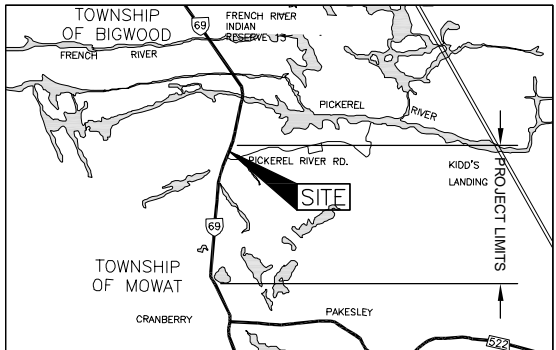


SWAMP 302  
HIGHWAY 69 (SBL) STA 17+750 TO 18+125  
HIGHWAY 69 (NBL) STA 17+750 TO 18+100  
MONITORING SECTION LOCATION PLAN

SHEET



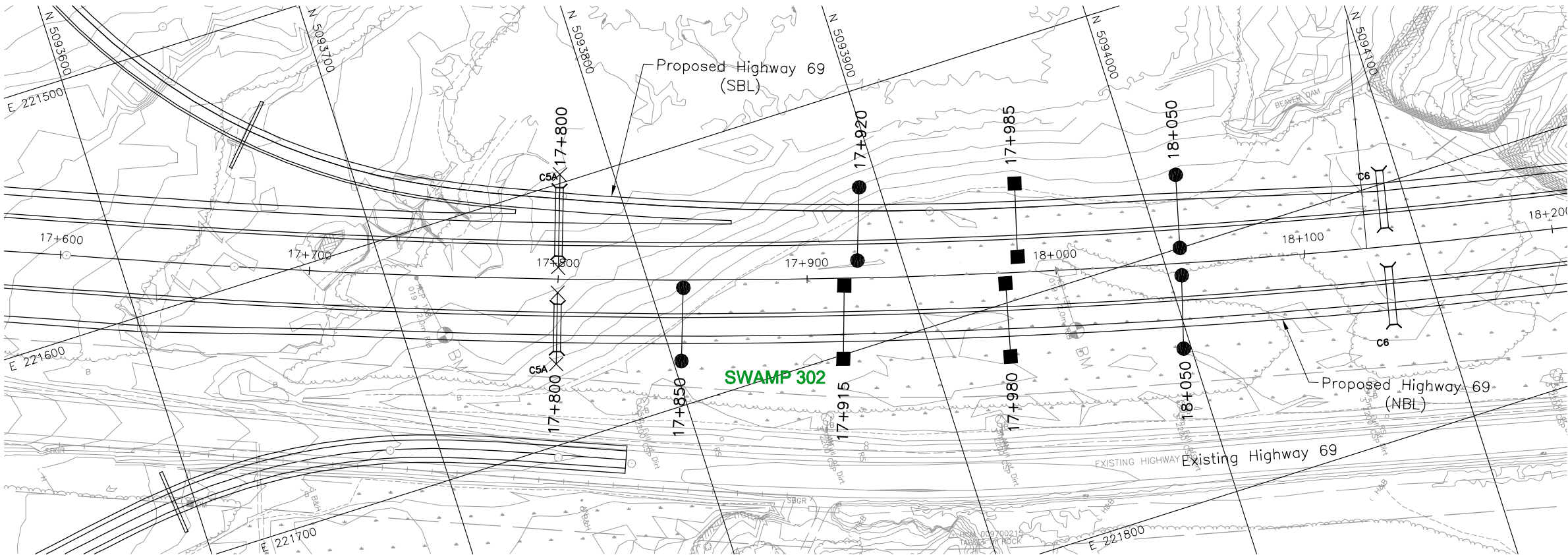
**Golder Associates Ltd.**  
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN

LEGEND

- — ● Monitoring Section — Type A
- — ■ Monitoring Section — Type B
- × — × Monitoring Section — Type C



PLAN

SCALE  
20 0 20 40 m

NOTES

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The boundaries between soil strata have been established only at borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

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

REFERENCE

Base plans provided in digital format by MRC, drawing file no. PHASE 3 Plan 090211 - Golder.dwg, received February 11, 2009.



|                     |                         |                 |          |
|---------------------|-------------------------|-----------------|----------|
| Geocres No. 41H-106 |                         |                 |          |
| NO.                 | DATE                    | BY              | REVISION |
| HWY. 69             | PROJECT NO. 06-1111-025 |                 | DIST.    |
| SUBM'D. MWK         | CHKD. MWK               | DATE: Feb, 2012 | SITE:    |
| DRAWN: JFC/RJ       | CHKD. VA/CN             | APPD. JPD/JMAC  | DWG. H5  |



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

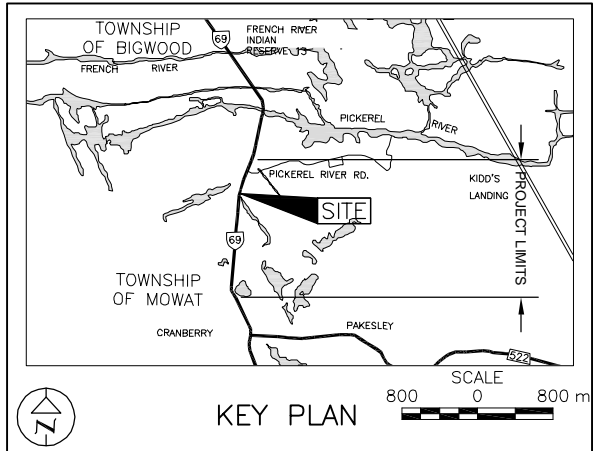
CONT No.  
GWP No. 5203-06-00

SWAMP 305  
HIGHWAY 69 (SBL) STA 16+075 TO 16+325  
MONITORING SECTION LOCATION PLAN

SHEET



**Golder Associates Ltd.**  
MISSISSAUGA, ONTARIO, CANADA



LEGEND

●

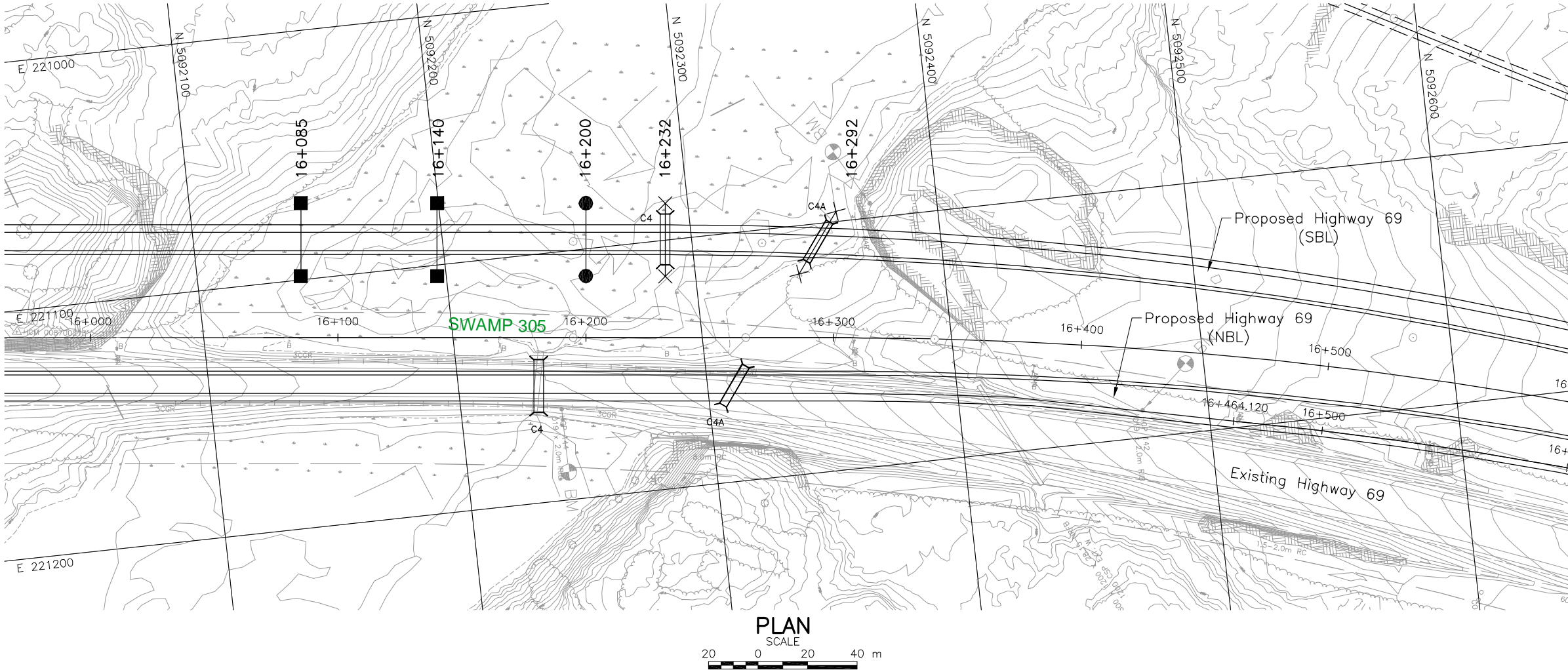
■

×

Monitoring Section – Type A

Monitoring Section – Type B

Monitoring Section – Type C



NOTES

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REFERENCE

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|                     |             |                         |          |
|---------------------|-------------|-------------------------|----------|
|                     |             |                         |          |
| NO.                 | DATE        | BY                      | REVISION |
| Geocres No. 41H-106 |             |                         |          |
| HWY. 69             |             | PROJECT NO. 06-1111-025 | DIST.    |
| SUBM'D. MWK         | CHKD. MWK   | DATE: Feb, 2012         | SITE:    |
| DRAWN: JFC/RJ       | CHKD. VA/CN | APPD. JPD/JMAC          | DWG. H6  |



CONT No.  
GWP No. 5203-06-00

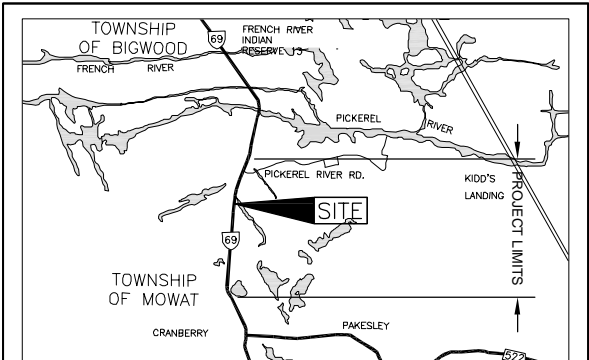


SWAMP 306  
HIGHWAY 69 (SBL) STA. 15+350 TO 15+800  
MONITORING SECTION LOCATION PLAN

SHEET






**Golder Associates Ltd.**  
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN

800 0 800 m

## LEGEND

-  Monitoring Section – Type A  
 Monitoring Section – Type B  
 Monitoring Section – Type C

## NOTES

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## REFERENCE

Base plans provided in digital format by MRC, drawing file no. PHASE 3  
Plan 090211 - Golder.dwg, received February 11, 2009.

|                     |             |                         |          |         |  |
|---------------------|-------------|-------------------------|----------|---------|--|
|                     |             |                         |          |         |  |
|                     |             |                         |          |         |  |
|                     |             |                         |          |         |  |
| NO.                 | DATE        | BY                      | REVISION |         |  |
| Geocres No. 41H-106 |             |                         |          |         |  |
| HWY. 69             |             | PROJECT NO. 06-1111-025 |          | DIST.   |  |
| SUBM'D. MWK         | CHKD. MWK   | DATE: Feb, 2012         |          | SITE:   |  |
| DRAWN: JFC/RJ       | CHKD. VA/CN | APPD. JPD/JMAC          |          | DWG. H7 |  |



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

CONT No.  
GWP No. 5203-06-00

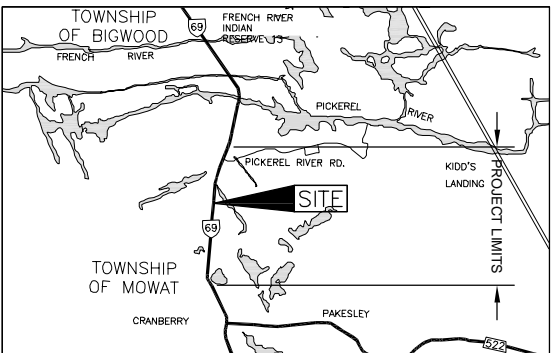


SWAMP 307  
HIGHWAY (SBL) STA. 14+425 TO 14+500  
MONITORING SECTION LOCATION PLAN

SHEET



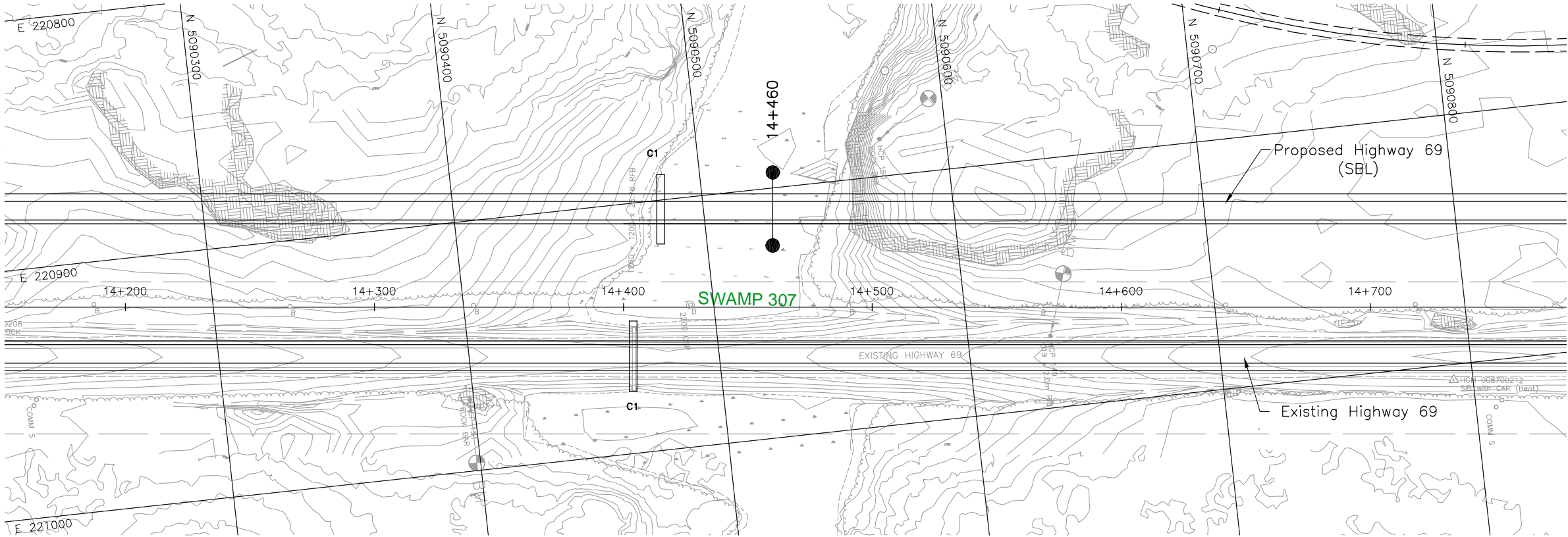
**Golder Associates Ltd.**  
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN

LEGEND

Monitoring Section – Type A



PLAN

SCALE  
20 0 20 40 m

NOTES

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

REFERENCE

Base plans provided in digital format by MRC, drawing file no. PHASE 3 Plan 090211 – Golder.dwg, received February 11, 2009.



|                     |                         |                 |          |
|---------------------|-------------------------|-----------------|----------|
| NO.                 | DATE                    | BY              | REVISION |
| 1                   |                         |                 |          |
| Geocres No. 41H-106 |                         |                 |          |
| HWY. 69             | PROJECT NO. 06-1111-025 |                 | DIST.    |
| SUBM'D. MWK         | CHKD. MWK               | DATE: Feb, 2012 | SITE:    |
| DRAWN: JFC/RJ       | CHKD. VA/CN             | APPD. JPD/JMAC  | DWG. HB  |

## **FOUNDATION MONITORING PROGRAM – Item No.**

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### **Non-Standard Special Provision**

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#### **1.0 GENERAL**

This Non-Standard Special Provision contains the requirements for the monitoring of the following geotechnical instruments:

- Settlement Plates (SP);
- Vibrating Wire Piezometers (VWP);
- Standpipe Piezometers (SPP).
- Settlement Pins (S);
- Nail Pins (NP);

The instrumentation monitoring services include: requirements for data collection; data reduction and reporting; and adherence to criteria used to assess the embankment performance based on the monitoring data collected from the instruments installed by others.

##### **1.0.1 Specialist Qualifications**

The Foundation Engineering Consultant services required for this assignment have been categorized as “Geotechnical specialty – High Complexity”.

The Foundation Engineering Consultants that are registered in MTO’s consultant registry acquisition system (RAQS) at complexity ratings in the required specialty that meet or exceed the identified complexity requirement for this assignment are eligible to provide Foundation Engineering services for this project. The Foundation Consultant shall not be the same Foundation Consultant retained by the Contractor for the supply and installation of embankment monitoring equipment.

The Foundation Engineer shall have a minimum of five (5) years experience in the supply, installation and monitoring of vibrating wire piezometers, standpipe piezometers, settlement plates, settlement pins, nail pins and survey bench marks or alternatively demonstrate expertise through providing satisfactory supply, installation and monitoring services for the instrumentation specified for a minimum of two (2) projects in which the work was similar in scope to that in the contract.

##### **1.0.2 Services, Deliverables and Records**

The Foundation Engineering Consultant shall:

- Review the monitoring program and, if deemed necessary, submit in writing to the Contract Administrator recommendations for modifications to the Monitoring Program;
- Meet with the Contractor in order to receive the Portable Laptop Computer used for downloading data from the DataLoggers that are monitoring the vibrating wire piezometers and the Water Level Indicator used for monitoring the standpipe piezometers, and to receive reports with details about installation of instruments installed by the Contractor and calibration certificates, as specified in

the Special Provision titled, “Supply and Installation of Embankment Monitoring Equipment”, included in the contract documents;

- With the exception of the Portable Laptop Computer, DataLoggers and Water Level Indicator referred to above and all instruments installed by the Contractor, supply all materials and equipment that are required for the Monitoring Program;
- Calibrate and maintain monitoring equipment;
- Take instrument readings, reduce data, prepare reports;
- Provide transmittal of instrumentation readings and reports to the Contract Administrator;
- Interpret instrumentation readings as needed for the purpose of on-going construction;
- Notify the Contract Administrator of required modifications to the construction procedures accordingly, if necessary. Interpretation shall include making correlations between instrumentation data and specific construction activities; and
- Notify the Contract Administrator if critical instrument readings, as specified herein, for any instrumentation are reached. Discuss as soon as possible (within 48 hours) with the Contract Administrator response action(s), and submit a plan of actions, to prevent the critical instrument readings to be exceeded.

Progress reports shall be submitted to the Contract Administrator, the MTO Contract Services Administrator and the MTO Foundations Engineer. As a minimum, progress reports shall be submitted on a monthly basis. Weekly reports shall be issued from the beginning of construction monitoring to the end of the one month period immediately after the top of the surcharge fill is reached. Thereafter, one report shall be submitted after each set of readings is taken. The progress reports shall discuss the Contractor’s operations with respect to the installation of instrumentation and/or a summary of the monitoring completed.

The Foundation Engineering Consultant shall maintain a Foundations Monitoring Diary. The diary shall document original conditions, work in progress, including any unusual or problem situations that arise, record of actions taken by the Contractor to rectify the situation, and restored conditions. The diary shall be supported by photographs of these conditions.

### 1.0.3 Submission of Foundation Monitoring Plan

The Foundation Engineering Consultant shall, in a brief narrative, discuss the applicable experience and qualifications of specialist staff, the role each will play in administration of the Contract, the authority to be assumed, and the reporting relationships with the construction administration staff.

The Consultant shall also complete the Foundation Monitoring Plan table in the format provided below.

| <b>Foundation Monitoring Plan</b>                                  |                                      |  |
|--|--------------------------------------|--|
| <b><i>Major Inspection Tasks</i></b>                               | <b><i>Level of Inspection</i></b>    | <b><i>Deliverable Record(s)</i></b>                |
| List major inspection tasks associated with foundation monitoring. | State frequency/level of inspection. | List associated Deliverable Records for each task. |

#### 1.0.4 Purpose

The purpose of this Monitoring Program is to monitor settlements and pore water pressures in the foundation soils at select locations during construction of the new Highway 69 embankments (including surcharge) over wick drain foundations between the following stations:

- Highway 69 SBL – STA 17+750 to 18+125 (Swamp 302)
- Highway 69 NBL – STA 17+750 to 18+100 (Swamp 302)
- Highway 69 SBL – STA 16+075 to 16+325 (Swamp 305)
- Highway 69 SBL – STA 15+360 to 15+750 (Swamp 306)
- Highway 69 SBL – STA 14+425 to 14+490 (Swamp 307)

The rate of fill placement and the timing for the removal of surcharge shall be controlled by the instrumentation readings.

#### 1.0.5 Drawings

Reference shall be made to the drawings titled, “Embankment Monitoring Program - Plan, Sections”, “Typical Instrument Installation Details” and “Monitoring Section Location Plans” included in the Contract Package.

#### 1.0.6 Subsurface Conditions

The subsurface Conditions at the site are described in Foundation Investigation Reports as specified elsewhere in the Contract Documents.

#### 1.0.7 Equipment Operation

Monitoring shall be conducted year round. All monitoring equipment shall be maintained and rendered operational throughout the monitoring period.

Any equipment malfunction shall be investigated and attempts shall be made to remedy the malfunction. Notification of any equipment malfunction and equipment that cannot be repaired shall be made to the Contract Administrator. Documentation of the possible causes and suggested remedial measures shall be forwarded to the Contract Administrator.

### 1.0.8 Reading Schedule and Frequency

The Foundation Engineering Consultant shall save and archive raw data in electronic and hard copy format.

Monitoring shall commence immediately after the installation of an instrument. Monitoring is to continue during a period from the start of embankment construction to at least six (6) months following surcharge removal. The actual length of the monitoring period depends on the construction schedule and the results of monitoring amongst other factors.

The minimum monitoring frequencies along with the anticipated number of readings for the embankments in this contract are given in Tables 1a to 1d. The monitoring frequency is the same for each individual instrument indicated in the following tables. Instruments shall be read more or less frequently if judged to be required by the Contract Administrator.

It should be noted that the number of readings given in Tables 1a to 1d are estimates and may vary depending on the actual construction schedule.

**Table 1a – Minimum Monitoring Frequency for the Staged Construction of Highway 69 Embankments (NBL and SBL) in Swamp 302 SBL/NBL**

| Stage   | Frequency  | Anticipated Number of Readings Per Monitoring Section <sup>1</sup> |
|---|--|--|
| Baseline Readings <sup>2</sup>  | Three readings on 3 consecutive days, no sooner than 7 days following installation             | 3  |
| Just prior to start of embankment construction  | Once   | 1  |
| During embankment construction (including surcharge placement)  | Once every 1.5 m fill lift within 20 m of the monitoring section                               | 6  |
| Waiting period after end of embankment construction to top of surcharge and prior to surcharge removal (anticipated duration: about 4 months) | Weekly: First month<br>Bi-weekly: Second month<br>Monthly: Third month to removal of surcharge | 8  |
| After surcharge removal to completion of consultant assignment  | Weekly: First month<br>Monthly: Second month to 6 months following surcharge removal           | 9  |

NOTE: 1. Due to uncertainty of the construction schedule, the anticipated number of readings per monitoring section is not equivalent to the number of site visits required to carry out the monitoring program described herein.

2. Baseline readings: Value of instrumentation readings taken prior to construction to provide a baseline against which all subsequent readings are compared to assess movements of the ground and changes in piezometric head.

**Table 1b – Minimum Monitoring Frequency for the Staged Construction of Highway 69 Embankment (SBL) in Swamp 305 SBL**

| <b>Stage</b>  | <b>Frequency</b>   | <b>Anticipated Number of Readings Per Monitoring Section<sup>1</sup></b> |
|---|--|--|
| Baseline Readings <sup>2</sup>  | Three readings on 3 consecutive days, no sooner than 7 days following installation             | 3  |
| Just prior to start of embankment construction  | Once   | 1  |
| During embankment construction (including surcharge placement)  | Once every 1.5 m fill lift within 20 m of the monitoring section                               | 4  |
| Waiting period after end of embankment construction to top of surcharge and prior to surcharge removal (anticipated duration: about 4 months) | Weekly: First month<br>Bi-weekly: Second month<br>Monthly: Third month to removal of surcharge | 8  |
| After surcharge removal to completion of consultant assignment  | Weekly: First month<br>Monthly: Second month to 6 months following surcharge removal           | 9  |

NOTE: 1. Due to uncertainty of the construction schedule, the anticipated number of readings per monitoring section is not equivalent to the number of site visits required to carry out the monitoring program described herein.

2. Baseline readings: Value of instrumentation readings taken prior to construction to provide a baseline against which all subsequent readings are compared to assess movements of the ground and changes in piezometric head.

**Table 1c – Minimum Monitoring Frequency for the Staged Construction of Highway 69 Embankment (SBL) in Swamp 306 SBL**

| <b>Stage</b>   | <b>Frequency</b>   | <b>Anticipated Number of Readings Per Monitoring Section<sup>1</sup></b> |
|--|--|--|
| Baseline Readings <sup>2</sup>                                 | Three readings on 3 consecutive days, no sooner than 7 days following installation | 3  |
| Just prior to start of embankment construction                 | Once   | 1  |
| During embankment construction (including surcharge placement) | Once every 1.5 m fill lift within 20 m of the monitoring section                   | 4  |

|   |  |   |
|---|--|---|
| Waiting period after end of embankment construction to top of surcharge and prior to surcharge removal (anticipated duration: about 4 months) | Weekly: First month<br>Bi-weekly: Second month<br>Monthly: Third month to removal of surcharge | 8 |
| After surcharge removal to completion of consultant assignment  | Weekly: First month<br>Monthly: Second month to 6 months following surcharge removal           | 9 |

NOTE: 1. Due to uncertainty of the construction schedule, the anticipated number of readings per monitoring section is not equivalent to the number of site visits required to carry out the monitoring program described herein.

2. Baseline readings: Value of instrumentation readings taken prior to construction to provide a baseline against which all subsequent readings are compared to assess movements of the ground and changes in piezometric head.

**Table 1d – Minimum Monitoring Frequency for the Staged Construction of Highway 69 Embankment (SBL) in Swamp 307 SBL**

| Stage   | Frequency  | Anticipated Number of Readings Per Monitoring Section <sup>1</sup> |
|---|--|--|
| Baseline Readings <sup>2</sup>  | Three readings on 3 consecutive days, no sooner than 7 days following installation             | 3  |
| Just prior to start of embankment construction  | Once   | 1  |
| During embankment construction (including surcharge placement)  | Once every 1.5 m fill lift within 20 m of the monitoring section                               | 4  |
| Waiting period after end of embankment construction to top of surcharge and prior to surcharge removal (anticipated duration: about 5 months) | Weekly: First month<br>Bi-weekly: Second month<br>Monthly: Third month to removal of surcharge | 8  |
| After surcharge removal to completion of consultant assignment  | Weekly: First month<br>Monthly: Second month to 6 months following surcharge removal           | 9  |

NOTE: 1. Due to uncertainty of the construction schedule, the anticipated number of readings per monitoring section is not equivalent to the number of site visits required to carry out the monitoring program described herein.

2. Baseline readings: Value of instrumentation readings taken prior to construction to provide a baseline against which all subsequent readings are compared to assess movements of the ground and changes in piezometric head.



## **2.0 INSTRUMENTATION SPECIFIC REQUIREMENTS**

### **2.0.1 Settlement Plates (SP), Settlement Pins (S) and Nail Pins (NP)**

#### **Surveying**

The elevations of Settlement Plates, Settlement Pins and Nail Pins shall be surveyed to an accuracy of plus/minus 2 mm or better and shall be reported to the nearest millimetre.

Surveying for settlement monitoring shall be conducted by a registered surveyor with appropriate equipment and experience. The surveyor shall be retained by the Foundation Engineering Consultant.

#### **Reporting**

A brief interpretation of the updated monitoring data shall be reported to the Contract Administrator within five (5) working days after each set of readings is obtained. A full set of up-to-date and processed monitoring data shall be presented in tabular and graphical form in the Progress Reports.

As a minimum, the following shall be submitted to the Contract Administrator in the Progress Reports based on the readings collected from the SPs, Ss and NPs:

- A plot of settlement of the base of the embankments (SPs) versus time;
- A plot of settlement of the temporary culvert (SPs and NPs) versus time;
- A plot of settlement of the top of the surcharge (Ss) versus time;
- Fill height within 20 m of the instruments versus time;
- Plan view, cross section and profile sketches showing the top of fill location while the SPs, Ss and NPs were being surveyed.

#### **Review and Alert Levels**

Typically, embankment failures result in an acceleration of settlements after placement of a lift of fill. If any of these conditions is observed or the maximum settlement measured exceeds the Review Levels in Table 2a, the Foundation Monitoring Consultant shall immediately inform the Contract Administrator and discuss response action(s). The Foundation Monitoring Consultant shall submit a plan of action(s) to prevent Alert Levels being reached. All construction work shall be continued such that instrument Alert Levels are not reached.

If the maximum settlement measured exceeds the Alert Levels in Table 2a, the Foundation Monitoring Consultant shall immediately inform the Contract Administrator and the Contract Administrator shall instruct the Contractor to stop all construction activities on and within the embankment. No construction shall take place on the affected embankment until all the following conditions are satisfied:

- The cause of the accelerated settlement has been identified and analyzed by the Foundation Engineer;
- Any corrective action deemed necessary by the Foundation Engineer has been implemented;
- The Contract Administrator deems it safe to proceed.

**Table 2a – Review and Alert Levels for Instruments Monitoring Settlements**

| Instrument Type        | Swamp Crossing | Monitoring Section | Station  | Offset from CL of Specified Lane (m) | Settlement Response Levels (mm) |       |
|------------------------|----------------|--------------------|----------|--------------------------------------|---------------------------------|-------|
|                        |                |                    |          |                                      | Review                          | Alert |
| Settlement Plates (SP) | Swamp 302 SBL  | C                  | 17+800   | 11.5 m Lt                            | 340                             | 440   |
|                        |                |                    |          | 3 m Lt                               | 490                             | 640   |
|                        |                |                    |          | 3 m Rt                               | 490                             | 640   |
|                        |                |                    |          | 11.5 m Rt                            | 390                             | 510   |
|                        |                | A                  | 17+920   | 3 m Lt                               | 570                             | 740   |
|                        |                |                    |          | 3 m Rt                               | 570                             | 740   |
|                        |                | B                  | 17+985   | 3 m Lt                               | 580                             | 750   |
|                        |                |                    |          | 3 m Rt                               | 580                             | 750   |
|                        |                | A                  | 18+050   | 3 m Lt                               | 600                             | 780   |
|                        |                |                    |          | 3 m Rt                               | 600                             | 780   |
|                        | Swamp 302 NBL  | C                  | 17+800   | 12.5 m Lt                            | 460                             | 600   |
|                        |                |                    |          | 3 m Lt                               | 440                             | 570   |
|                        |                |                    |          | 3 m Rt                               | 440                             | 570   |
|                        |                |                    |          | 12.5 m Rt                            | 410                             | 530   |
|                        |                | A                  | 17+850   | 3 m Lt                               | 400                             | 520   |
|                        |                |                    |          | 3 m Rt                               | 400                             | 520   |
|                        |                | B                  | 17+915   | 3 m Lt                               | 500                             | 650   |
|                        |                |                    |          | 3 m Rt                               | 500                             | 650   |
|                        |                | B                  | 17+980   | 3 m Lt                               | 135                             | 540   |
|                        |                |                    |          | 3 m Rt                               | 135                             | 540   |
|                        |                | A                  | 18+050   | 3 m Lt                               | 670                             | 870   |
|                        |                |                    |          | 3 m Rt                               | 670                             | 870   |
|                        | Swamp 305 SBL  | B                  | 16+140   | 3 m Lt                               | 600                             | 780   |
|                        |                |                    |          | 3 m Rt                               | 600                             | 780   |
|                        |                | A                  | 16+200   | 3 m Lt                               | 390                             | 510   |
|                        |                |                    |          | 3 m Rt                               | 390                             | 510   |
|                        |                | C                  | 16+232   | 11.5 m Lt                            | 510                             | 660   |
|                        |                |                    |          | 3 m Lt                               | 690                             | 900   |
|                        |                |                    |          | 3 m Rt                               | 690                             | 900   |
|                        |                |                    |          | 11.5 m Rt                            | 530                             | 690   |
|                        |                | C                  | 16+286.5 | 11.5 m Lt                            | 510                             | 660   |
|                        |                |                    | 16+289.5 | 3 m Lt                               | 600                             | 780   |
|                        |                |                    | 16+294.5 | 3 m Rt                               | 600                             | 780   |
|                        |                |                    | 16+297.5 | 11.5 m Rt                            | 510                             | 660   |
|                        | Swamp 306 SBL  | A                  | 15+400   | 3 m Lt                               | 570                             | 740   |
|                        |                |                    |          | 3 m Rt                               | 570                             | 740   |
|                        |                | B                  | 15+450   | 3 m Lt                               | 730                             | 950   |
|                        |                |                    |          | 3 m Rt                               | 730                             | 950   |
|                        |                | B                  | 15+500   | 3 m Lt                               | 720                             | 940   |
|                        |                |                    |          | 3 m Rt                               | 720                             | 940   |
|                        |                | A                  | 15+550   | 3 m Lt                               | 680                             | 880   |
|                        |                |                    |          | 3 m Rt                               | 680                             | 880   |
|                        |                | B                  | 15+600   | 3 m Lt                               | 810                             | 1050  |
|                        |                |                    |          | 3 m Rt                               | 810                             | 1050  |

|                          |                  |   |          |           |     |     |
|--------------------------|------------------|---|----------|-----------|-----|-----|
|                          | Swamp 307<br>SBL | C | 15+648.5 | 10.5 m Lt | 250 | 330 |
|                          |                  |   | 15+651.5 | 3 m Lt    | 520 | 680 |
|                          |                  |   | 15+656.5 | 3 m Rt    | 560 | 730 |
|                          |                  |   | 15+659.5 | 10.5 m Rt | 240 | 310 |
|                          |                  | A | 14+460   | 3 m Lt    | 150 | 200 |
|                          |                  |   |          | 3 m Rt    | 150 | 200 |
| Settlement<br>Pin<br>(S) | Swamp 302<br>SBL | C | 17+801   | 6.0 m Lt  | 350 | 460 |
|                          |                  |   |          | 0 m       | 490 | 640 |
|                          |                  |   |          | 6.0 m Rt  | 410 | 530 |
|                          |                  | A | 17+921   | 6.0 m Lt  | 530 | 690 |
|                          |                  |   |          | 0 m       | 590 | 770 |
|                          |                  |   |          | 6.0 m Rt  | 530 | 690 |
|                          |                  | B | 17+986   | 6.0 m Lt  | 540 | 700 |
|                          |                  |   |          | 0 m       | 590 | 770 |
|                          |                  |   |          | 6.0 m Rt  | 540 | 700 |
|                          |                  | A | 18+051   | 6.0 m Lt  | 540 | 700 |
|                          |                  |   |          | 0 m       | 610 | 790 |
|                          |                  |   |          | 6.0 m Rt  | 540 | 700 |
| Settlement<br>Pin<br>(S) | Swamp 302<br>NBL | C | 17+801   | 6.0 m Lt  | 460 | 600 |
|                          |                  |   |          | 0 m       | 450 | 590 |
|                          |                  |   |          | 6.0 m Rt  | 410 | 530 |
|                          |                  | A | 17+851   | 6.0 m Lt  | 380 | 490 |
|                          |                  |   |          | 0 m       | 410 | 530 |
|                          |                  |   |          | 6.0 m Rt  | 380 | 490 |
|                          |                  | B | 17+916   | 6.0 m Lt  | 460 | 600 |
|                          |                  |   |          | 0 m       | 510 | 660 |
|                          |                  |   |          | 6.0 m Rt  | 460 | 600 |
|                          |                  | B | 17+981   | 6.0 m Lt  | 500 | 650 |
|                          |                  |   |          | 0 m       | 550 | 720 |
|                          |                  |   |          | 6.0 m Rt  | 500 | 650 |
|                          |                  | A | 18+051   | 6.0 m Lt  | 580 | 750 |
|                          |                  |   |          | 0 m       | 680 | 880 |
|                          |                  |   |          | 6.0 m Rt  | 580 | 750 |
|                          | Swamp 305<br>SBL | B | 16+141   | 6.0 m Lt  | 530 | 690 |
|                          |                  |   |          | 0 m       | 620 | 810 |
|                          |                  |   |          | 6.0 m Rt  | 530 | 690 |
|                          |                  | A | 16+201   | 6.0 m Lt  | 340 | 440 |
|                          |                  |   |          | 0 m       | 410 | 530 |
|                          |                  |   |          | 6.0 m Rt  | 340 | 440 |
|                          |                  | C | 16+233   | 6.0 m Lt  | 510 | 660 |
|                          |                  |   |          | 0 m       | 720 | 940 |
|                          |                  |   |          | 6.0 m Rt  | 550 | 720 |
|                          |                  | C | 16+290   | 6.0 m Lt  | 560 | 730 |
|                          |                  |   | 16+293   | 0 m       | 620 | 810 |
|                          |                  |   | 16+296   | 6.0 m Rt  | 560 | 730 |
|                          | Swamp 306<br>SBL | A | 15+401   | 6.0 m Lt  | 510 | 660 |
|                          |                  |   |          | 0 m       | 590 | 770 |
|                          |                  |   |          | 6.0 m Rt  | 510 | 660 |
|                          |                  | B | 15+451   | 6.0 m Lt  | 640 | 830 |
|                          |                  |   |          | 0 m       | 750 | 980 |

|                  |                  |   |                     |  |     |      |
|------------------|------------------|---|---------------------|--|-----|------|
|                  |                  | B | 15+501              | 6.0 m Rt   | 640 | 830  |
|                  |                  |   |                     | 6.0 m Lt   | 640 | 830  |
|                  |                  |   |                     | 0 m  | 740 | 960  |
|                  |                  |   |                     | 6.0 m Rt   | 640 | 830  |
|                  |                  | A | 15+551              | 6.0 m Lt   | 600 | 780  |
|                  |                  |   |                     | 0 m  | 700 | 910  |
|                  |                  |   |                     | 6.0 m Rt   | 600 | 780  |
|                  |                  | B | 15+601              | 6.0 m Lt   | 710 | 920  |
|                  |                  |   |                     | 0 m  | 830 | 1080 |
|                  |                  |   |                     | 6.0 m Rt   | 710 | 920  |
|                  |                  | C | 15+652              | 6.0 m Lt   | 520 | 680  |
|                  |                  |   | 15+655              | 0 m  | 270 | 350  |
|                  |                  |   | 15+658              | 6.0 m Rt   | 480 | 620  |
|                  | Swamp 307<br>SBL | A | 14+461              | 6.0 m Lt   | 120 | 160  |
|                  |                  |   |                     | 0 m  | 170 | 220  |
|                  |                  |   |                     | 6.0 m Rt   | 120 | 160  |
| Nail Pin<br>(NP) | Swamp 302<br>SBL | C | 17+800 <sup>1</sup> | 0.5 m of West end<br>of the temporary<br>culvert | 190 | 250  |
|                  |                  |   |                     | 0.5 m of East end of<br>the temporary<br>culvert | 290 | 380  |
|                  | Swamp 302<br>NBL | C | 17+800 <sup>1</sup> | 0.5 m of West end<br>of the temporary<br>culvert | 480 | 620  |
|                  |                  |   |                     | 0.5 m of East end of<br>the temporary<br>culvert | 380 | 490  |
|                  | Swamp 305<br>SBL | C | 16+232 <sup>1</sup> | 0.5 m of West end<br>of the temporary<br>culvert | 310 | 400  |
|                  |                  |   |                     | 0.5 m of East end of<br>the temporary<br>culvert | 340 | 440  |
|                  |                  | C | 16+292 <sup>1</sup> | 0.5 m of West end<br>of the temporary<br>culvert | 410 | 530  |
|                  |                  |   |                     | 0.5 m of East end of<br>the temporary<br>culvert | 410 | 530  |
|                  | Swamp 306<br>SBL | C | 15+654 <sup>1</sup> | 0.5 m of West end<br>of the temporary<br>culvert | 200 | 260  |
|                  |                  |   |                     | 0.5 m of East end of<br>the temporary<br>culvert | 240 | 310  |

NOTE: 1. Stations for the nail pins are approximate. All nail pins shall be installed on the top of the temporary culverts and along the culvert's centreline based on the locations above.

## 2.0.2 Vibrating Wire Piezometers (VWP) and Standpipe Piezometers (SPP)

### Readout Unit

The VWPs and SPPs shall be read using the Portable Laptop Computer and Water Level Indicator, respectively, supplied by the Contractor.

### Coordination of Readings

The VWP data reduction (calculation of excess pore pressure) requires the groundwater level elevation at the time the VWPs are read. Therefore, the elevation of the SPPs should be obtained by surveying on the same day the VWPs and groundwater depth in the SPPs are monitored.

### Surveying

The elevations of the top of the SPPs shall be surveyed to an accuracy of plus/minus 2 mm or better and shall be reported to the nearest millimetre.

Surveying shall be conducted by a registered surveyor with appropriate equipment and experience. The surveyor shall be retained by the Foundation Consultant.

### Reporting

A brief interpretation of the updated monitoring data shall be reported to the Contract Administrator within one (1) day during construction and within five (5) working days after each set of readings is obtained. A full set of up-to-date and processed monitoring data shall be presented in tabular and graphical form in the Progress Reports.

As a minimum, the following shall be submitted to the Contract Administrator in the Progress Reports based on the readings collected from the VWPs and SPPs:

- Plots of piezometric elevation versus time for VWPs located in the same monitoring section and at the same approximate relative position with respect to the embankment centreline;
- Same as above for excess pore pressure (EPP);
- Plots of EPP versus embankment height, for VWPs located in the same monitoring section and at the same approximate relative position with respect to the embankment centreline;
- Plots of groundwater elevation versus time for SPPs for each monitoring section;
- Plots of fill height versus time;
- Plan view, cross section and profile sketches showing the top of fill location while the VWP and SPP readings were being taken.

### Review and Alert Levels

The increase in pore pressure in the foundation soils associated with the placement of fill lifts should be equal to or lower than the increase in total vertical stress due to the fill

placement. The failure of embankments founded on soft soils is usually associated with increases in pore pressure in excess of the increase in total stress as described above. If any of these conditions is observed or the maximum excess pore pressure measured exceeds the Review Levels in Table 2b, the Foundation Monitoring Consultant shall immediately inform the Contract Administrator and discuss response action(s). The Foundation Monitoring Consultant shall submit a plan of action(s) to prevent Alert Levels being reached. All construction work shall be continued such that the instrument Alert Levels are not reached.

If the maximum excess pore pressure measured exceeds the Alert Levels in Table 2b, the Foundation Monitoring Consultant shall immediately inform the Contract Administrator and the Contract Administrator shall instruct the Contractor to stop all construction activities on and within the embankment until all the following conditions are satisfied:

- The cause of the excess pore pressure has been identified and analyzed by the Foundation Engineer;
- Any corrective action deemed necessary by the Foundation Engineer has been implemented;
- The Contract Administrator deems it safe to proceed.

**Table 2b – Review and Alert Levels for Excess Pore Pressures**

| Swamp Crossing | Section Type | Station | Offset from CL of Specified Lane (m) | Elevation (m) | Stage         | Excess Pore Pressure (EPP) – Response Levels (kPa) |             |                                    |
|----------------|--------------|---------|--------------------------------------|---------------|---------------|--|-------------|------------------------------------|
|                |              |         |                                      |               |               | Review Level                                       | Alert Level | Maximum EPP Before Following Stage |
| Swamp 302 SBL  | C            | 17+800  | 0.0                                  | 181.4         | 1             | 59   | 75          | 16                                 |
|                |              |         |                                      |               | 2             | 59   | 75          | 29                                 |
|                |              |         |                                      |               | 3             | 59   | 75          | 34                                 |
|                |              |         |                                      |               | 4 (Surcharge) | 59   | 75          | 6                                  |
|                |              |         | 0.0                                  | 180.0         | 1             | 58   | 69          | 15                                 |
|                |              |         |                                      |               | 2             | 58   | 69          | 26                                 |
|                |              |         |                                      |               | 3             | 58   | 69          | 19                                 |
|                |              |         |                                      |               | 4 (Surcharge) | 58   | 69          | 6                                  |
|                | A            | 17+920  | 0.0                                  | 181.4         | 1             | 64   | 76          | 16                                 |
|                |              |         |                                      |               | 2             | 64   | 76          | 28                                 |
|                |              |         |                                      |               | 3             | 64   | 76          | 37                                 |
|                |              |         |                                      |               | 4             | 64   | 76          | 44                                 |
|                |              |         |                                      |               | 5 (Surcharge) | 64   | 76          | 7                                  |
|                |              |         | 13.2 Lt                              | 181.4         | 1             | 41   | 48          | 10                                 |
|                |              |         |                                      |               | 2             | 39   | 47          | 17                                 |
|                |              |         |                                      |               | 3             | 38   | 46          | 21                                 |
|                |              |         |                                      |               | 4             | 36   | 45          | 15                                 |
|                |              |         |                                      |               | 5 (Surcharge) | 23   | 30          | 5                                  |
|                |              |         | 13.2 Rt                              | 181.4         | 1             | 41   | 48          | 10                                 |
|                |              |         |                                      |               | 2             | 39   | 47          | 17                                 |
|                |              |         |                                      |               | 3             | 38   | 46          | 21                                 |
|                |              |         |                                      |               | 4             | 36   | 45          | 15                                 |

|                  |               |        |               |               |               |    |     |    |
|------------------|---------------|--------|---------------|---------------|---------------|----|-----|----|
|                  |               |        |               |               | 5 (Surcharge) | 23 | 30  | 5  |
|                  |               |        | 0.0           | 180.0         | 1             | 39 | 50  | 15 |
|                  |               |        |               |               | 2             | 39 | 50  | 26 |
|                  |               |        |               |               | 3             | 39 | 50  | 34 |
|                  |               |        |               |               | 4             | 39 | 50  | 24 |
|                  | 5 (Surcharge) | 39     |               |               | 50            | 3  |     |    |
|                  | B             | 17+985 | 0.0           | 181.3         | 1             | 76 | 88  | 19 |
|                  |               |        |               |               | 2             | 76 | 88  | 33 |
|                  |               |        |               |               | 3             | 76 | 88  | 42 |
|                  |               |        |               |               | 4             | 76 | 88  | 49 |
|                  |               |        |               |               | 5 (Surcharge) | 76 | 88  | 7  |
|                  |               | 0.0    | 179.3         | 1             | 67            | 77 | 16  |    |
|                  |               |        |               | 2             | 67            | 77 | 29  |    |
|                  |               |        |               | 3             | 67            | 77 | 37  |    |
|                  |               |        |               | 4             | 67            | 77 | 47  |    |
|                  |               |        |               | 5 (Surcharge) | 67            | 77 | 6   |    |
|                  |               | A      | 18+050        | 0.0           | 183.5         | 1  | 42  | 49 |
|                  | 2             |        |               |               |               | 42 | 49  | 35 |
|                  | 3             |        |               |               |               | 48 | 65  | 39 |
|                  | 4 (Surcharge) |        |               |               |               | 66 | 93  | 6  |
|                  | 14.9 Lt       |        |               | 183.5         | 1             | 16 | 22  | 9  |
|                  |               |        |               |               | 2             | 16 | 22  | 14 |
|                  |               |        |               |               | 3             | 16 | 22  | 10 |
|                  |               |        |               |               | 4 (Surcharge) | 16 | 22  | 2  |
|                  | 14.9 Rt       |        |               | 183.5         | 1             | 16 | 22  | 9  |
|                  |               |        |               |               | 2             | 16 | 22  | 14 |
|                  |               |        |               |               | 3             | 16 | 22  | 10 |
|                  |               |        |               |               | 4 (Surcharge) | 16 | 22  | 2  |
|                  | 0.0           |        |               | 181.5         | 1             | 37 | 42  | 18 |
|                  |               |        |               |               | 2             | 37 | 42  | 31 |
|                  |               |        |               |               | 3             | 41 | 56  | 22 |
|                  |               |        |               |               | 4 (Surcharge) | 67 | 144 | 6  |
| Swamp 302<br>NBL | C             | 17+800 | 0.0           | 181.4         | 1             | 68 | 81  | 17 |
|                  |               |        |               |               | 2             | 68 | 81  | 30 |
|                  |               |        |               |               | 3             | 68 | 81  | 42 |
|                  |               |        |               |               | 4 (Surcharge) | 68 | 81  | 6  |
|                  |               |        | 0.0           | 180.3         | 1             | 62 | 75  | 16 |
|                  |               |        |               |               | 2             | 62 | 75  | 28 |
|                  |               |        |               |               | 3             | 62 | 75  | 23 |
|                  | A             | 17+850 | 0.0           | 181.6         | 4 (Surcharge) | 62 | 75  | 7  |
|                  |               |        |               |               | 1             | 82 | 95  | 20 |
|                  |               |        |               |               | 2             | 82 | 95  | 36 |
|                  |               |        |               |               | 3             | 82 | 95  | 47 |
|                  |               |        |               |               | 4             | 82 | 95  | 82 |
|                  |               |        |               |               | 5             | 82 | 95  | 64 |
|                  |               |        | 6 (Surcharge) | 82            | 95            | 9  |     |    |
|                  |               |        | 14.4 Lt       | 181.6         | 1             | 53 | 62  | 13 |
|                  |               |        |               |               | 2             | 48 | 57  | 21 |
|                  |               |        |               |               | 3             | 43 | 54  | 25 |
|                  |               |        |               |               | 4             | 40 | 51  | 27 |

|                  |   |        |         |       |               |     |     |    |
|------------------|---|--------|---------|-------|---------------|-----|-----|----|
|                  |   |        |         |       | 5             | 36  | 45  | 21 |
|                  |   |        |         |       | 6 (Surcharge) | 25  | 33  | 6  |
|                  |   |        | 14.4 Rt | 181.6 | 1             | 53  | 62  | 13 |
|                  |   |        |         |       | 2             | 48  | 57  | 21 |
|                  |   |        |         |       | 3             | 43  | 54  | 25 |
|                  |   |        |         |       | 4             | 40  | 51  | 27 |
|                  |   |        |         |       | 5             | 36  | 45  | 21 |
|                  |   |        |         |       | 6 (Surcharge) | 25  | 33  | 6  |
|                  |   |        | 0.0     | 179.5 | 1             | 64  | 78  | 18 |
|                  |   |        |         |       | 2             | 64  | 78  | 32 |
|                  |   |        |         |       | 3             | 64  | 78  | 41 |
|                  |   |        |         |       | 4             | 64  | 78  | 47 |
|                  |   |        |         |       | 5             | 64  | 78  | 37 |
|                  |   |        |         |       | 6 (Surcharge) | 64  | 114 | 9  |
|                  | B | 17+915 | 0.0     | 182.4 | 1             | 77  | 93  | 20 |
|                  |   |        |         |       | 2             | 77  | 93  | 35 |
|                  |   |        |         |       | 3             | 77  | 93  | 46 |
|                  |   |        |         |       | 4             | 77  | 93  | 49 |
|                  |   |        |         |       | 5 (Surcharge) | 77  | 93  | 8  |
|                  |   |        | 0.0     | 180.1 | 1             | 68  | 82  | 17 |
|                  |   |        |         |       | 2             | 68  | 82  | 31 |
|                  |   |        |         |       | 3             | 68  | 82  | 40 |
|                  |   |        |         |       | 4             | 68  | 82  | 48 |
|                  |   |        |         |       | 5 (Surcharge) | 68  | 82  | 7  |
|                  | B | 17+980 | 0.0     | 183.6 | 1             | 80  | 96  | 21 |
|                  |   |        |         |       | 2             | 80  | 96  | 36 |
|                  |   |        |         |       | 3             | 80  | 96  | 46 |
|                  |   |        |         |       | 4 (Surcharge) | 80  | 96  | 7  |
|                  |   |        | 0.0     | 181.4 | 1             | 68  | 83  | 18 |
|                  |   |        |         |       | 2             | 68  | 83  | 31 |
|                  |   |        |         |       | 3             | 68  | 83  | 43 |
|                  |   |        |         |       | 4 (Surcharge) | 68  | 83  | 6  |
|                  | A | 18+050 | 0.0     | 183.3 | 1             | 41  | 48  | 20 |
|                  |   |        |         |       | 2             | 41  | 48  | 35 |
|                  |   |        |         |       | 3             | 47  | 63  | 39 |
|                  |   |        |         |       | 4 (Surcharge) | 66  | 92  | 6  |
|                  |   |        | 14.4 Lt | 183.3 | 1             | 17  | 22  | 9  |
|                  |   |        |         |       | 2             | 17  | 22  | 15 |
|                  |   |        |         |       | 3             | 17  | 22  | 10 |
|                  |   |        |         |       | 4 (Surcharge) | 16  | 22  | 2  |
|                  |   |        | 14.4 Rt | 183.3 | 1             | 17  | 22  | 9  |
|                  |   |        |         |       | 2             | 17  | 22  | 15 |
|                  |   |        |         |       | 3             | 17  | 22  | 10 |
|                  |   |        |         |       | 4 (Surcharge) | 16  | 22  | 2  |
|                  |   |        | 0.0     | 181.4 | 1             | 36  | 42  | 17 |
|                  |   |        |         |       | 2             | 36  | 42  | 30 |
|                  |   |        |         |       | 3             | 41  | 55  | 22 |
|                  |   |        |         |       | 4 (Surcharge) | 66  | 94  | 6  |
| Swamp 305<br>SBL | B | 16+140 | 0.0     | 176.7 | 1             | 108 | 144 | 13 |
|                  |   |        |         |       | 2             | 108 | 144 | 22 |



|                  |   |        |         |       |               |     |     |    |
|------------------|---|--------|---------|-------|---------------|-----|-----|----|
|                  |   |        | 0.0     | 171.0 | 3             | 108 | 144 | 24 |
|                  |   |        |         |       | 4 (Surcharge) | 108 | 144 | 14 |
|                  |   |        |         |       | 1             | 36  | 48  | 9  |
|                  |   |        |         |       | 2             | 36  | 48  | 16 |
|                  |   |        |         |       | 3             | 36  | 48  | 21 |
|                  | A | 16+200 | 0.0     | 178.2 | 4 (Surcharge) | 36  | 48  | 5  |
|                  |   |        |         |       | 1             | 126 | 168 | 14 |
|                  |   |        |         |       | 2             | 126 | 168 | 24 |
|                  |   |        |         |       | 3             | 126 | 168 | 29 |
|                  |   |        |         |       | 4 (Surcharge) | 126 | 168 | 17 |
|                  |   |        | 12.6 Lt | 178.2 | 1             | 36  | 47  | 9  |
|                  |   |        |         |       | 2             | 36  | 47  | 16 |
|                  |   |        |         |       | 3             | 36  | 47  | 18 |
|                  |   |        |         |       | 4 (Surcharge) | 36  | 47  | 5  |
|                  |   |        | 12.6 Rt | 178.2 | 1             | 36  | 47  | 9  |
|                  |   |        |         |       | 2             | 36  | 47  | 16 |
|                  |   |        |         |       | 3             | 36  | 47  | 18 |
|                  |   |        |         |       | 4 (Surcharge) | 36  | 47  | 5  |
|                  |   |        | 0.0     | 171.4 | 1             | 38  | 51  | 9  |
|                  |   |        |         |       | 2             | 38  | 51  | 16 |
|                  |   |        |         |       | 3             | 38  | 51  | 19 |
|                  |   |        |         |       | 4 (Surcharge) | 38  | 51  | 5  |
|                  | C | 16+232 | 0.0     | 176.4 | 1             | 53  | 71  | 14 |
|                  |   |        |         |       | 2             | 53  | 71  | 24 |
|                  |   |        |         |       | 3             | 53  | 71  | 25 |
|                  |   |        |         |       | 4 (Surcharge) | 53  | 71  | 7  |
|                  |   |        | 0.0     | 170.3 | 1             | 39  | 49  | 10 |
|                  |   |        |         |       | 2             | 39  | 49  | 17 |
|                  |   |        |         |       | 3             | 39  | 49  | 17 |
|                  |   |        |         |       | 4 (Surcharge) | 39  | 49  | 5  |
|                  | C | 16+292 | 0.0     | 181.0 | 1             | 132 | 177 | 18 |
|                  |   |        |         |       | 2             | 132 | 177 | 33 |
|                  |   |        |         |       | 3             | 132 | 177 | 35 |
|                  |   |        |         |       | 4 (Surcharge) | 132 | 177 | 17 |
|                  |   |        | 0.0     | 178.6 | 1             | 121 | 161 | 15 |
|                  |   |        |         |       | 2             | 121 | 161 | 27 |
|                  |   |        |         |       | 3             | 121 | 161 | 29 |
|                  |   |        |         |       | 4 (Surcharge) | 121 | 161 | 16 |
| Swamp 306<br>SBL | A | 15+400 | 0.0     | 184.7 | 1             | 76  | 99  | 19 |
|                  |   |        |         |       | 2             | 76  | 99  | 33 |
|                  |   |        |         |       | 3 (Surcharge) | 76  | 99  | 24 |
|                  |   |        | 11.4 Lt | 184.7 | 1             | 52  | 78  | 11 |
|                  |   |        |         |       | 2             | 45  | 52  | 17 |
|                  |   |        |         |       | 3 (Surcharge) | 28  | 34  | 17 |
|                  |   |        | 11.4 Rt | 184.7 | 1             | 52  | 78  | 11 |
|                  |   |        |         |       | 2             | 45  | 52  | 17 |
|                  |   |        |         |       | 3 (Surcharge) | 28  | 34  | 17 |
|                  |   |        | 0.0     | 183.4 | 1             | 55  | 73  | 17 |
|                  |   |        |         |       | 2             | 55  | 73  | 30 |
|                  |   |        |         |       | 3 (Surcharge) | 55  | 73  | 25 |

|                  |   |        |         |       |               |    |    |    |
|------------------|---|--------|---------|-------|---------------|----|----|----|
|                  | B | 15+450 | 0.0     | 185.3 | 1             | 56 | 75 | 19 |
|                  |   |        |         |       | 2             | 56 | 75 | 27 |
|                  |   |        |         |       | 3 (Surcharge) | 56 | 75 | 24 |
|                  |   |        | 0.0     | 182.7 | 1             | 45 | 60 | 15 |
|                  |   |        |         |       | 2             | 45 | 60 | 23 |
|                  |   |        |         |       | 3 (Surcharge) | 45 | 60 | 21 |
|                  | B | 15+500 | 0.0     | 185.4 | 1             | 50 | 62 | 19 |
|                  |   |        |         |       | 2             | 50 | 62 | 28 |
|                  |   |        |         |       | 3 (Surcharge) | 50 | 62 | 27 |
|                  |   |        |         | 182.4 | 1             | 39 | 48 | 15 |
|                  |   |        |         |       | 2             | 39 | 48 | 22 |
|                  |   |        |         |       | 3 (Surcharge) | 39 | 48 | 11 |
|                  | A | 15+550 | 0.0     | 185.6 | 1             | 67 | 75 | 19 |
|                  |   |        |         |       | 2             | 67 | 75 | 23 |
|                  |   |        |         |       | 3 (Surcharge) | 67 | 75 | 19 |
|                  |   |        | 10.4 Lt | 185.6 | 1             | 35 | 40 | 10 |
|                  |   |        |         |       | 2             | 34 | 38 | 12 |
|                  |   |        |         |       | 3 (Surcharge) | 20 | 25 | 13 |
|                  |   |        | 10.4 Rt | 185.6 | 1             | 35 | 40 | 10 |
|                  |   |        |         |       | 2             | 34 | 38 | 12 |
|                  |   |        |         |       | 3 (Surcharge) | 32 | 39 | 14 |
|                  |   |        | 0.0     | 181.8 | 2             | 32 | 39 | 16 |
|                  |   |        |         |       | 3 (Surcharge) | 32 | 39 | 17 |
|                  |   |        |         |       | 3 (Surcharge) | 32 | 39 | 17 |
|                  | B | 15+600 | 0.0     | 186.0 | 1             | 55 | 74 | 20 |
|                  |   |        |         |       | 2             | 55 | 74 | 24 |
|                  |   |        |         |       | 3 (Surcharge) | 55 | 74 | 22 |
|                  |   |        | 0.0     | 184.4 | 1             | 48 | 65 | 18 |
|                  |   |        |         |       | 2             | 48 | 65 | 31 |
|                  |   |        |         |       | 3 (Surcharge) | 48 | 65 | 20 |
|                  | C | 15+654 | 0.0     | 185.6 | 1             | 48 | 59 | 20 |
|                  |   |        |         |       | 2             | 48 | 59 | 24 |
|                  |   |        |         |       | 3 (Surcharge) | 48 | 59 | 24 |
|                  |   |        | 0.0     | 184.6 | 1             | 45 | 48 | 18 |
|                  |   |        |         |       | 2             | 45 | 48 | 22 |
|                  |   |        |         |       | 3 (Surcharge) | 45 | 48 | 21 |
| Swamp 307<br>SBL | A | 14+460 | 0.0     | 188.2 | 1             | 67 | 73 | 21 |
|                  |   |        |         |       | 2             | 67 | 73 | 37 |
|                  |   |        |         |       | 3 (Surcharge) | 67 | 73 | 23 |
|                  |   |        | 12.1 Lt | 188.2 | 1             | 35 | 38 | 11 |
|                  |   |        |         |       | 2             | 32 | 37 | 17 |
|                  |   |        |         |       | 3 (Surcharge) | 29 | 35 | 10 |
|                  |   |        | 12.1 Rt | 188.2 | 1             | 35 | 38 | 11 |
|                  |   |        |         |       | 2             | 32 | 37 | 17 |
|                  |   |        |         |       | 3 (Surcharge) | 29 | 35 | 10 |
|                  |   |        | 0.0     | 184.6 | 1             | 51 | 56 | 16 |
|                  |   |        |         |       | 2             | 51 | 56 | 28 |
|                  |   |        |         |       | 3 (Surcharge) | 51 | 56 | 17 |

### **3.0 CONTROL MONITORING LEVELS**

#### General

The monitoring program will provide input for the control of the appropriate time for embankment construction (preload fill) and surcharge placement, removal of surcharge and installation of permanent culverts.

#### Stabilization of Settlements due to Primary Consolidation

Settlement data monitored at the SPs, Ss and NPs allow for an approximate assessment of the total settlement due to primary consolidation and the approximate time required for settlements due to primary consolidation to stabilize.

The anticipated total settlement amount and the required time for settlements due to primary consolidation to stabilize shall be assessed for each of the SPs, Ss and NPs using an appropriate method.

### **4.0 FINAL REPORT**

At the completion of the monitoring program, a final monitoring report shall be issued to the Contract Administrator. The monitoring results shall be presented in tabular and graphical form as described above for each instrument type. Interpretation of the monitoring readings shall be included in the report.

At Golder Associates we strive to be the most respected global group of companies specializing in ground engineering and environmental services. Employee owned since our formation in 1960, we have created a unique culture with pride in ownership, resulting in long-term organizational stability. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees now operating from offices located throughout Africa, Asia, Australasia, Europe, North America and South America.

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