

FOUNDATION INVESTIGATION AND DESIGN REPORT
QEW BRONTE CREEK TWIN BRIDGE
OAKVILLE, ONTARIO
G.W.P. 169-00-00, SITE 10-150

Geocres Number: 30M5-236

Report to

McCormick Rankin Corporation

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation carried out at QEW and Bronte Creek in Oakville, Ontario. This location is the site of a proposed bridge to carry the QEW over Bronte Creek. The proposed structure will twin the existing structure.

The purpose of the investigation was to explore the subsurface conditions at the site and, based on the data obtained, to provide a borehole location plan, borehole logs, stratigraphic profile and cross-sections and a written description of the subsurface conditions. A model of the subsurface conditions was developed through interpretation of the data obtained in the course of the present investigation.

Thurber carried out the investigation as a sub-consultant to McCormick Rankin Corporation, under the Ministry of Transportation Ontario (MTO) Agreement Number 2005-A-000346.

2 SITE DESCRIPTION

The structure site is located adjacent to and on the south side of the existing structure carrying QEW over Bronte Creek. Bronte Road runs along the east valley slope of Bronte Creek and passes under QEW through the second from east span of the existing bridge.

The creek valley is incised approximately 25 m below the surrounding tableland. The valley slopes are steep and a short distance to the south of the site, at a bend in the creek, a near-vertical bluff is eroded in the shale bedrock. At the site, the width of the valley, crest-to-crest is approximately 220 m and the creek is approximately 20 m wide with a normal water level at Elevation 90.0 and the 100 year high water level at Elevation 91.3. The depth of water in the creek was measured at 280 mm on July 18, 2005.

Drainage in the site flows down the valley slopes and directly into Bronte Creek, which flows southward from the site to Lake Ontario.

Approximately 30 m south of the site, at the toe of the west valley slope there is a concrete structure that appears to be a former bridge abutment. There is an opening in the face of the structure that is assumed to be a storm outfall. Immediately opposite, on the east bank of the creek, there is a more recently constructed storm outfall.

The lands north of the QEW and west of Bronte Road are occupied by the Bronte Creek Provincial Park while to the north of QEW and east of Bronte Road lies Deerfield Golf Course. Within the latter area, the Halton Regional Centre lies on the east side of Bronte Road a short distance north of the QEW E – N/S Ramp terminal. To the south of QEW, the lands to the east and west have been developed for industrial and commercial uses.

3 SITE INVESTIGATION AND FIELD TESTING

Site investigation and field testing for this project was carried out between January 30 and April 2, 2002. Work on the project was suspended later in 2002 and was resumed in 2005. The site investigation and field testing was completed between July 29 and September 14, 2005.

A total of eighteen sampled boreholes have been drilled at the locations shown on the Borehole Locations and Soil Strata Drawing. Drilling was carried out using truck and track-mounted drill rigs equipped for auger drilling and for diamond coring.

The positions of the new boreholes relative to the structure site are as shown in Table 3.1.

Table 3.1 – Borehole Locations Relative to Structure

Location on Structure	Boreholes Considered in Design
West Approach	BH 02-1
West Abutment	BHs 02-2, 02-3, 02-4, 02-5
Pier #1	BHs 02-6, 02-7, 02-7A
Pier #2	BHs 02-8, 04-9
Pier #3	BHs 02-10, 02-11
Pier #4	BHs 05-12, 05-13
East Abutment	BH 05-14, 02-15
East Approach	BH 02-16

One borehole was also drilled at the north east corner of the existing bridge (BH 02-19) and is included in the report.

All boreholes were advanced to bedrock and thirteen were advanced into bedrock by coring.

Prior to any drilling being carried out, utility clearances were obtained at the borehole locations by Thurber.

Standpipe piezometers were installed in selected boreholes.

Details of the piezometer installations are as shown in Table 3.1.

Table 3.1 – Piezometer Installation Details

Piezometer Location	Piezometer Details	
	Tip Depth/ Elevation	Completion Details
BH 02-3	6.1/107.5	Piezometer with 1.8 m tip installed at 6.1m. Sand filter to 3.7, bentonite seal to 3.1, Holeplug to 0.6, bentonite to the surface.
BH 02-4	6.4/107.7	Piezometer with 1.8 m tip installed at 6.4. Sand filter to 3.7, bentonite seal to 3.1, Holeplug to 0.6, bentonite to the surface.
BH 02-7	19.8/93.3	Piezometer with 2.1 m tip installed at 19.8m. Sand filter to 17.1, bentonite seal to 16.5, Holeplug to 0.6, bentonite to the surface.
BH 02-7A	4.2/84.8	Piezometer with 1.8 m tip installed at 4.2. Sand filter to 2.1, bentonite seal to 1.5, Holeplug to 1.1, cuttings and bentonite to the surface
BH 02-9	11.0/78.6	Record of installation unavailable.
BH 05-10A	15.3/76.2	Piezometer with 1.5 m tip installed at 15.3m. Sand filter to 12.9, bentonite seal to 11.6. Bentonite grout to 0.6, soil to the surface.
BH 05-14	13.9/93.5	Piezometer with 1.5 m tip installed at 13.9m. Sand filter to 10.7, bentonite seal to 9.6. Bentonite grout to the surface.
BH 02-15	10.5/94.8	Piezometer with 1.8 m tip installed at 10.5m. Sand filter to 7.8, bentonite seal to 7.6, Holeplug to 3.0, soil and bentonite to the surface.
BH 02-16	20.0/96.5	Piezometer with 1.8 m tip installed at 20.0m. Sand filter to 16.9, bentonite seal to 16.3, Holeplug to 0.6, bentonite to the surface.

The drilling and sampling operations were supervised on a full time basis by a member of Thurber's technical staff. The supervisor logged the boreholes and the recovered samples and processed the samples for transport to Thurber's Oakville office.

4 LABORATORY TESTING

All recovered samples were subjected to Visual Identification (VI) and geological logging. The results of this testing are shown on the Record of Borehole sheets in Appendix A.

Moisture content determinations were carried out on all soil samples and grain size analyses were carried out on nine selected samples. Three samples were selected for Atterberg limit tests.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets in Appendix A. The investigation, combined with visual inspection, showed that the predominant stratigraphic unit on site is Queenston Shale bedrock and that the creek valley is incised into the bedrock to approximately 25 m into the surrounding tableland. The general stratigraphy, therefore, consists of shale bedrock overlain by varying thicknesses of fill, silt, silty alluvium and talus from the valley slopes.

The interpreted subsurface conditions are described below but the factual data in the Record of Borehole sheets in Appendix A governs any interpretation of site conditions.

5.1 Fill

A layer of soil was encountered that was identified as fill on the basis of its composition and disturbed appearance. This soil was encountered at the ground surface at the west approach, west abutment, east abutment and east approach. The composition of the fill was mainly silt and clayey silt with sand and included fragments of shale and sandstone.

Based on SPT values generally ranging from 5 to 23 blows for 0.3 m of penetration, the deposit is classified as firm to very stiff.

The measured natural moisture contents range from 6 to 19% and the soil is described as dry to moist.

The layer of fill ranged in thickness from 1.5 to 2.3 m in the west approach and west abutment and approximately 1.5 m at the east approach. At the west approach and abutment, the base of the layer lay between Elevations 111.2 and 112.5. At the east approach the base of the layer lay about Elevation 115.0.

At Pier #4, the measured thickness of fill ranged from 12.2 to 12.5 m and the base of the layer lay at Elevation 94.8 to Elevation 94.1.

At the East Abutment, the fill was identified as being 2.4 to 5.7 m thick and to extend to Elevation 105.0 to 99.6.

The grain size distributions of selected samples of this soil are plotted on the Record of Borehole sheets and shown in Figure B1 in Appendix B.

5.2 Alluvium

The boreholes drilled in the valley floor for Pier #2 and Pier #3 encountered a layer of soil at the surface with a composition similar to the fill described above. However, due to its location on the valley floor it has been identified as possible alluvium. The composition of the alluvium was mainly silt and clayey silt with sand and included fragments of shale and sandstone.

Based on SPT values ranging from 15 to 24 blows for 0.3 m of penetration, the deposit is classified as very stiff. In one instance a value of 59 blows for 0.3 m of penetration was recorded but this may be due to a stone in the deposit.

The measured natural moisture contents range from 9 to 21% and the soil is described as moist.

The layer of alluvium ranged in thickness from 1.4 to 1.5 m at Pier #2 and 1.8 to 2.1 m at Pier #3. At Pier #2, the base of the layer lay between Elevations 88.2 and 88.4. At Pier #3, the base of the layer lay between Elevations 89.4 and 89.9.

The grain size distribution of a selected sample of this soil is plotted on the Record of Borehole sheet and shown in Figure B2 in Appendix B.

5.3 Clayey Silt Till

The boreholes drilled for Pier #2, Pier #3, Pier #4 and at the east approach encountered a layer of soil described as a till, silt, clayey, some sand, trace shale and siltstone fragments. The till underlay the alluvium at pier #2 and Pier #3 and underlay the fill at Pier #4 and the east approach.

Based on SPT values generally ranging from 13 to 44 blows for 0.3 m of penetration, the deposit is classified as stiff to hard. At Pier #4 and the East Abutment, the SPT values rise markedly below elevations 100 to 102 and the composition of the till becomes more that of a reworked weathered rock.

The measured natural moisture contents range from 10 to 20% and the soil is described as moist.

The layer of glacial till ranged in thickness from 1.6 to 2.6 m at Pier #3 and the base of the layer lay between Elevations 87.3 and 88.0.

At Pier #4, the thickness of the till varied from 5.8 to 7.7 m, from north to south, and the base of the layer varied from Elevation 88.3 to Elevation 87.1, north to south.

At the east approach, the base of the layer lay about Elevation 114.2.

The grain size distributions of selected samples of this soil are plotted on the Record of Borehole sheets and shown in Figure B3 in Appendix B.

5.4 Bedrock

The soils described above were found to be underlain by Queenston Shale bedrock.

Total core recovery values in the bedrock was good, ranging from 90% to 100%.

RQD values generally ranged from 30% to 100%, indicating a wide range in the rock quality, i.e. poor quality to excellent quality. One borehole at the west abutment had an RQD value of 10%, indicating very poor quality rock.

Elevations of the top of bedrock are shown in Table 5.1.

Table 5.1 – Elevation of Top of Bedrock

Foundation Element	Bedrock Elevation
West Abutment	112.0 to 113.5 (mean 112.7)
Pier #1	92.0 (interpolated)
Pier #2	88.2 to 88.4 (mean 88.3)
Pier #3	87.3 to 88.0 (mean 87.7)
Pier #4	87.1 to 88.3 (mean 87.7)
East Abutment	99.6 to 99.9. (mean 99.8)

5.5 Water Levels

Except where drilling fluid had been added for rock coring, the boreholes contained no free water on completion. Groundwater levels and elevations in the installed piezometers were measured on completion of the installation and again in July 2005. The results are shown in Table 5.2.

Table 5.2 – Groundwater Depths and Elevations

Borehole	Groundwater Depth (Elevation)		
	Completion	July 21/05	October 27/05
BH 02-3	0.8 (112.9)	4.1 (109.6)	Not found.
BH 02-4	0.9 (113.2)	5.1 (109.0)	5.0 (109.1)
BH 02-7	7.7 (105.4)	17.8 (95.3)	17.8 (95.3)
BH 02-7A	0.2 (88.8)	0.4 (88.6)	0.4 (88.6)
BH 02-9	-	1.0 (88.6)	0.9 (88.7)
BH 05-10A	-	-	Destroyed
BH 05-14	-	-	12.6 (96.8)
BH 02-15	2.1 (103.2)	9.5 (95.8)	9.3 (95.6)
BH 02-16	3.9 (112.6)	17.9 (98.6)	17.6 (98.9)

Groundwater levels fluctuate on a seasonal basis and can be expected to be higher in the spring and after heavy rainfall events.

6 MISCELLANEOUS

Borehole locations and ground surface elevations were supplied to Thurber by McCormick Rankin Corporation.

The drilling and sampling equipment was supplied and operated by All Terrain Drilling Ltd. of Waterloo, Ontario.

The field work was supervised on a full time basis by Mr. George Azzopardi of Thurber.

Mr. Alastair E. Gorman, P.Eng. of Thurber oversaw the field program and prepared the report.

Dr. Paulo J. Branco, P.Eng., a Designated Principal Contact for MTO Foundations Projects, reviewed the report.

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PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

7 INTRODUCTION

This report presents interpretation of the geotechnical data in the factual report and presents geotechnical design recommendations to assist the design team to select and design a suitable foundation system for the proposed structure.

The proposed bridge will twin the existing structure over Bronte Creek and will ultimately carry the eastbound traffic on QEW. The bridge will have an overall length of 175.6 m and will consist of a five-span (21.5:44.2:44.2:44.2:21.5) CPCI girder structure supported on concrete columns. The centreline of the west abutment foundation will lie approximately 5.3 m west of the existing structure west abutment foundation. The centreline of the east abutment foundation will lie approximately 12.7 m west of the existing structure east abutment foundation.

At the west approach, the final grade will be less than 2 m above the existing ground surface. At the east approach the final grade will be approximately 11 m above the existing grade at the south end of the abutment. The existing ground surface rises to the northeast and the final grade at the northeast of the immediate approach fill will be essentially at existing grade. The final centreline grades and approach fill heights are summarized in Table 7.1.

Table 7.1 – Grades and Embankment Height

Location	Original Ground Elevation	Proposed QEW Grade	Embankment Height
West Abutment	113.8	115.5	1.7 m
East Abutment	105.3	116.5	11.2*

* maximum embankment height at the south end of the east abutment.

The discussion and recommendations presented in this report are based on our understanding of the project and on the factual data obtained in the course of the investigation and available from the preliminary investigation.

8 STRUCTURE FOUNDATIONS

Consideration was given to various possible foundations systems, taking account of the site stratigraphy and the structure General Arrangement. Since the soils encountered at the site consist of alluvium, fill or shallow deposits of native soil overlying bedrock at shallow depth, it was concluded that foundations bearing on bedrock were the most practical solution at this site. Accordingly, solutions involving foundations bearing in soil were not developed for this project.

The following alternatives were considered feasible for foundations bearing on bedrock at this site:

- Spread footings
- Caissons (drilled shafts)

Initial consideration was given to driven H-piles bearing in the bedrock. However, the bedrock lies close to the underside of the footing at several footing locations and piles were deemed to be impractical at this site.

8.1 Spread Footings on Bedrock

8.1.1 Geotechnical Resistance

Spread footings bearing on the undisturbed bedrock below the elevations given in Table 5.1 may be designed on the basis of a factored geotechnical resistance at ULS of 1,000 kPa. The SLS condition will not govern for footings bearing on bedrock.

If the bedrock surface lies below the required footing base, any difference between the underside of the footing and the top of bedrock may be made up using mass concrete fill. It is recommended that 30 MPa concrete be used as fill and in that case the geotechnical resistance of 1,000 kPa may still be used for footing design.

The mass concrete fill must extend beyond the footing perimeter by sufficient distance to distribute the shear stresses from the footing and prevent stress concentrations under the edge of the footing. This condition must be checked structurally but extension of the mass concrete to 600 to 800 mm beyond the edge of the footing should be considered. Similarly, the maximum depth of mass concrete that may be permitted below the footing is a function of the structural behaviour of the concrete and is not an issue of geotechnical resistance.

8.1.2 Lateral Sliding Resistance

Calculations of the lateral resistance of a footing poured on bedrock may be carried out using a value of 0.70 for the ultimate friction factor between the concrete and bedrock. If the bedrock surface slopes, the force and resistance must be resolved about a plane representing the overall slope of the bedrock surface.

8.2 Caisson Foundations

The site conditions are considered to be suitable for the design and installation of caisson foundations in bedrock.

8.2.1 Geotechnical Resistance

The vertical geotechnical resistance for caisson foundations has been calculated assuming contributions from both skin friction and end bearing.

Geotechnical resistance has been calculated for a range of probable caisson diameters and for a range of socket depths and the values are shown in Table 8.1.

Table 8.1 – Vertical Geotechnical Resistance for Caisson Foundations

Caisson Diameter 1.2 m		Caisson Diameter 2.4 m		Caisson Diameter 2.9 m	
Socket Depth* (m)	Geotechnical Resistance (kN)	Socket Depth* (m)	Geotechnical Resistance (kN)	Socket Depth* (m)	Geotechnical Resistance (kN)
4.2	4,000	5.4	17,000	5.9	24,000
5.5	10,000	7.0	31,000	7.0	36,000
7.0	19,000	8.0	41,000	9.0	58,000

* Depth of penetration into bedrock from elevation given in Table 5.1.

In calculating the vertical geotechnical resistance, the first 3 m of penetration into rock has been ignored, to allow for localized variations in the weathering profile.

In the case of a caisson bearing in bedrock, the SLS condition will not govern.

The depths of penetration shown above are based on a nominally horizontal bedrock surface. On a sloping surface, deeper penetration is required as described later.

8.2.2 Caisson Lateral Resistance

Piers 1, 2 and 3

The caisson foundations for these piers must be regarded as founded entirely in bedrock. Any overlying overburden must be ignored due to the risk of the overburden being disturbed or removed by erosion or scour action.

At this site, the upper 3.0 m of the shale is regarded as highly weathered and treated as a soil. Below the 3.0 m depth the shale is treated as rock. Accordingly, the lateral resistance of a caisson may be calculated using the values for the coefficient of horizontal subgrade reaction k_s and the ultimate lateral resistance p_{ult} given in Table 8.1.

Table 8.1 – Caisson Lateral Resistance Parameters

Caisson Diameter								
1.2 m			2.4 m			2.9 m		
Depth* (m)	k_s (kN/m ³)	p_{ult} (kPa)	Depth* (m)	k_s (kN/m ³)	p_{ult} (kPa)	Depth* (m)	k_s (kN/m ³)	p_{ult} (kPa)
0 to 3.0	16,000	600	0 to 3.0	8,000	600	0 to 3.0	7,000	600
3.0**	40,000	4,000	3.0**	20,000	4,000	3.0**	16,000	4,000
7.0**	200,000	19,000	8.0**	75,000	14,000	9.0**	62,000	14,000

* Depth of penetration into bedrock from elevation given above

** Values may be increased linearly between these depths.

The recommended parameters may be used for numerical analysis of the interaction between the caisson and the surrounding soil. The lateral pressure must not exceed the ultimate lateral resistance.

The modulus of subgrade reaction may have to be reduced, based on the caisson spacing. The reduction factors to be used for a caisson group oriented perpendicular or parallel to the direction of loading are provided in Table 8.3. Intermediate values may be obtained by interpolation.

Table 8.3 - Subgrade Reduction Factors for Caisson Spacing

Condition	Caisson Spacing, Centre to Centre*	Reduction Factor
Caissons oriented <i>perpendicular</i> to direction of loading	4D	1.0
	1D	0.5
Caissons oriented <i>parallel</i> to direction of loading	8D	1.0
	6D	0.7
	4D	0.4
	3D	0.25

* where D is the caisson diameter.

Pier 4

The caissons at Pier 4 will penetrate a significant depth of fill and native soil before encountering bedrock. These soils cannot be assumed to contribute to the vertical geotechnical resistance but may make a contribution to the lateral resistance.

The lateral resistance developed in the soils can be added to the lateral resistance developed in the bedrock. However, the model must take account of the strain incompatibility between the soil and the bedrock.

The lateral resistance factors must be reduced to account for the sloping ground surface into which the caissons will be installed. In the case of Pier #4, the following values may be used:

$$k_s = 1,000 * z/D \text{ (kN/m}^3\text{)}$$

$$p_{ult} = 90 * z \text{ (kPa)}$$

Where: z = depth below ground surface (m) and D = caisson diameter (m)

East Abutment

The caissons at the east abutment will penetrate approximately 5.7 to 7.5 m of fill and native soil before encountering bedrock. These soils cannot be assumed to contribute to the vertical geotechnical resistance but may make a contribution to the lateral resistance.

The lateral resistance developed in the soils can be added to the lateral resistance developed in the bedrock. However, the model must take account of the strain incompatibility between the soil and the bedrock.

In the case of the east abutment, the GA shows that the abutment will initially be constructed with roadway protection in place rather than a forward fill. In this case, lateral resistance can be attributed only to the soil below existing ground level and the following parameters may be used:

$$k_s = 1,500 * z/D \text{ (kN/m}^3\text{)}$$

$$p_{ult} = 180 * z \text{ (kPa)}$$

Where: z = depth below ground surface (m) and D = caisson diameter (m)

In cases where the lateral resistance is insufficient, consideration could be given to the following to increase the lateral resistance or reduce the active load:

- Installing permanent tie-backs anchored into bedrock
- Constructing a mechanically stabilized earth (MSE) mass behind the abutment to relieve the active earth load on the abutment
- Backfill the abutment using lightweight fill
- Substituting driven, batter H- piles for the caisson foundation at the abutment.

Permanent tie-back anchors installed in the shale bedrock may be designed on the basis of an ultimate bond strength of 250 kPa. The anchor length must lie beyond a line projected upward from the pile/bedrock intersection at an angle of 60° to the horizontal.

Using lightweight fill such ultra lightweight slag or EPS would be effective in reducing the active load but may be unacceptably expensive and may be rejected for other technical considerations.

Construction of a MSE mass would be effective in reducing the active load. The overall implications for the bridge must be considered from a structural point of view.

The substitution of driven, batter H-piles is not recommended at this site due to the bedrock surface that slopes away from the abutment at a relatively steep angle.

8.3 Integral Abutment Considerations

Due to the impracticality of H-pile foundations at this site, the design of an integral abutment is not feasible.

The design of a semi-integral abutment could be considered.

8.4 Recommended Foundation Systems

From a geotechnical perspective, the recommended foundation systems for this site are:

- Spread footings bearing on bedrock, where the bedrock surface is comparatively shallow and the loads are appropriate, e.g. at the west abutment
- Caissons bearing in bedrock sockets where:
 - the bedrock surface is deeper
 - the loads are high
 - embedment in the bedrock is required for scour protection

Caisson foundations are considered to be appropriate for all piers and for the east abutment.

8.5 Frost Protection

The design depth of frost penetration at this site through earth or granular fill is 1.2 m.

Although the Queenston Shale is geologically defined as bedrock it is susceptible to frost action. Therefore, all footings and pile caps must be provided with a minimum of 1.2 m of earth cover as frost protection.

8.6 Caisson Installation

The caissons can be installed by augering techniques commonly employed by local contractors. The contract documents must contain a warning to alert bidders to the fact that hard layers are typically encountered in the shale. These hard layers may consist of

limestone, calcareous shale or siltstone and will require the use of coring or breaking equipment in addition to the auger equipment.

Caissons at Pier #1 and Pier #4 may be installed into a sloping bedrock surface. The contract documents must contain a warning to alert bidders to the possibility of installation into a sloping bedrock surface.

The first observed contact with bedrock will typically be on the "high" side of the caisson and the bedrock on the "low" side will be lower. To provide for adequate embedment of the caisson into bedrock, the socket depth must be measured from the "low" side contact at Pier #1, Pier #4 and the east abutment and anywhere a sloping bedrock surface is encountered.

Since the recommended design is based on a combination of skin friction and end bearing, the base of the caisson must be hand cleaned and inspected. To facilitate these operations, the minimum caisson diameter must be 760 mm and a temporary safety liner must be utilized during cleaning and inspection.

9 ROADWAY PROTECTION

Roadway protection may be required at the following locations:

- Between the new structure and the embankment serving the current QEW
- Between the new east abutment and existing Bronte Road
- Between existing Bronte Road and the new Pier #4

The roadway protection must be provided in accordance with SP 539S01. Soil parameters for design are given in Section 15.

It is recommended that, in general, the Roadway Protection be designed for Performance Level 2. However, attention must be paid to the requirement in clause 539.04.02.01 for design to Performance Level 1a if the face of the protection system is within one third of its height from any structure foundation.

10 EXCAVATION AND BACKFILL

10.1 General

All excavation must be carried out in accordance with the Occupational Health and Safety Act (OHSA).

10.2 Foundations

The excavation and backfilling for foundations must be carried out in accordance with SP 902S01.

10.3 Rock Excavation

Rock excavation will be required at this site.

Bidders must be alerted to the fact that rock excavation will be required and that breaking equipment must be provided.

Footing excavation bases must be protected by a mud slab immediately after inspection and approval to protect against degradation of the exposed shale. It is recommended that a minimum thickness of 100 mm of concrete be used for the mud slab. In view of the fact that the footings will bear on bedrock, 30 MPa concrete must be used.

11 UNWATERING

All excavations for foundations must be unwatered prior to the placement of concrete.

The design of the unwatering system is the responsibility of the Contractor. However, for footing excavations to bedrock at this site, a suitable system may consist of the provision of low points or sumps within the footing excavation from which the accumulated water may be pumped.

A suitable system for unwatering caissons may consist of a submersible pump. In the event that the caisson cannot be effectively dewatered, the concrete must be placed by tremie methods.

12 APPROACH EMBANKMENTS

12.1 West Approach

At the west approach, the embankment will be in the order of 2 m high.

Based on the boreholes drilled in the west approach and at the west abutment, the soils under the approach embankment will consist of 1.5 to 2.3 m of firm to stiff clayey silt fill or clayey silt till.

These soils are assessed to provide satisfactory resistance to instability under the loading imposed by a 2 m high embankment.

Long term settlement will not be a problem at the west approach and most of the settlement induced by the embankment loading will be complete within 3 months of the end of construction. It is recommended, therefore, that the embankment construction be completed at least 3 months prior to construction of the pavement sub-base.

12.2 East Approach

At the east approach, the height of the embankment will vary from 0 at the northeast of the immediate approach to approximately 11 m adjacent to the south end of the east abutment.

Based on the borehole drilled in the approach, the soils underlying the northeast limits of the approach fill will consist of approximately 2.3 m of stiff clayey silt fill and hard clayey silt till. Adjacent to the south end of the east abutment, where the fill is approximately 11 m high, the soils will consist of 6 m of stiff to hard clayey silt fill.

Long term settlement of these soils will not be a problem at the east approach and most of the settlement in the existing soil induced by the embankment loading will be complete within 3 months of the end of construction.

Settlement within the fill itself is potentially a greater problem as there could be noticeable settlement at the abutment but very little settlement at 10 to 20 m back from the abutment. To reduce the magnitude of this differential settlement, it is recommended that the fill used to construct the immediate approach fill should be Granular "A". The contract documents should be written to specify that the compaction achieved in the fill must be 100% standard Proctor maximum dry density (SPMDD), with no compaction values falling below 98% SPMDD. The documents should also specify that the fill must be placed at a moisture content equal to the optimum moisture content $\pm 2\%$.

It is recommended that the embankment construction be completed at least 3 months prior to construction of the pavement sub-base. If feasible within the construction schedule, the east approach fill should be completed and allowed to pass through at least one winter prior to construction of the pavement.

In addition to the General Embankment Requirements set out below, at the east approach fill, it is important that:

- All topsoil, disturbed soil and other deleterious materials be stripped from the area of the fill
- The existing ditch be thoroughly cleaned out to remove all softened material
- The existing slope be benched to key the new fill into the slope.

12.3 General Embankment Requirements

All topsoil and organic soils should be stripped from the footprint of the approach fills.

Embankment construction should be in accordance with OPSS 206, as amended by Special Provision "Amendment to OPSS 206, December 1993", dated November 2002.

Where embankments are higher than 8 m, mid-height berms must be incorporated in the design. The berms must:

- extend for the length through which the embankment height exceeds 8 m
- be 2 m wide
- have 2% positive drainage to shed run-off water (earth fill embankments).

The forward slope at the east abutment will be 6 m high, measured from the level of the recreational trail and a berm is not required in front of the abutment. Provision should be made to access the forward slope from the trail for possible future maintenance.

Earth fill embankment slopes must be provided with erosion protection in accordance with OPSS 572.

13 RETAINED SOIL SYSTEMS

The soil conditions encountered on site are generally suitable for the support of RSS walls. However, as no RSS walls have been identified, so specific recommendations have been developed.

If the need for RSS walls does arise, then:

- The RSS walls must be specified to be “High Performance” and “High Appearance”
- The contract drawings must include information on the longitudinal alignment of the wall in plan, the top and base elevations of the wall in profile, cross-sectional space constraints and an NSSP for the RSS wall
- The design, supply and construction of RSS must be in accordance with SP 599S22.

In addition to these requirements, the global stability of the RSS wall must be analyzed prior to finalizing the design.

14 BACKFILL TO ABUTMENTS

Either Granular “A” or Granular “B” is suitable for use as backfill to the abutment. The earth pressure acting on the abutment will be dependent on the material used and so the contract must specify backfill that is consistent with the design assumptions.

In all cases where the approach embankment consists of rock fill and granular backfill to the abutment wall is used, the granular backfill must consist of OPSS Granular “B” Type II in order to reduce the loss of granular material into the rock fill.

The backfill to the abutment walls must be in accordance with OPSS 902 as amended by Special Provision 902S01. Granular backfill must be placed to the extents shown in OPSD 3501.000, and rock backfill must be placed to the extents shown in OPSD 3505.000.

Compaction equipment to be used adjacent to retaining structures must be restricted in accordance with SSP 105S10.

The design of the abutment must incorporate a subdrain as shown in OPSD 3501.000 or OPSD 3505.000, as applicable.

15 STATIC EARTH PRESSURE

Earth pressures acting on the structure may be assumed to be triangular and to be governed by the characteristics of the abutment backfill. The pressures should be computed in accordance with the CHBDC but generally are given by the expression:

$$P_h = K(\gamma h + q)$$

Where:

P_h = horizontal pressure on the wall (kPa)

K = earth pressure coefficient (see below)

γ = unit weight of retained soil (see table below)

h = depth below top of fill where pressure is computed (m)

q = value of any surcharge (kPa)

In accordance with Clause 6.9.3 of the CHBDC, a compaction surcharge should be added. The magnitude should be 12 kPa at the top of fill and decreasing to 0 kPa at a depth of 2.0 m for Granular B Type I or 1.7 m for Granular A or Granular B Type II.

Earth pressure coefficients for backfill to the abutment wall are dependent on the material used as backfill. Typical values are shown in Table 15.1.

The factors in Table 15.1 are "ultimate" values and require certain movements for the respective conditions to be mobilized. The values to use in design can be estimated from Figure C6.9.1 (a) in the Commentary to the Canadian Highway Bridge Design Code.

Table 15.1 – Earth Pressure Coefficient (K)

Condition	Earth Pressure Coefficient (K)					
	OPSS Granular A or OPSS Granular B Type II $\phi = 35^\circ, \gamma = 22.8 \text{ kN/m}^3$		OPSS Granular B Type I $\phi = 32^\circ, \gamma = 21.2 \text{ kN/m}^3$		Rock Fill (Limited to 300 mm size) $\phi = 42^\circ, \gamma = 19 \text{ kN/m}^3$	
	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall(2H:1 V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall(2H:1 V)
Active (Unrestrained Wall)	0.27	0.40*	0.31	0.43*	0.2	.30*
At rest (Restrained Wall)	0.43	-	0.47	-	0.33	-
Passive (Movement Towards Soil Mass)	3.7	-	3.3	-	5.0	-

* For wing walls.

16 IMPACT ON ADJACENT STRUCTURES

The Contract must include constraints to limit the impact of the Contractor's work on the existing bridge and any other adjacent structures.

These constraints should include, among others:

- Protection of the existing QEW during excavation at the new abutments
- Protection of Bronte Road During construction of Pier #4 and the east abutment
- Protection of the foundations of the existing bridge and any other adjacent structure

17 CONSTRUCTION CONCERNS

Potential construction concerns include, but are not necessarily limited to:

- Adequate cleaning and unwatering of caisson bases
- Protection of geotechnical bearing surfaces in shale to prevent degradation of the shale due to exposure to the air.

18 CLOSURE

The engineering analysis was carried out by and the report written by Alastair E. Gorman, P.Eng., a Senior Foundations Engineer with Thurber.

The report was reviewed by Paulo J. Branco, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

Thurber Engineering Ltd.



Alastair E. Gorman, P.Eng.,
Senior Geotechnical Engineer



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Review Principal

Appendix A

Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

CLASSIFICATION	PARTICLE SIZE	VISUAL IDENTIFICATION
Boulders	Greater than 200mm	same
Cobbles	75 to 200mm	same
Gravel	4.75 to 75mm	5 to 75mm
Sand	0.075 to 4.75mm	Not visible particles to 5mm
Silt	0.002 to 0.075mm	Non-plastic particles, not visible to the naked eye
Clay	Less than 0.002mm	Plastic particles, not visible to the naked eye

2. COARSE GRAIN SOIL DESCRIPTION (50% greater than 0.075mm)

TERMINOLOGY	PROPORTION
Trace or Occasional	Less than 10%
Some	10 to 20%
Adjective (e.g. silty or sandy)	20 to 35%
And (e.g. sand and gravel)	35 to 50%

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

DESCRIPTIVE TERM	UNDRAINED SHEAR STRENGTH (kPa)	APPROXIMATE SPT ⁽¹⁾ 'N' VALUE
Very Soft	12 or less	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	Greater than 200	Greater than 30

NOTE: Hierarchy of Soil Strength Prediction

- 1) Laboratory Triaxial Testing
- 2) Field Insitu Vane Testing
- 3) Laboratory Vane Testing
- 4) SPT value
- 5) Pocket Penetrometer



4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

DESCRIPTIVE TERM	SPT 'N' VALUE
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Greater than 50

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE	SS Split Spoon Sample	WS Wash Sample	AS Auger (Grab) Sample
	TW Thin Wall Shelby Tube Sample	TP Thin Wall Piston Sample	
	PH Sampler Advanced by Hydraulic Pressure	PM Sampler Advanced by Manual Pressure	
	WH Sampler Advanced by Self Static Weight	RC Rock Core	SC Soil Core

$$\text{Sensitivity} = \frac{\text{Undisturbed Shear Strength}}{\text{Remoulded Shear Strength}}$$

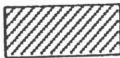
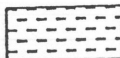



 Water Level
 Shear Strength Determination by Pocket Penetrometer

- (1) SPT 'N' Value Standard Penetration Test 'N' Value – refers to the number of blows from a 63.5kg hammer free falling a height of 0.76m to advance a standard 50 mm outside diameter split spoon sampler for 0.3 m depth into undisturbed ground.
- (2) DCPT Dynamic Cone Penetration Test – Continuous penetration of a 50 mm outside diameter, 60° conical steel point attached to "A" size rods driven by a 63.5 kg hammer free falling a height of 0.76 m. The resistance to cone penetration is the number of hammer blows required for each 0.3 m advance of the conical point into undisturbed ground.

UNIFIED SOILS CLASSIFICATION

MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, gravel-sand-clay mixtures.
	SAND AND SANDY SOILS	SW	Well-graded sands or gravelly sands, little or no fines.
		SP	Poorly-graded sands or gravelly sands, little or no fines.
		SM	Silty sands, sand-silt mixtures.
		SC	Clayey sands, sand-clay mixtures.
FINE GRAINED SOILS	SILTS AND CLAYS $W_L < 50\%$	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. ($W_L < 30\%$).
		CI	Inorganic clays of medium plasticity, silty clays. ($30\% < W_L < 50\%$).
		OL	Organic silts and organic silty-clays of low plasticity.
	SILTS AND CLAYS $W_L > 50\%$	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.
		CH	Inorganic clays of high plasticity, fat clays.
		OH	Organic clays of medium to high plasticity, organic silts.
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils.
CLAY SHALE			
SANDSTONE			
SILTSTONE			
CLAYSTONE			
COAL			

EXPLANATION OF ROCK LOGGING TERMS

ROCK WEATHERING CLASSIFICATION		SYMBOLS	
Fresh (FR)	No visible signs of weathering.		
Fresh Jointed (FJ)	Weathering limited to the surface of major discontinuities.		CLAYSTONE
Slightly Weathered (SW)	Penetrative weathering developed on open discontinuity surfaces, but only slight weathering of rock material.		SILTSTONE
Moderately Weathered (MW)	Weathering extends throughout the rock mass, but the rock material is not friable.		SANDSTONE
Highly Weathered (HW)	Weathering extends throughout the rock mass and the rock is partly friable.		COAL
Completely Weathered (CW)	Rock is wholly decomposed and in a friable condition, but the rock texture and structure are preserved.		Bedrock (general)

DISCONTINUITY SPACING		STRENGTH CLASSIFICATION			
Bedding	Bedding Plane Spacing	Rock Strength	Approximate Uniaxial Compressive Strength		Field Estimation of Hardness*
			(MPa)	(psi)	
Very thickly bedded	Greater than 2m	Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Thickly bedded	0.6 to 2m				
Medium bedded	0.2 to 0.6m	Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Thinly bedded	60mm to 0.2m				
Very thinly bedded	20 to 60mm	Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Laminated	6 to 20mm				
Thinly Laminated	Less than 6mm	Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.

TERMS		Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.	Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.	Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail
Rock Quality Designation: (RQD)	Total length of sound core recovered in pieces 0.1m in length or larger as a percentage of total core run length.				
Uniaxial Compressive Strength (UCS)	Axial stress required to break the specimen				
Fracture Index: (FI)	Frequency of natural fractures per 0.3m of core run.				

RECORD OF BOREHOLE No 02-1

1 OF 1

METRIC

W.P. 19-1351-27 LOCATION N 4807583.7 E 285174.2 ORIGINATED BY MT
 HWY QEW BOREHOLE TYPE Hollow Stem Augers COMPILED BY HS
 DATUM DATE 15.02.02 - 15.02.02 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
113.8																	
0.0	SILT, some clay, some sand, trace organics and rootlets Firm Reddish Brown (POSSIBLE FILL)		1	SS	5		113										0 20 60 18
112.0			2	SS	47		112										
1.8	SHALE, weathered, fissile, reddish brown		3	SS	100/ .125		111										
110.8																	
3.0	END OF THE BOREHOLE AT 3.05m. BOREHOLE BACKFILLED WITH DRILL CUTTINGS.																

RECORD OF BOREHOLE No 02-2

1 OF 1

METRIC

W.P. 19-1351-27 LOCATION N 4807598.6 E 285176.7 ORIGINATED BY MT
 HWY QEW BOREHOLE TYPE Hollow Stem Augers COMPILED BY HS
 DATUM DATE 18.02.02 - 18.02.02 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV 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		
114.4 0.0	SILT, some clay, some sand, trace limestone fragments, occasional greenish interbeds, occasional shale fragments Very Stiff Reddish Brown (POSSIBLE FILL)		1	SS	15		114							
112.5			2	SS	23		113							
1.9	SHALE, weathered, weak, thinly bedded, reddish brown		3	SS	100/ .125		112							
111.4 3.0	END OF THE BOREHOLE AT 3.05m. BOREHOLE DRY ON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS.													

RECORD OF BOREHOLE No 02-3

1 OF 1

METRIC

W.P. 19-1351-27 LOCATION N 4807589.4 E 285189.0 ORIGINATED BY MT
 HWY QEW BOREHOLE TYPE Hollow Stem Augers/NQ Core Barrel COMPILED BY HS
 DATUM DATE 18.02.02 - 18.02.02 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
113.7														
0.0	Clayey SILT, some sand, occasional sandstone fragments Stiff Reddish Brown (POSSIBLE FILL)(CL-ML)		1	SS	8		113							0 23 54 20
112.0							112							
1.7	Clayey SILT, some sand, occasional sandstone fragments Hard		2	SS	38									
111.5	Reddish Brown (TILL)(CL-ML)		3	SS	100/									
2.1	SHALE, weathered, thinly bedded, occasional greenish limey interbeds, reddish brown				.050		111							RUN 1# TCR=83%, SCR=71%, RQD=48%
111.1	Slightly weathered to weathered, very weak, reddish brown, SHALE, thinly bedded		1	CORE										RUN 2# TCR=100%, SCR=72%, RQD=53%
2.6	2.74 - 2.79m siltstone layer becoming highly weathered to fresh, very weak to weak						110							
	3.65 - 3.70m siltstone layer		2	CORE										
	becoming weathered, weak						109							RUN 3# TCR=91%, SCR=45%, RQD=45%
			3	CORE			108							
107.5	5.79 - 5.87m siltstone layer													
6.1	END OF THE BOREHOLE AT 6.15m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.83m slotted screen.													
	WATER LEVEL READINGS: DATE DEPTH (m) July 21/ 05 4.1													

+ 3, x 3: Numbers refer to Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 02-4

1 OF 1

METRIC

W.P. 19-1351-27 LOCATION N 4807604.3 E 285181.9
 HWY QEW BOREHOLE TYPE Hollow Stem Augers/NQ Core Barrel
 DATUM DATE 18.02.02 - 18.02.02

ORIGINATED BY MT
 COMPILED BY HS
 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100					
114.1														
0.0	Clayey SILT, trace sand, occasional greenish limey pockets, trace sandstone fragments Firm Reddish Brown (POSSIBLE FILL)(CL-ML)		1	SS	5									
112.6														
1.5	SHALE, weathered, thinly bedded, occasional limey interbeds, reddish brown		2	SS	72									
			3	SS	100/ .125									
111.1														
3.0	Moderately weathered, very weak to weak, thinly bedded, reddish brown, SHALE weathered to slightly weathered		1	CORE										
			2	CORE										
	4.42 - 14.47m siltstone layer													
	becoming weathered to highly weathered													
			3	CORE										
107.7														
6.4	END OF THE BOREHOLE AT 6.40m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.83m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) July 21/ 05 5.1 Oct. 27/ 05 5.0													

RUN 1#
TCR=100%,
SCR=82%,
RQD=64%
 RUN 2#
TCR=100%,
SCR=94%,
RQD=90%

RUN 3#
TCR=97%,
SCR=17%,
RQD=10%

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RECORD OF BOREHOLE No 02-5

1 OF 1

METRIC

W.P. 19-1351-27 LOCATION N 4807595.7 E 285194.8 ORIGINATED BY MT
 HWY QEW BOREHOLE TYPE Hollow Stem Augers COMPILED BY HS
 DATUM DATE 18.02.02 - 18.02.02 CHECKED BY AEG




SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100		
113.5														
0.0	Clayey SILT, some sand, trace gravel, occasional black staining Stiff Reddish Brown (POSSIBLE FILL)(CL-ML)		1	SS	9		113							
			2	SS	12		112							0 29 37 32
111.2														
2.3	SHALE, weathered, thinly bedded, fissile, reddish brown		3	SS	50		111							
			4	SS	100/ .075		110							
109.8														
3.7	END OF THE BOREHOLE AT 3.66m. BOREHOLE DRY ON COMPLETION. BOREHOLE BACKFILLED WITH CUTTINGS.													

RECORD OF BOREHOLE No 02-6

1 OF 1

METRIC

W.P. 19-1351-27 LOCATION N 4807612.4 E 285189.4 ORIGINATED BY MT
 HWY QEW BOREHOLE TYPE Hollow Stem Augers/NQ Core Barrel COMPILED BY HS
 DATUM DATE 18.02.02 - 18.02.02 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								20 40 60 80 100							
113.7															
0.0	Clayey SILT, trace sand, occasional cemented siltstone fragments Stiff Reddish Brown (POSSIBLE FILL)		1	SS	11										
112.0															
1.7	SHALE, weathered, weak, thinly bedded. occasional limey interbeds, reddish brown		2	SS	100/ 125										
111.2															
2.4	Moderately weathered to slightly weathered, very weak to weak, reddish brown, SHALE, thinly bedded, occasional grey interbedded shale		1	CORE										RUN 1# TCR=86%, SCR=56%, RQD=33%	
														RUN 2# TCR=100%, SCR=70%, RQD=62%	
	becoming slightly weathered to fresh 4.95 - 5.03m medium strong shale		2	CORE											
														RUN 3# TCR=100%, SCR=94%, RQD=81%	
</															

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RECORD OF BOREHOLE No 02-7

1 OF 3

METRIC

W.P. 19-1351-27 LOCATION N 4807604.4 E 285201.1 ORIGINATED BY MT
 HWY QEW BOREHOLE TYPE Hollow Stem Augers/NQ Core Barrel COMPILED BY HS
 DATUM DATE 15.02.02 - 15.02.02 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT Y kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	
113.1								SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				
0.0	Clayey SILT, some shale fragments Stiff Reddish Brown (POSSIBLE FILL)		1	SS	8		113					0 17 58 23
111.3			2	SS	13		112					
1.8	SILT, some sand, some siltstone and shale fragments, occasional oxide lenses Compact Reddish Brown (TILL)(ML-NONPLASTIC)		3	SS	22		111					0 37 40 22
109.9			4	SS	13		110					
3.2	SHALE, highly weathered, weak, thinly bedded, reddish brown						109					
108.5			1	CORE			108					RUN 1# TCR=100%, SCR=77%, RQD=65%
4.6	Highly weathered to weathered, very weak to weak, reddish brown, SHALE, thinly interbedded		2	CORE			107					RUN 2# TCR=100%, SCR=100%, RQD=100%
	5.94 - 6.10m siltstone layer becoming slightly weathered, weak to medium strong, occasional mechanical breaks						106					
	slightly weathered to weathered, weak to very weak		3	CORE			105					RUN 3# TCR=100%, SCR=83%, RQD=83%
	8.18 - 8.25m siltstone layer						104					RUN 4# TCR=100%, SCR=53%, RQD=38%
	highly weathered to slightly weathered, very weak to medium strong		4	CORE								

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Continued Next Page

+ 3, × 3: Numbers refer to
Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE

METRIC

ONIM14S 51Z/M10.GPJ 28/10/03

+ 3, × 3: Numbers refer to Sensitivity

RECORD OF BOREHOLE No 02-7

3 OF 3

METRIC

W.P. 19-1351-27 LOCATION N 4807604.4 E 285201.1 ORIGINATED BY MT
 HWY QEW BOREHOLE TYPE Hollow Stem Augers/NQ Core Barrel COMPILED BY HS
 DATUM DATE 15.02.02 - 15.02.02 CHECKED BY AEG

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
	Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 2.13m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) July 21/ 05 17.8 Oct. 27/ 05 17.8						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	20 40 60				kN/m ³	GR SA SI CL

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RECORD OF BOREHOLE No 02-7A

1 OF 1

METRIC

W.P. 19-1351-27 LOCATION N 4807626.2 E 285225.6 ORIGINATED BY MT
HWY QEW BOREHOLE TYPE Hollow Stem Augers/NQ Core Barrel COMPILED BY HS
DATUM DATE 12.02.02 - 12.02.02 CHECKED BY AEG

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20 40 60 80 100					
89.0	0.0	Clayey SILT, some sand, trace rootlets Reddish Brown											
87.9	1.1	Slightly weathered to weathered, very weak to weak, reddish brown, SHALE, thinly bedded	1	SS	100/ .275								RUN 1# TCR=89%, SCR=79%, RQD=61%
87.0	2.0	Moderately to Slightly weathered, very weak to weak, reddish brown, SHALE, occasional mechanical breaks	2	CORE									RUN 2# TCR=100%, SCR=70%, RQD=37%
84.8	3.38 - 3.48m	siltstone layer slightly weathered, medium strong	3	CORE									RUN 3# TCR=100%, SCR=67%, RQD=33%
4.2		END OF THE BOREHOLE AT 4.17m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 2.13m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) July 21/ 05 0.4 Oct. 27/ 05 0.4											

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RECORD OF BOREHOLE No 02-8

1 OF 1

METRIC

W.P. 19-1351-27 LOCATION N 4807659.0 E 285216.6 ORIGINATED BY MT
 HWY QEW BOREHOLE TYPE Hollow Stem Augers/NQ Core Barrel COMPILED BY HS
 DATUM DATE 13.02.02 - 13.02.02 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
89.8 0.0	SILT, some sand and limestone fragments Brown		1	SS	21									
88.4 1.5	SHALE, reddish brown Highly to slightly weathered, very weak to weak, reddish brown, SHALE, thinly bedded, occasional grey silt interbeds 2.36 - 2.41m siltstone layer		1	CORE										
86.7 3.1	END OF THE BOREHOLE AT 3.12m.													

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RECORD OF BOREHOLE No 02-9

1 OF 2

METRIC

W.P. 19-1351-27 LOCATION N 4807643.1 E 285235.2 ORIGINATED BY MT
 HWY QEW BOREHOLE TYPE Hollow Stem Augers/NQ Core Barrel COMPILED BY HS
 DATUM DATE 12.02.02 - 12.02.02 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE CONTENT LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W _P W W _L				
89.6 0.0	Clayey SILT, some sand, some limestone fragments, occasional wood fragments Very Stiff Reddish Brown (RECENT ALLUVIUM)		1	SS	17									
88.1 1.5	SHALE, weathered, reddish brown													
87.8 1.8	Fresh to slightly weathered, very weak to moderately strong, reddish brown to grey, SHALE, thinly laminated. END OF THE SOIL SAMPLING AT 1.78m. CORING STARTED AT 1.78m. FOR CORING DETAILS PLEASE REFER TO BH 02-9R.		1	CORE										RUN 1# TCR=100%, SCR=78%, RQD=72%
	3.40-3.45m siltstone layer 3.53-3.63m siltstone layer 4.01-4.14m siltstone layer 4.45-4.52m siltstone layer		2	CORE										RUN 2# TCR=100%, SCR=87%, RQD=53%
			3	CORE										RUN 3# TCR=100%, SCR=95%, RQD=87%
			4	CORE										RUN 4# TCR=100%, SCR=90%, RQD=80%
			5	CORE										RUN 5# TCR=100%, SCR=95%, RQD=85%
														RUN 6# TCR=100%, SCR=85%

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Continued Next Page

+ 3, x 3: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 02-9

2 OF 2

METRIC

W.P. 19-1351-27 LOCATION N 4807643.1 E 285235.2 ORIGINATED BY MT
 HWY QEW BOREHOLE TYPE Hollow Stem Augers/NQ Core Barrel COMPILED BY HS
 DATUM DATE 12.02.02 - 12.02.02 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40					
78.6			6	CORE			79							
11.0	END OF THE BOREHOLE AT 11.00m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 2.13m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) July 21/ 05 1.0 Oct. 27/ 05 0.9													


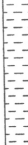
ONTMT4S 5127MTO.GPJ 28/10/05

RECORD OF BOREHOLE No 02-10

1 OF 1

METRIC

W.P. 19-1351-27 LOCATION N 4807690.2 E 285247.9 ORIGINATED BY MT
 HWY QEW BOREHOLE TYPE Hollow Stem Augers COMPILED BY HS
 DATUM DATE 31.01.02 - 31.01.02 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
91.5 0.0	Clayey SILT mixed with sand, siltstone and shale fragments Hard to Very Stiff Reddish Brown (RECENT ALLUVIUM)		1	SS	59	○	+	20	40	60	80	100	0 19 54 24	
89.4			2	SS	15	○	+	20	40	60	80	100		
2.1			Silty CLAY, trace sand, occasional shale fragments Hard Reddish Brown (TILL) (CL)	3	SS	34	○	+	20	40	60	80		100
87.9	4	SS		44	○	+	20	40	60	80	100			
3.7	SHALE, weathered, reddish brown					○	+	20	40	60	80	100		
86.9			5	SS	100/	○	+	20	40	60	80	100		
4.7	END OF THE BOREHOLE AT 4.67m. BOREHOLE DRY ON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS.				.100									

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RECORD OF BOREHOLE No 05-10A

1 OF 2

METRIC

W.P. 19-1351-27 LOCATION N 4807690.2 E 285247.9 ORIGINATED BY SLL
 HWY QEW BOREHOLE TYPE Hollow Stem Augers/NQ Core Barrel COMPILED BY HS
 DATUM DATE 29.07.05 - 29.07.05 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED + FIELD VANE							
								● QUICK TRIAXIAL × LAB VANE							
91.5						20	40	60	80	100	20	40	60		
0.0	SAND, trace gravel, occasional clay		1	SS	18										
0.2	Compact														
90.8	Brown to Reddish Brown														
0.8	Dry														
	(FILL)														
90.0	Silty CLAY, occasional sand, occasional gravel		2	SS	43										
0.8	Very Stiff														
	Reddish Brown														
90.0	Dry														
1.5	(FILL)														
	SHALE, highly weathered, thinly bedded		3	SS	13										
	Dense														
	Reddish Brown														
	Dry														
	(FILL)														
	Silty CLAY, trace to some sand, trace gravel		4	SS	24										
	Very Stiff														
	Reddish Brown														
	Moist to Wet														
	(TILL)		5	SS	16										
87.7															
3.8	SHALE														
			6	SS	50/075										
86.8															
4.7	SHALE, fresh to highly weathered, thinly bedded, weak to very weak, reddish brown, occasional limestone and siltstone interbeds		1	RUN											
	clay seams at 4.75 to 4.8m														
	horizontal joint at 5.41m														
	rubble zone at 4.83 to 4.88m, 4.96 to 4.98m, 5.77 to 6.15m														
	siltstone interbeds at 5.28m, 5.41m, 5.64m														
	limestone interbed at 5.66 - 5.72m														
	siltstone interbeds at 6.14 to 6.25m, 6.43m, 6.63 to 6.76m		2	RUN											
	rubble zone at 6.45m, 6.61m, 6.65 to 6.71m														
	limestone interbed at 6.55m, 7.36 to 7.42m														
	horizontal joint at 7.39m														
	siltstone interbeds at 7.87 to 8.10m, 8.31m, 8.41 to 8.46m		3	RUN											
	limestone interbed at 7.95m, 8.76 to 8.84m														
	siltstone interbeds at 9.65 to 9.76m, 9.58m, 9.78 to 9.88m, 10.13m		4	RUN											

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+ 3, x 3. Numbers refer to Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 05-10A

2 OF 2

METRIC

W.P. 19-1351-27 LOCATION N 4807690.2 E 285247.9 ORIGINATED BY SLL
 HWY QEW BOREHOLE TYPE Hollow Stem Augers/NQ Core Barrel COMPILED BY HS
 DATUM DATE 29.07.05 - 29.07.05 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40						60	80
	limestone interbed at 10.24 to 9.96m, 10.39m, 10.59m to 10.64m						81							0	RUN 5# TCR=0%, SCR=0%, RQD=0%	
	no recovery		5	RUN			80							0		
			7	SS	100/ .075		79									RUN 6# TCR=0%, SCR=0%, RQD=0%
	no recovery		6	RUN			78									
	rubble zone at 13.82 to 13.57m, 14.23 to 14.25m horizontal joint at 139.2m, 14.10m, 14.58m limestone interbed at 14.10 to 14.23m, 14.65m, 15.19m to 15.24m						77							5	RUN 7# TCR=100%, SCR=90%, RQD=90%	
			7	RUN										1		
														1		
														0		
76.2																
15.3	END OF BOREHOLE AT 15.34m. BOREHOLE OPEN TO BOTTOM UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.															
	DATE DEPTH July 21/ 05 (m) Destroyed															

+ 3, x 3: Numbers refer to
Sensitivity 20
15 10 5
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 02-11

1 OF 2

METRIC

W.P. 19-1351-27 LOCATION N 4807679.5 E 285263.0 ORIGINATED BY MT
HWY QEW BOREHOLE TYPE Hollow Stem Augers/NQ Core Barrel COMPILED BY HS
DATUM DATE 31.01.02 - 31.01.02 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						WATER CONTENT (%)	
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							
							20 40 60 80 100						20 40 60		
91.7															
0.0	Clayey SILT, some sand, some limestone fragments Very Stiff Reddish Brown (RECENT ALLUVIUM)		1	SS	24										
89.9			2	SS	13										
1.8	Clayey SILT, trace sand, occasional siltstone fragments, occasional limey interbeds Very Stiff to Hard Reddish Brown (TILL) (CL-ML)		3	SS	17										
			4	SS	36										
87.3															
87.4	SHALE, highly weathered, reddish brown END OF THE SOIL SAMPLING AT 4.57m.		5	SS	100/										
4.6	Fresh to moderately weathered, weak to moderately strong, reddish brown to grey, SHALE, thinly laminated. CORING STARTED AT 4.57m. FOR CORING DETAILS PLEASE REFER TO BH 02-11R.		1	CORE		.125									
			2	CORE											
			3	CORE											
			4	CORE											

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+ 3, × 3: Numbers refer to Sensitivity 20 15 10 5 10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 05-12

1 OF 3

METRIC

W.P. 19-1351-27 LOCATION N 4807726.6 E 285282.2 ORIGINATED BY SLL
 HWY QEW BOREHOLE TYPE Hollow Stem Augers/NQ Core Barrel COMPILED BY HS
 DATUM DATE 17.08.05 - 17.08.05 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)			
106.5							20	40	60	80	100							
0.0	ASPHALT (150mm)																	
0.2	SAND, some gravel Firm Brown Moist (FILL)		1	SS	33													
105.3																		
1.2	CLAY, with silty sand seams Firm Brown Moist to Wet (FILL)		2	SS	6													
	becoming very stiff																	
			3	SS	21													
	trace roots		4	SS	19													
100.5																		
6.1	CLAY, with cobble and gravel, trace roots Very Stiff Redbrown Moist (FILL)		5	SS	18													
			6	SS	5													
	trace wood fragments		7	SS	11													

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+ 3, × 3: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 05-12

2 OF 3

METRIC

W.P. 19-1351-27 LOCATION N 4807726.6 E 285282.2 ORIGINATED BY SLL
 HWY QEW BOREHOLE TYPE Hollow Stem Augers/NQ Core Barrel COMPILED BY HS
 DATUM DATE 17.08.05 - 17.08.05 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W _P W W _L	20 40 60			
	with silt pockets, limestone fragments		8	SS	12									
94.1			9	SS	24									
12.5	Clayey SILT Very Stiff to Hard Redbrown Moist (TILL) (CL-ML)		10	SS	36									
			11	SS	73									
			12	SS	29									
88.3			13	SS	50/									
18.3	BEDROCK, SHALE , with limestone layers, brown, fresh to slightly weathered, very thinly bedded				.075									
	Limestone layers from 19.15 to 19.18m, 19.41 to 19.46m		1	RUN										
	Clay seams from 19.66 to 19.68m, 19.79 to 19.86m													

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Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 05-13

1 OF 3

METRIC

W.P. 19-1351-27 LOCATION N 4807719.6 E 285294.5 ORIGINATED BY SLL
 HWY QEW BOREHOLE TYPE Hollow Stem Augers/NQ Core Barrel COMPILED BY HS
 DATUM DATE 22.08.05 - 23.08.05 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)					
								○ UNCONFINED	+ FIELD VANE	w _P	w	w _L			
								● QUICK TRIAXIAL	× LAB VANE						
107.0						20	40	60	80	100	20	40	60		
0.0	ASPHALT (90mm)					107									
0.1	SAND, trace to some silt, trace to some gravel Dense Brown Moist (FILL)		1	SS	45										
						106									
105.4															
1.7	Silty CLAY, trace to some sand, trace gravel Firm Brown Moist (FILL) becoming hard		2	SS	5										
						105									
						104									
						103									
						102									
						101									
						100									
						99									
						98									

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+ 3, × 3: Numbers refer to Sensitivity

20
15 5
10 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 05-13

2 OF 3

METRIC

W.P. 19-1351-27 LOCATION N 4807719.6 E 285294.5 ORIGINATED BY SLL
 HWY QEW BOREHOLE TYPE Hollow Stem Augers/NQ Core Barrel COMPILED BY HS
 DATUM DATE 22.08.05 - 23.08.05 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)		
								20 40 60 80 100										
								○ UNCONFINED + FIELD VANE										
								● QUICK TRIAXIAL × LAB VANE										
								20 40 60 80 100										
96.4							97											
10.7	SILT, some clay to clayey, trace to some sand Very Stiff Brownish Grey Moist becoming sandy		8	SS	25		96											
94.8							95											
12.2	Clayey SILT, trace sand, trace gravel, some grey silt pockets, occasional brown sand pockets at tip. Hard Brown (TILL) (CL-ML)		9	SS	31		94											
	occasional shale fragments, wet		10	SS	41		93											
	sandy silt pocket at 15.54m.		11	SS	35		92											
							91											
	shale fragments at 16.92m silt pockets at 17.07m		12	SS	121/ 230		90											
							89											
			13	SS	83													
							88											
87.1			14	SS	63/													

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+ 3, × 3 : Numbers refer to
Sensitivity

20
15-5
10 (%) STRAIN AT FAILURE

METRIC

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)				
								20	40	60	80	100	W _P	W			W _L
19.9	<p>BEDROCK, SHALE, with greenish grey limestone layers, brown, fresh to slightly weathered, very thinly bedded Limestone layers from 20.19 to 20.27m, 20.37 to 20.47m, 20.63 to 20.65m, 20.80 to 20.83m, 21.01 to 21.03m, 21.44 to 21.51m. Rubble from 19.99 to 20.19m. Vertical joint from 20.82 to 20.84m.</p> <p>Limestone layers from 21.51 to 21.54m, 22.20 to 22.30m, 22.33 to 22.40m, 22.75 to 22.78m, 22.91 to 22.99m. Clay seam at 21.87m.</p> <p>Vertical joint from 22.38 to 22.40m, 22.86 to 22.94m. Rubble from 22.72 to 22.75m.</p> <p>Limestone layers from 23.14 to 23.25m, 24.04 to 24.08m, 24.35 to 24.38m.</p> <p>Broken zone from 24.10 to 24.13m</p> <p>Shale and limestone interbed from 24.56 to 24.92m Rubble from 24.79 to 24.83m Limestone layer from 25.05 to 25.07m, 25.47 to 25.60m, 25.91 to 26.08m.</p>		1	RUN	.175											<p>>25</p> <p>7</p> <p>9</p> <p>4</p> <p>2</p> <p>5</p> <p>6</p> <p>6</p> <p>>25</p> <p>3</p> <p>2</p> <p>3</p> <p>2</p> <p>2</p> <p>1</p> <p>>25</p> <p>2</p> <p>5</p> <p>3</p> <p>3</p>	<p>GR SA SI CL</p> <p>RUN 1# TCR=97%, SCR=80%, RQD=43%</p> <p>RUN 2# TCR=100%, SCR=88%, RQD=38%</p> <p>RUN 3# TCR=100%, SCR=97%, RQD=80%</p> <p>RUN 4# TCR=100%, SCR=95%, RQD=53%</p>
81.0																	
26.1	<p>END OF BOREHOLE AT 26.08m. BOREHOLE GROUTED WITH BENTONITE GROUT AND PATCHED WITH ASPHALT AT SURFACE.</p>																

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RECORD OF BOREHOLE No 05-14

2 OF 2

METRIC

W.P. 19-1351-27 LOCATION N 4807741.9 E 285288.1 ORIGINATED BY JL
 HWY QEW BOREHOLE TYPE Hollow Stem Augers/NQ Core Barrel COMPILED BY HS
 DATUM DATE 14.09.05 - 14.09.05 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa	WATER CONTENT (%)					
			2	RUN			97							RUN 3# TCR=96.67%, SCR=96.67%, RQD=96.67% RUN 4# TCR=100%, SCR=100%, RQD=91.67%
	limestone interbeds at 10.82m to 10.85m, 11.28m to 11.31m, 11.41m to 11.43m, 11.61m to 11.62m		3	RUN			96							
			4	RUN			95							
							94							
93.5	13.9	END OF BOREHOLE AT 13.87m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS DATE Oct. 27/ 05 DEPTH (m) 12.6												

ONTMT4S 5127MTO.GPJ 28/10/05

RECORD OF BOREHOLE No 02-15

1 OF 2

METRIC

W.P. 19-1351-27 LOCATION N 4807732.9 E 285306.8 ORIGINATED BY MT
HWY QEW BOREHOLE TYPE Hollow Stem Augers/NQ Core Barrel COMPILED BY HS
DATUM DATE 13.02.02 - 13.02.02 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV 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		
105.3 0.0	Clayey SILT, some sand, occasional shale fragments, occasional limey pockets, occasional rootlets and black organics Very Stiff to Hard Mottled Reddish Brown- Grey (POSSIBLE FILL)		1	SS	24		105							0 21 52 25
			2	SS	12		104							
			3	SS	31		103							
			4	SS	31		102							
			5	SS	11		101							
	becoming stiff						100							
99.6 5.7	SHALE, weathered, reddish brown		6	SS	100	.50	99							
98.2 7.1	Slightly weathered to Fresh, weak to medium strong, reddish brown, SHALE, thinly bedded, occasional mechanical breaks 7.39 - 7.44m siltstone layer		1	CORE			98							RUN 1# TCR=94%, SCR=64%, RQD=48%
	8.74 - 8.79m siltstone layer		2	CORE			97							RUN 2# TCR=100%, SCR=95%, RQD=72%
	becoming slightly weathered, weak to very weak						96							RUN 3# TCR=98%, SCR=95%,

Continued Next Page

+ 3, x 3 : Numbers refer to
Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 02-15

2 OF 2

METRIC

W.P. 19-1351-27 LOCATION N 4807732.9 E 285306.8 ORIGINATED BY MT
HWY QEW BOREHOLE TYPE Hollow Stem Augers/NQ Core Barrel COMPILED BY HS
DATUM DATE 13.02.02 - 13.02.02 CHECKED BY AEG

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL RQD=95%
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80	100	W _P	W		
94.8			3	CORE		95										
10.5	END OF THE BOREHOLE AT 10.52m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.83m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) July 21/ 05 9.5 Oct. 27/ 05 9.3															

RECORD OF BOREHOLE No 02-16

1 OF 3

METRIC

W.P. 19-1351-27 LOCATION N 4807771.4 E 285315.3 ORIGINATED BY MT
HWY QEW BOREHOLE TYPE Hollow Stem Augers/NQ Core Barrel COMPILED BY HS
DATUM DATE 04.02.02 - 04.02.02 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV 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		
116.5 0.0	Clayey SILT , some sand, trace shale fragments Stiff Reddish Brown (POSSIBLE FILL)		1	SS	14		116							
115.0 1.5	Clayey SILT , trace sand, trace shale fragments Hard Reddish Brown (TILL) (CL-ML)		2	SS	34		115							0 22 50 27
114.2 2.3	SHALE , weathered, occasional limey interbeds, reddish brown		3	SS	100/ .125		114							
			4	SS	100/ .050		113							
111.9 4.6	Slight weathered, very weak to weak, thinly bedded, reddish brown, SHALE 4.85 - 4.93m siltstone layer		5	SS	100/ .125		112							RUN 1# TCR=100%, SCR=78%, RQD=70%
	5.20 - 5.25m and 5.43 - 5.48m siltstone layers		1	CORE			111							
	5.89 - 5.94m siltstone layer becoming weak, fresh to slightly weathered, thinly laminated 6.38 - 6.15m siltstone layer 6.63 - 6.76m siltstone layer		2	CORE			110							RUN 2# TCR=100%, SCR=75%, RQD=48%
	Oct. 27/ 05 17.6 7.52 - 7.57m siltstone layer becoming fresh, medium strong 7.62 - 7.70m and 7.75 - 7.82m siltstone layers						109							RUN 3# TCR=97%, SCR=74%, RQD=50%
	8.23 - 8.31m siltstone layer		3	CORE			108							
	8.53 - 8.69m siltstone layer						107							RUN 4# TCR=100%, SCR=93%, RQD=85%
	8.99 - 9.07m siltstone layer													
	9.30 - 9.40m siltstone layer													
	9.60 - 9.65m siltstone layer		4	CORE										

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Continued Next Page

+ 3, × 3 : Numbers refer to Sensitivity 20 15 10 5 0 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 02-16

3 OF 3

METRIC

W.P. 19-1351-27 LOCATION N 4807771.4 E 285315.3 ORIGINATED BY MT
 HWY QEW BOREHOLE TYPE Hollow Stem Augers/NQ Core Barrel COMPILED BY HS
 DATUM DATE 04.02.02 - 04.02.02 CHECKED BY AEG

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W _P W W _L				
96.4 20.1	END OF THE BOREHOLE AT 20.06m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.83m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) July 21/ 05 17.9						96							

ONTMT4S 5127MTO.GPJ 28/10/05

RECORD OF BOREHOLE No 02-19

1 OF 3

METRIC

W.P. 19-1351-27 LOCATION N 4807796.9 E 285267.6 ORIGINATED BY MT
 HWY QEW BOREHOLE TYPE Hollow Stem Augers/NQ Core Barrel COMPILED BY HS
 DATUM DATE 30.01.02 - 30.01.02 CHECKED BY AEG

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20 40 60 80 100	20 40 60 80 100	W _P W W _L	20 40 60		
116.0													
0.0	Sandy SILT, some clay, occasional limestone and siltstone fragments, trace organics and rootlets, stiff, reddish brown: (POSSIBLE FILL) Stiff Reddish Brown (POSSIBLE FILL)		1	SS	12								
114.3			2	SS	100/								
1.7	SHALE, weathered, weak, fissile, reddish brown		3	SS	100/								
			4	SS	100/								
					.275								
111.3													
4.7	END OF THE SOIL SAMPLING AT 4.67m. CORING STARTED AT 4.67m. FOR CORING DETAILS PLEASE REFER TO BH 02-19R.		1	CORE									RUN 1# TCR=93%, SCR=80%, RQD=67%
			2	CORE									RUN 2# TCR=100%, SCR=55%, RQD=22%
			3	CORE									RUN 3# TCR=100%, SCR=98%, RQD=93%
													RUN 4# TCR=100%, SCR=100%, RQD=97%

ONTMT4S 5127MTO.GPJ 28/10/05

Continued Next Page

+ 3, x 3; Numbers refer to Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 02-19

2 OF 3

METRIC

W.P. 19-1351-27 LOCATION N 4807796.9 E 285267.6 ORIGINATED BY MT
 HWY QEW BOREHOLE TYPE Hollow Stem Augers/NQ Core Barrel COMPILED BY HS
 DATUM DATE 30.01.02 - 30.01.02 CHECKED BY AEG

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W _p W W _L	20 40 60			
			4	CORE			106							RUN 5# TCR=100%, SCR=75%, RQD=73% RUN 6# TCR=92%, SCR=92%, RQD=87% RUN 7# TCR=100%, SCR=100%, RQD=100% RUN 8# TCR=92%, SCR=90%, RQD=90% RUN 9# TCR=100%, SCR=100%, RQD=100% RUN 10# TCR=100%, SCR=100%, RQD=98%
			5	CORE			105							
			6	CORE			104							
			7	CORE			103							
			8	CORE			102							
			9	CORE			101							
			10	CORE			100							
							99							
							98							
							97							
96.1														

ONTMT4S 5127MTO.GPJ 28/10/05

Continued Next Page

+ 3, x 3; Numbers refer to
Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 02-19

3 OF 3

METRIC

W.P. 19-1351-27 LOCATION N 4807796.9 E 285267.6 ORIGINATED BY MT
 HWY QEW BOREHOLE TYPE Hollow Stem Augers/NQ Core Barrel COMPILED BY HS
 DATUM DATE 30.01.02 - 30.01.02 CHECKED BY AEG

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
19.9	END OF THE BOREHOLE AT 20.06m.						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE	20 40 60					

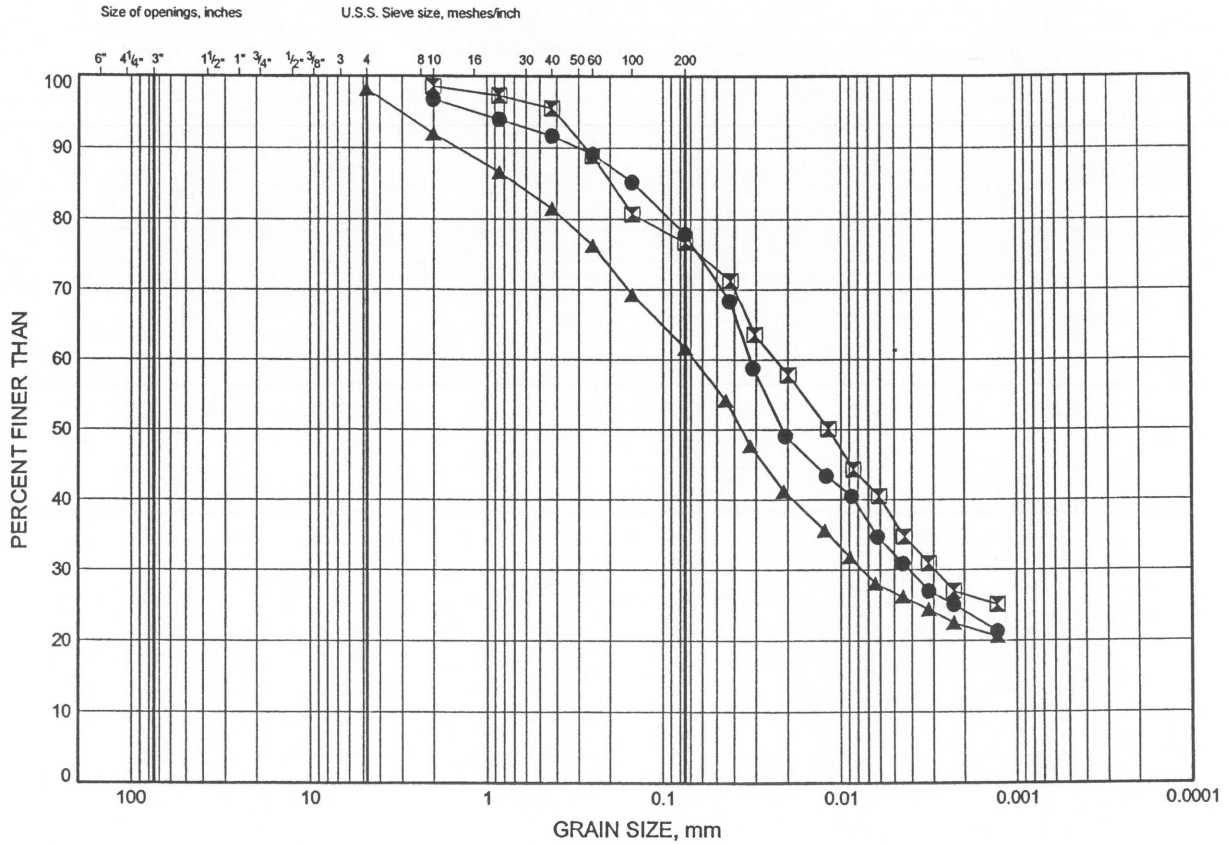
ONTMT4S 5127MTO.GPJ 28/10/05

Appendix B

Laboratory Test Results

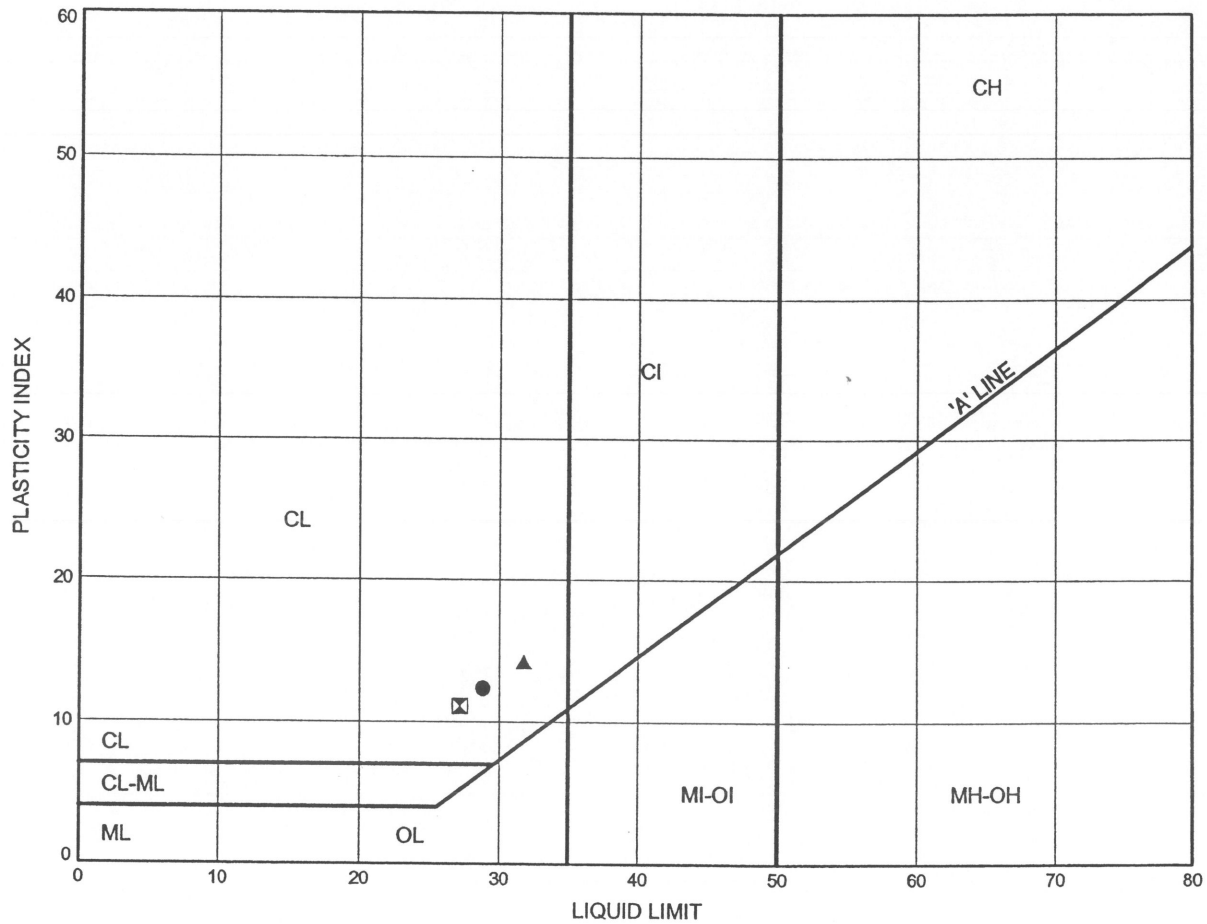
QEW Third Line to Burloak GRAIN SIZE DISTRIBUTION

FIGURE B2



QEW Third Line to Burloak
ATTERBERG LIMITS TEST RESULTS

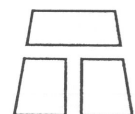
FIGURE B3



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	02-10	2.59	88.96
⊠	02-15	3.35	101.92
▲	02-16	1.83	114.68

Date July 2005

Project 19-1351-27



THURBER

Prep'd HS

Chkd. AEG

Appendix C

Foundation Comparison

COMPARISON OF FOUNDATION ALTERNATIVES

Foundation Element	Footing on Bedrock	Caisson
West Abutment	<p>Advantages:</p> <ul style="list-style-type: none"> i. Comparatively high values of geotechnical resistance are available on the bedrock ii. Readily installed and cost effective. <p>Disadvantages:</p> <ul style="list-style-type: none"> i. May require more extensive roadway protection. 	<p>Advantages:</p> <ul style="list-style-type: none"> i. High bearing resistance ii. May reduce need for roadway protection. <p>Disadvantages:</p> <ul style="list-style-type: none"> i. Higher costs than spread footings. ii. Difficulties in cleaning and inspecting bases iii. Unwatering difficulties.
Pier #1	Not recommended for this location due to depth to bearing stratum and location of valley slope.	<p>Advantages:</p> <ul style="list-style-type: none"> i. High bearing resistance. ii. More suitable for installation at this foundation location. <p>Disadvantages:</p> <ul style="list-style-type: none"> i. Higher costs than spread footings. ii. Difficulties in cleaning and inspecting bases iii. Unwatering difficulties.
Pier #2	<p>Advantages:</p> <ul style="list-style-type: none"> i. Comparatively high values of geotechnical resistance are available on the bedrock ii. Readily installed and cost effective. <p>Disadvantages:</p> <ul style="list-style-type: none"> i. More susceptible to scour problems. 	<p>Advantages:</p> <ul style="list-style-type: none"> i. High bearing resistance. ii. Less susceptible to scour problems than footings. iii. More suitable for installation at this foundation location. <p>Disadvantages:</p> <ul style="list-style-type: none"> i. Higher costs than spread footings. ii. Difficulties in cleaning and inspecting bases iii. Unwatering difficulties.
Pier #3	<p>Advantages:</p> <ul style="list-style-type: none"> i. Comparatively high values of geotechnical resistance are available on the bedrock ii. Readily installed and cost effective. <p>Disadvantages:</p> <ul style="list-style-type: none"> i. More susceptible to scour problems. 	<p>Advantages:</p> <ul style="list-style-type: none"> i. High bearing resistance. ii. Less susceptible to scour problems than footings. iii. More suitable for installation at this foundation location. <p>Disadvantages:</p> <ul style="list-style-type: none"> i. Higher costs than spread footings. ii. Difficulties in cleaning and inspecting bases iii. Unwatering difficulties.

Pier #4	Not recommended for this location due to depth to bearing stratum and location of valley slope.	<p>Advantages:</p> <ul style="list-style-type: none"> i. High bearing resistance. ii. More suitable for installation at this foundation location. <p>Disadvantages:</p> <ul style="list-style-type: none"> i. Higher costs than spread footings. ii. Difficulties in cleaning and inspecting bases iii. Unwatering difficulties.
East Abutment	Not recommended for this location due to depth to bearing stratum.	<p>Advantages:</p> <ul style="list-style-type: none"> i. High bearing resistance. ii. More suitable for installation at this foundation location. <p>Disadvantages:</p> <ul style="list-style-type: none"> i. Higher costs than spread footings. ii. Difficulties in cleaning and inspecting bases iii. Unwatering difficulties.

Appendix D

Special Provisions

The following Special Provisions are referenced in this report:

OPSS 206, as amended by Special Provision "Amendment to OPSS 206, December 1993", dated November 2002.

SP 539S01

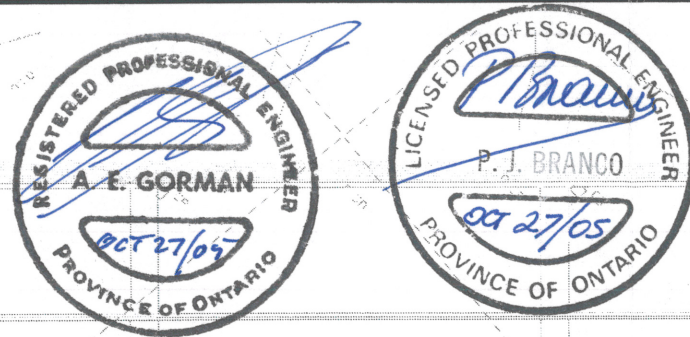
SP 599S22

SP 902S01

Appendix E

Borehole Locations and Soil Strata Drawing

Soil Strata Drawing



DISTRICT
CONT. No.
GWP No. 169-00-00

QEW
BRONTE CREEK TWIN BRIDGE

SHEET
S2

BOREHOLE LOCATIONS AND SOIL STRATA

MRC
McCORMICK RANKIN
CORPORATION

THURBER
THURBER ENGINEERING LTD.



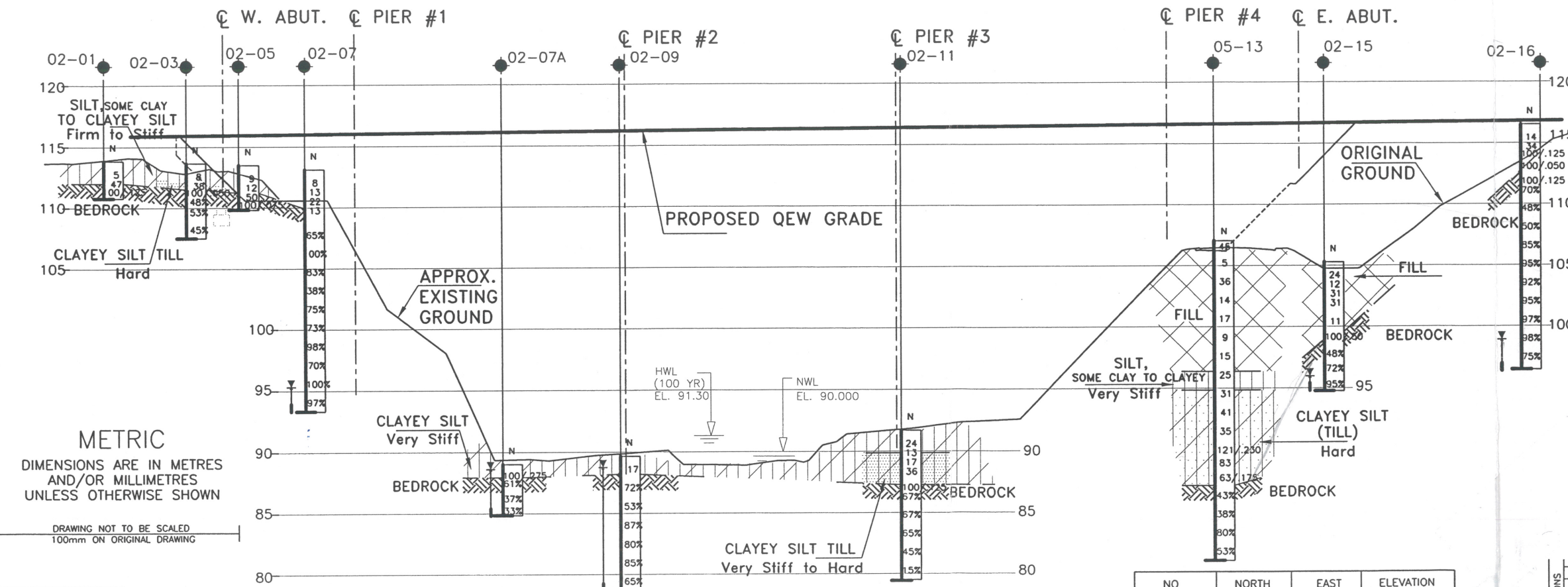
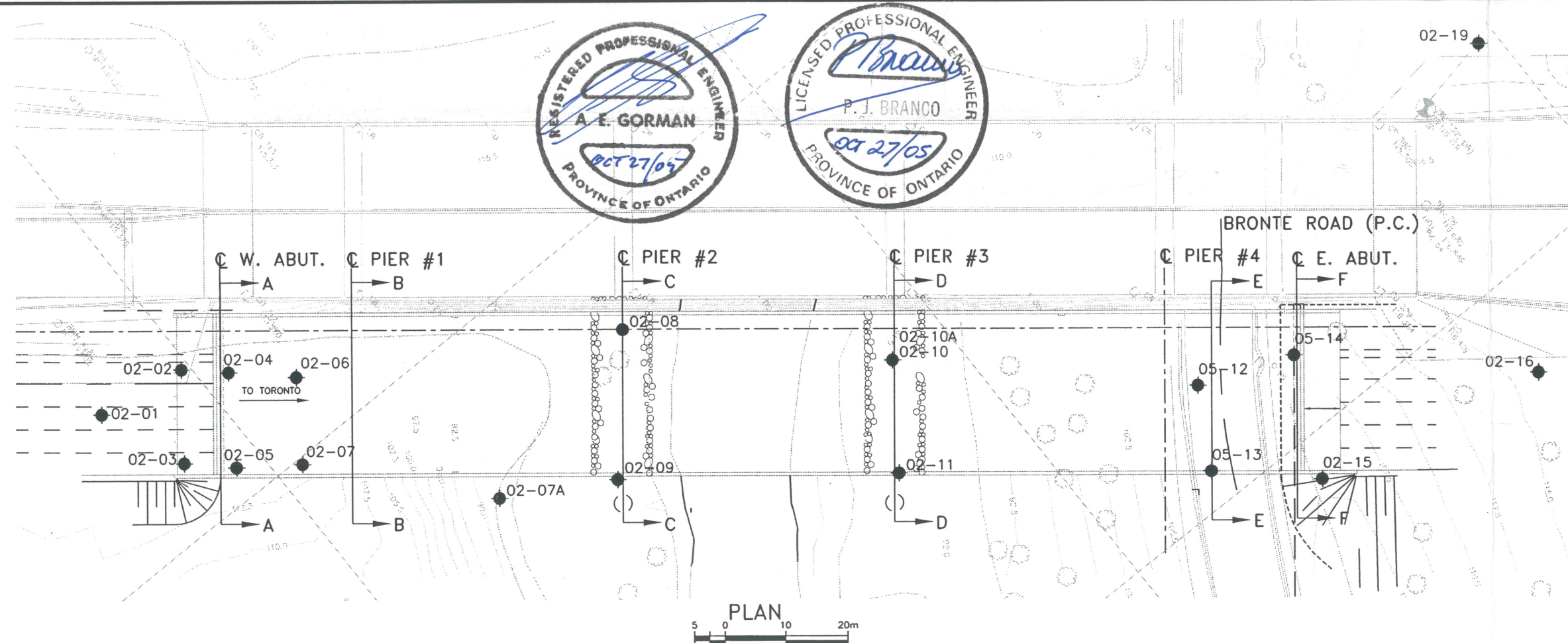
- LEGEND
- Bore Hole
 - Dynamic Cone Penetration Test (cone) or Probe Hole
 - Bore Hole & Cone
 - Blows/0.3m (Std pen Test, 475J/blow)
 - Blows/0.3m (60' Cone, 475J/blow)
 - Pressure, Hydraulic
 - WL in Piezometer at Time of Investigation (Date)
 - Head Artesian Water
 - Piezometer
 - WL in Open Borehole Upon Completion of Drilling
 - 90% Rock Quality Designation (RQD)

NO	NORTH	EAST	ELEVATION
02-1	4807583.7	285174.2	113.8
02-2	4807598.6	285176.7	114.4
02-3	4807589.4	285189.0	113.7
02-4	4807604.3	285181.9	114.1
02-5	4807595.7	285194.8	113.5
02-6	4807612.4	285189.4	113.7
02-7	4807604.4	285201.1	113.1
02-7A	4807626.2	285225.0	95.0
02-8	4807659.0	285216.6	89.8
02-9	4807643.1	285235.2	89.6
02-10	4807690.2	285247.9	91.5
02-11	4807679.5	285263.0	91.7
02-15	4807732.9	285306.8	105.3
02-16	4807771.4	285315.3	116.5
02-19	4807796.9	285267.6	116.0

NOTE

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

DESIGN	AEG	CHK	CODE	CODE	LOAD	LOAD	DATE
DRAWN	HS	CHK	AEG	SITE	SITE	STRUCT	SCHEME
							DWG



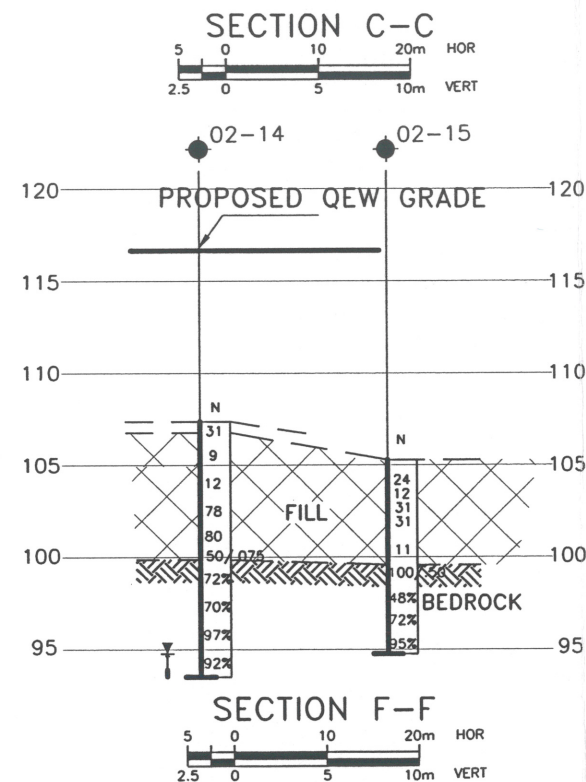
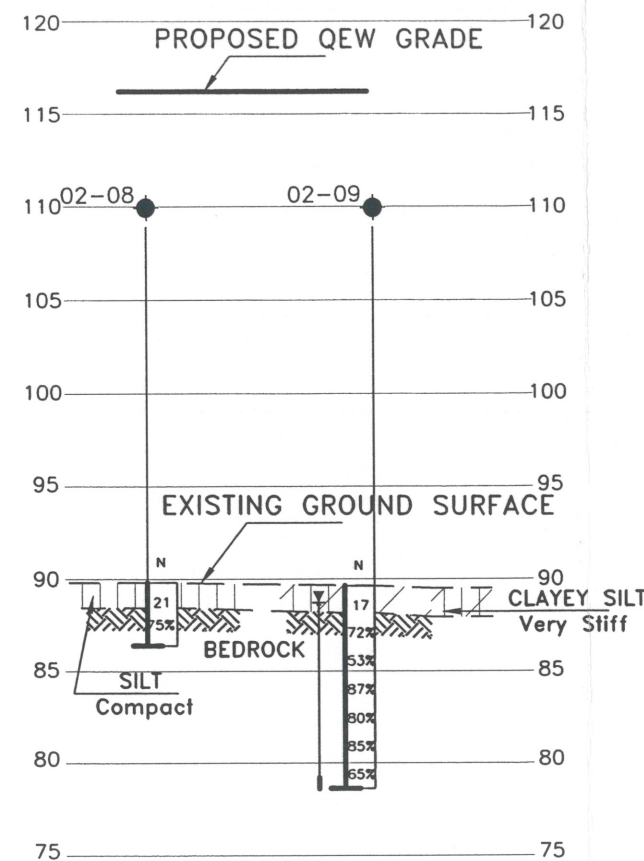
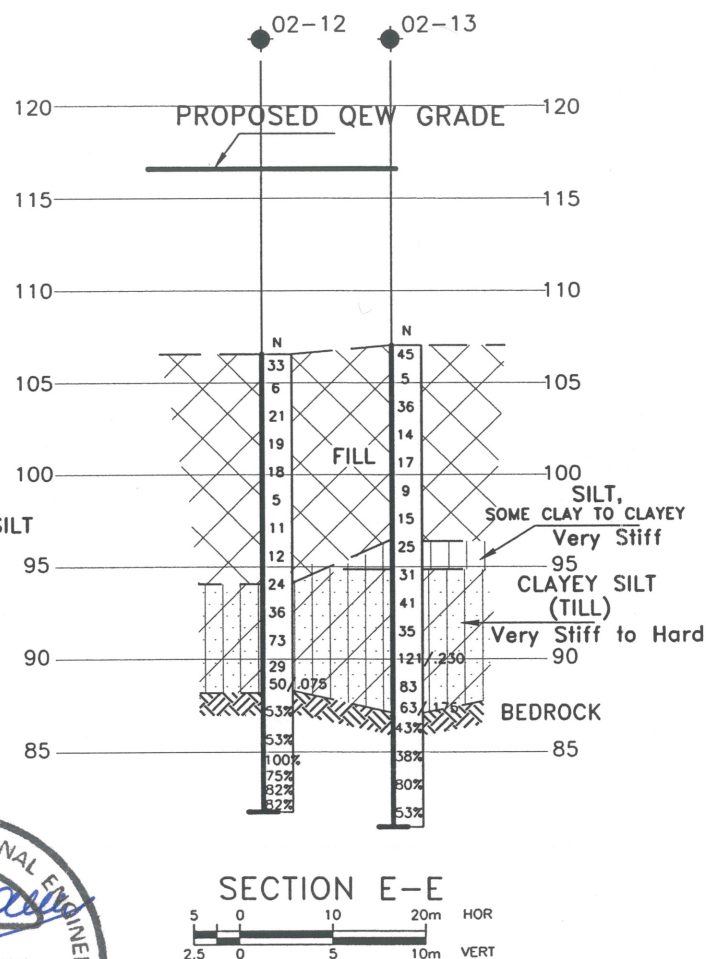
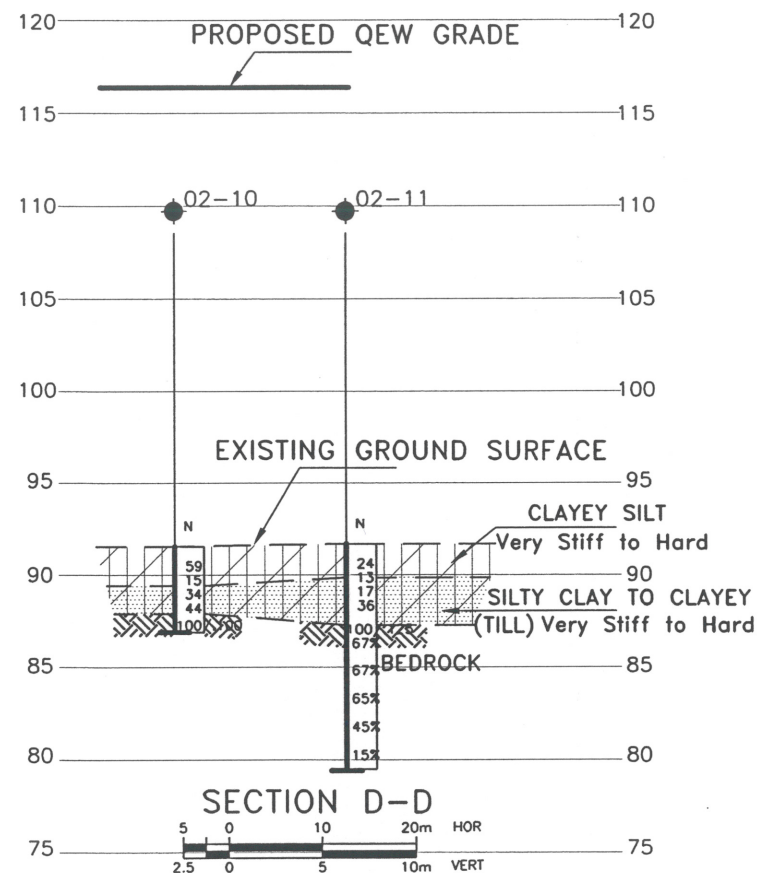
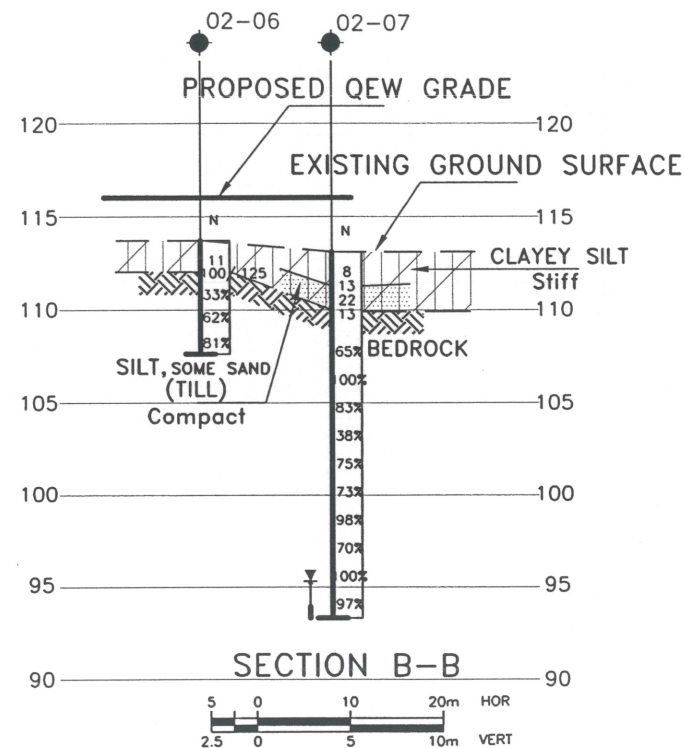
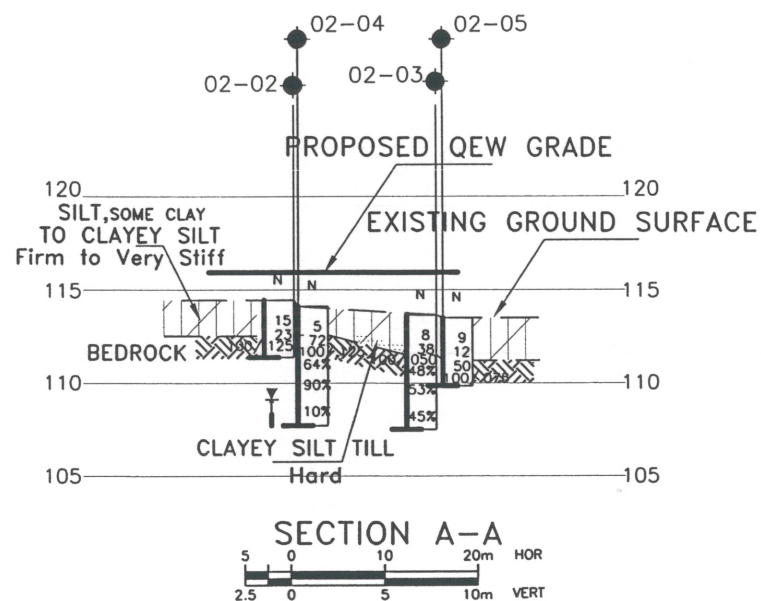
NO	NORTH	EAST	ELEVATION
05-10A	4807690.2	285247.9	91.5
05-12	4807726.6	285282.2	106.6
05-13	4807719.6	285294.5	107.0
05-14	4807741.9	285288.1	107.0

BM 1491
EL. 118.921
TOP OF HCM 9690020
53.6 LT 11+659.800
4807512.2 N 285025.0 E

PROFILE

2.5 0 10 20m HOR

2.5 0 5 10m VERT



DISTRICT
CONT. No.
GWP No. 169-00-00

QEW
BRONTE CREEK TWIN BRIDGE

CROSS SECTIONS

McCORMICK RANKIN CORPORATION

THURBER ENGINEERING LTD.

KEY PLAN

SHEET
S3

LEGEND

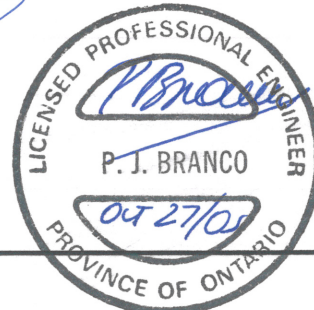
- Bore Hole
- ⊕ Dynamic Cone Penetration Test (cone) or Probe Hole
- ⊕ Bore Hole & Cone
- N Blows/0.3m (Std pen Test, 475J/blow)
- CONE Blows/0.3m (60' Cone, 475J/blow)
- PH Pressure, Hydraulic
- WL in Piezometer at Time of Investigation (Date)
- Head Artesian Water
- Piezometer
- WL in Open Borehole Upon Completion of Drilling
- 90% Rock Quality Designation (RQD)

NO	NORTH	EAST	ELEVATION
02-1	4807583.7	285174.2	113.8
02-2	4807598.6	285176.7	114.4
02-3	4807589.4	285189.0	113.7
02-4	4807604.3	285181.9	114.1
02-5	4807595.7	285194.8	113.5
02-6	4807612.4	285189.4	113.7
02-7	4807604.4	285201.1	113.1
02-7A	4807626.2	285225.6	89.0
02-8	4807659.0	285216.6	89.8
02-9	4807643.1	285235.2	89.6
02-10	4807690.2	285247.9	91.5
02-11	4807679.5	285263.0	91.7
02-15	4807732.9	285306.8	105.3
02-16	4807771.4	285315.3	116.5
02-19	4807796.9	285267.6	116.0

NOTE

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

BM 1491
EL. 118.921
TOP OF HCM 9690020
53.6 LT 11+659.800
4807512.2 N 285025.0 E



NO	NORTH	EAST	ELEVATION
05-10A	4807690.2	285247.9	91.5
05-12	4807726.6	285282.2	106.6
05-13	4807719.6	285294.5	107.0
05-14	4807741.9	285288.1	107.4

DESIGN	CHK	CODE	CODE	LOAD	LOAD	DATE	DATE
AEG	HS	CHK	AEG	SITE	SITE	STRUCT	SCHEME
DWG	2						