FOUNDATION INVESTIGATION AND DESIGN REPORT SERVICE ROAD I/C UNDERPASS HIGHWAY 11, BURK'S FALLS TO SOUTH RIVER ONTARIO G.W.P. 759-93-00, W.P. 5321-03-01, SITE 44-412

Geocres Number: 31E-198

Report to

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TABLE OF CONTENTS

Part 1

Part 2

Appendices

FOUNDATION INVESTIGATION AND DESIGN REPORT
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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a foundation investigation at the Service Road I/C Underpass structure over re-aligned Highway 11 near the village of South River, Ontario. Golder Associates Ltd. (Golder) carried out a previous preliminary investigation in the vicinity of the site for a different alignment and different structure arrangement. The factual data from that investigation is not directly applicable to the current design but has been taken into consideration in developing the subsurface model.

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 considering a combination of the data from the previous Golder investigation and the data obtained in the course of the present investigation.

Thurber carried out the investigation as a sub-consultant to Marshall Macklin Monaghan, under the Ministry of Transportation Ontario (MTO) Agreement Number 5005-A-000188.

2 SITE DESCRIPTION

The site is located at the intersection of the new alignment of Highway 11 and Service Road, in the Township of Machar, Ontario (Mainline Station 15+787.980). This location is approximately 2 km north of the centre of the village of South River.

The site is located in an area of rolling terrain characterized by bedrock outcrops and glacial drift of variable thickness. Locally, the terrain exhibits relatively steep slopes. Large diameter boulders are present at several locations at ground surface near the bridge site. The bedrock is typically Precambrian granitic gneiss and gabbro of the Central Gneiss Belt of the Canadian Shield and the shallow overburden soils are typically non-cohesive outwash or basal till deposits.

General drainage in the area is to the southwest, towards the South River. Locally, however, west and east of the bridge site, there are low-lying areas where drainage is poor and the land is mantled by deposits of organic soils. These organic deposits do not affect the immediate bridge site.

The area is heavily wooded and development is sparse.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project were carried out between May 27 and May 29, 2003 and September 8 and September 29, 2003. The site investigation consisted of drilling and sampling a total of sixteen boreholes to depths ranging from 1.3m to 18.4m. The boreholes were numbered 412-1 to 412-14, 412-17 and 412-20. In addition to the boreholes drilled by Thurber, seven boreholes were drilled by Golder as part of the preliminary design assignment. The results of the investigation carried out by Golder are summarized in Appendix C. The bridge alignment has been modified since the preliminary investigation program carried out by Golder. The boreholes drilled by Golder are more than 100m from the revised proposed bridge alignment and are of limited value to the current investigation program.

Surveyors from Marshall Macklin Monaghan Ltd. marked the borehole locations in the field. Thurber obtained utility clearances prior to any drilling being carried out.

All-Terrain Drilling Limited of Waterloo, Ontario supplied a CME 75 drill rig mounted on a Nodwell tracked carrier and conducted the drilling, sampling and in-situ testing operation. Auger and tricone drilling techniques were used to advance the boreholes. Overburden samples were obtained using a split spoon sampler in conjunction with Standard Penetration Testing (SPT). At least two boreholes within each of the three foundation elements were advanced 3 m into bedrock by diamond coring.

Standpipe piezometers were installed at each of the foundation elements in boreholes BH412-2, BH412-13 and BH412-14.

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

On completion of drilling and sampling, the boreholes without piezometer installations were backfilled using drill cuttings. Details of the piezometer installations are provided in Table 3.1 on the following page.

A summary of the borehole information is presented in Table 1.

4 LABORATORY TESTING

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

Selected samples were subjected to gradation analysis (sieve test). Since only deposits of non-cohesive soils were encountered overlying bedrock, no other laboratory testing was deemed

necessary. A total of 20 samples were selected for these tests and the results are shown on the Record of Borehole sheets in Appendix A and on the plots in Appendix B.

Table 3.1 – Piezometer Installation Details

Piezometer Location	Piezometer Details	
	Tip Depth/ Elevation (m)	Completion Details
412-2	5.5/363.3	Piezometer with 1.5 m slotted screen installed with sand to 3.7 m, bentonite seal from 3.7 m to 3.4 m, drill cuttings from 3.4 m to 0.9 m, bentonite seal from 0.9 m to 0.3 m and drill cuttings from 0.2 m to ground surface, bentonite seal at surface.
412-13	14.1/354.0	Piezometer with 1.5 m slotted screen installed to 14.1 m with native sand backfill (borehole collapse) to ground surface.
412-14	18.4/346.4	Piezometer with 1.5 m slotted screen installed to 18.4 m with native sand backfill (borehole collapse) to ground surface.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

5.1 General

Reference is made to the Record of Borehole sheets in Appendix A. Details of the encountered soil and rock stratigraphy are also presented on the "Borehole Locations and Soil Strata" and "Soil Strata" drawings inserted at the end of the report. A description of the stratigraphy is given in the following paragraphs.

In general terms, the site was found to be underlain by topsoil, a relatively thin deposit of silt in the low-lying areas east and west of the bridge site, sand and Pre-Cambrian bedrock.

5.2 Topsoil

Dark brown, moist, sandy topsoil was encountered in all boreholes to depths of 100mm to 400mm.

5.3 Silt

A layer of silt was encountered underlying the topsoil at the west abutment and west approach and also at the east approach. It was not encountered at the east abutment or pier locations.

At the west abutment and west approach, the silt extended to depth ranging from 1.3 to 2.2 m, corresponding to Elevation 367.6 to Elevation 366.4. At the east approach, where the ground surface is lower, the silt extended to a depth of 2.2 m, corresponding to Elevation 359.8.

This material is non-plastic and contains trace of organics, some sand to sandy, brown and grey. The bottom of the silt layer contained a clay content of 10% to 15% in some of the boreholes at the west abutment. The SPT blow count values typically ranged from 20 to 60, with most values larger than 40, reflecting dense to very dense state. At BH412-6 and BH412-20, isolated SPT values of 10 and 3 were obtained. The moisture content ranged from 15% to 21%.

Grain size distributions for selected samples are shown on the Record of Borehole sheets and in Figures B2 and B3 in Appendix B.

5.4 Sand

A layer of brown sand was encountered below the topsoil or silt layer in all boreholes, except in boreholes BH412-5, BH412-6, BH 412-7 and BH412-20, where it was absent.

At the west abutment and west approach, the sand extended to depths of 1.7 to 3.7 m, corresponding to Elevation 367.0 to Elevation 364.9. The thickness of the sand layer at this location ranged from 0.2 to 0.3 m. At the pier, the sand extended to depths of 9.7 to 11.4 m, corresponding to Elevation 358.3 to Elevation 356.8. The thickness of the sand layer at this location ranged from 9.5 to 10.9 m. At the east abutment, the sand extended to depths of 11.2 to 14.8 m, corresponding to Elevation 351.2 to Elevation 350.0. The thickness of the sand layer at this location ranged from 11.0 to 14.7 m.

The sand is described as very fine to coarse grained, with variable amounts of silt, gravel, cobbles and boulders. The presence of boulders was confirmed by coring at some of the boreholes and their locations and dimensions are shown on the borehole logs.

The sand was found to be typically in a dense to very dense state. The SPT values were typically larger than 30 and very often in excess of 50 blows for 100mm penetration of the split spoon. Resistance to drilling advance and high blow count values (SPT more than 100) encountered in most boreholes and at different elevations were attributed to the presence of cobbles and boulders. Relatively low SPT values were encountered in some boreholes at depths less than 2m or below the groundwater table where the bottom of the borehole was disturbed by the upward flow of water up the hollow stem auger or casing.

Grain size distributions for selected samples are shown on the Record of Borehole sheets and in Figures B1, B4, B5 and B6 in Appendix B.

5.5 Bedrock

The soils described above were found to be underlain by granitic gneiss or gabbro bedrock of the Pre-Cambrian Canadian Shield. The bedrock was proved by coring in Boreholes 412-2, 412-7, 412-8, 412-9, 412-10, 412-11, 412-12, 412-13, 412-14 and 412-17. The bedrock surface was inferred from refusal to auger penetration in other boreholes drilled at this site.

The bedrock is relatively shallow at the west abutment (approximate EL.368.7) and it dips eastward along the bridge alignment to approximately 15m depth (approximate EL.350.5) at the East Abutment.

Core recovery in the bedrock ranged from 80% to 100% and the RQD values ranged from 30% (near the surface) to 100% and for the most part lay between 80% and 100%. Based on the RQD values, the bedrock quality is generally good to excellent.

The condition of the joints ranged from planar to uneven and were generally rough though some smooth, planar joints were noted. The joints were mostly tight with no infilling or secondary weathering material.

Strength values of the intact rock obtained from Point Load Tests in selected rock cores ranged from 41MPa to 350MPa, with most values larger than 200MPa. The rock is generally described as very strong to extremely strong. A summary of the Pont Load Test results is presented in Table 2.

5.6 Water Levels

The groundwater levels observed at the standpipe piezometers are summarized in Table 1 and shown on Drawing "Borehole Locations and Soil Strata" and indicate that the groundwater flow along the bridge alignment is eastward. The groundwater level is approximately 0.5m, 3.8m and 2.0m below the existing ground surface at the West Abutment, Centre Pier and East Abutment, respectively. The proposed alignment for Hwy11 will be slightly above to lower than the observed groundwater levels.

All groundwater observations at this site are short term and the levels are expected to fluctuate seasonally and after severe weather events.

6 MISCELLANEOUS

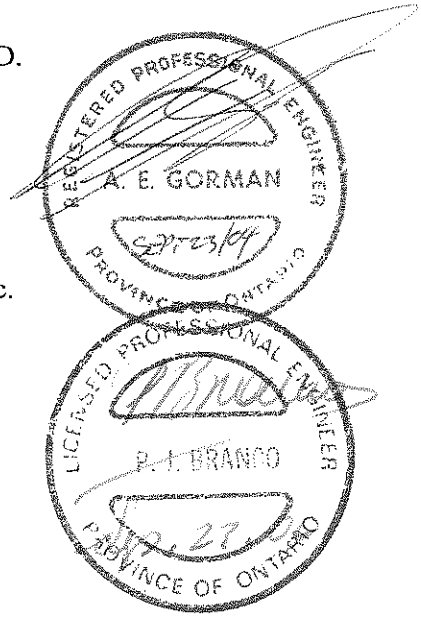
All-Terrain Drilling Ltd. of Waterloo, Ontario supplied a CME 75 drill rig mounted on a tracked, Nodwell carrier. The crew from All-Terrain performed the drilling and sampling operations under the direction of technical staff from Thurber.

Donald Parent, B.Sc. of Thurber obtained utility clearances, supervised the drilling and sampling operations and logged and sampled the boreholes.

Alastair E. Gorman, P.Eng, M.Sc. of Thurber prepared the report.

Paulo J. Branco, P.Eng., Ph.D. of Thurber, a Designated principal Contact for MTO Foundations Projects reviewed the report.

THURBER ENGINEERING LTD.



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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 underpass structure will be 88m long and will have two spans. Each span will be approximately 44 m long and the structure will be skewed at 29°.

The Highway 11 mainline at the structure will be in a cut with maximum depth of 6m at the centreline of the Southbound Lane. The cut will be in the overburden soils except near the west abutment where it the bedrock surface is anticipated to be 3m above the bottom of the east ditch.

At the west abutment, the finished grade will be 373.2 and the mean ground surface elevation is 368.8, resulting in an approach embankment in the order of 4.4 m high.

At the east abutment, the finished grade will be at 371.5 and the mean ground surface elevation is 363.6, resulting in an approach embankment in the order of 7.9 m high.

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 presented herein.

8 STRUCTURE FOUNDATIONS

8.1 General

The proposed bridge for this site will consist of a two-span underpass structure with a total of three foundation elements: two abutments and one pier. The Highway 11 mainline will lie in a cut up to 6m deep.

The elevations at which bedrock was encountered at the three foundation elements are summarized in Table 1.

8.2 Foundation Alternatives

This section discusses the feasible foundation alternatives, provides geotechnical design parameters and recommends a preferred foundation scheme.

Initial consideration was given to the following foundation types:

- Spread footings
- Driven piles
- Caissons (drilled shaft piles)

A comparison of the foundation alternatives based on advantages and disadvantages of each is included in Appendix D. An analysis of the options indicates that driven piles and caissons were eliminated from consideration as being unnecessary and impractical. Accordingly, the recommended foundation type at this site is spread footings and these could be designed either to bear on the bedrock or on engineered fill pads.

The ground conditions at this site are not considered favourable for an integral abutment design. Semi-integral abutment design utilizing footings is feasible.

8.3 Spread Footings

8.3.1 General

Based on the subsurface stratigraphy encountered at this site and the vertical alignment of the highway, it is recommended that the structure be supported on footings bearing on the bedrock at the West Abutment, on dense to very dense sand or on bedrock at the Centre Pier and on engineered fill at the East Abutment.

8.3.2 West Abutment

OPSD 201.01 permits a vertical face for mainline rock cuts. However, it is recommended that the forward toe of the West Abutment foundation lie behind a line projected up at 1H:2V from the toe of the rock cut to a maximum offset of 1 m behind the crest of the rock cut.

The top of rock varies from Elevation 366.3m to elevation 367.6m across this foundation, as shown elsewhere in this report. In practical terms, the underside of the concrete footing should be designed to lie above the local top of rock and the difference made up using mass concrete fill. Typically, the footing may be stepped down across the width of the structure to accommodate changes in the elevation of the top of bedrock.

The top surface of the bedrock should be stripped of all overburden and be cleaned. All shattered and loosened rock fragments should be removed from the footprint of the footing or mass concrete fill.

The stability of the rock cut in front of the West Abutment should be protected as described in Section 10.

Rock excavation is expensive and un-necessary excavation of bedrock should be avoided where practical.

Bearing Resistance on Bedrock

The West Abutment footings bearing on sound bedrock should be designed on the basis of a geotechnical resistance of up to 10,000 kPa at factored ULS for vertical, concentric loads. In the case of eccentric or inclined loading, the geotechnical resistance must be calculated as illustrated in the CHBDC Clause 6.7.3 and Clause 6.7.4. The design of the footing may be governed by other considerations such as sliding resistance or overturning moment.

The SLS condition will not govern for footings founded on bedrock.

The same value of resistance may be used where mass concrete of suitable strength is poured in neat contact with a clean, sound bedrock surface.

Horizontal Resistance on Bedrock

The horizontal resistance may be carried out using a value of 0.7 for the ultimate friction factor of concrete poured on rock.

If the frictional component is insufficient, the horizontal resistance may be increased by dowelling into the rock mass. Dowels are considered to be comparatively short steel bars that may be assumed to provide only shear resistance. If vertical resistance in tension is required, rock anchors should be included in the design.

The dowel may be considered as acting as a fully embedded pile in the rock and hence will fail when the ultimate lateral resistance of the rock or grout is exceeded. Using a lower bound value of 20 MPa for the strength of the rock or grout, an ultimate horizontal resistance of 1.5 MN may be assumed for a 50 mm steel dowel embedded 500 mm into the rock. The depth of embedment is measured below the bearing surface prepared to receive the concrete footing.

The shearing resistance of the selected dowel must be checked structurally.

8.3.3 Pier

The pier foundation will be situated in a cut, approximately 6m below the existing ground surface. The top of rock varies from Elevation 357.7m to elevation 358.6m across this foundation, 9.6m to 10.7m below the existing ground surface, as shown elsewhere in this report. Assuming that the underside of the foundation will be situated below the anticipated frost penetration depth, 1.9m below final grade, it is anticipated that the underside of the footing will be in the order of 1.7m to 2.8m above the top of bedrock.

In order to detect the presence of and to allow for the removal of large boulders that may be present beneath the footing, the overburden soils should be excavated to 0.5m below the underside of the footing and backfilled with engineered fill.

Alternatively, the excavation may be deepened to the top of bedrock for the footing to bear directly on the bedrock surface.

Bearing Resistance on Very Dense Sand

If a footing bearing on earth is selected for the pier, it must be design to bear at or below Elevation 364.0 and be designed on the basis of a geotechnical resistance of 900 kPa at factored ULS and 600 kPa at SLS for vertical, concentric loads. In the case of eccentric or inclined loading, the geotechnical resistance must be calculated as illustrated in the CHBDC Clause 6.7.3 and Clause 6.7.4.

The SLS resistance value has been based on a maximum settlement of 25 mm. Differential settlement is not expected to exceed 20 mm in a 6 m span.

Horizontal Resistance on Very Dense Sand

The horizontal resistance may be calculated using a value of 0.65 for the ultimate friction factor of concrete poured on the very dense sand.

Bearing Resistance and Horizontal Resistance on Bedrock

The vertical and horizontal resistance for a pier footing founded on the bedrock are the same as those provided for the west abutment. The founding elevation for a footing on bedrock at the pier averages 357.8, but varies from 356.2 at the northeast corner to 358.6 in the middle portion of the footing.

8.3.4 East Abutment

The proposed Service Road profile results in the underside of the east abutment footing lying approximately 1 m above the existing ground surface at the south end of the east abutment. In view of this situation and the relatively looser soil at the soil end of the footing, a spread footing bearing on native soil is not considered feasible and it is recommended that the spread footing be supported on an engineered fill pad.

If an engineered fill pad is used at this site, all topsoil and loose native sand should be stripped. The highest elevations at which the engineered fill may be founded are 364.0 at the north end and 361.0 at the south end. The engineered fill should consist of OPSS Granular "A" compacted in accordance with OPSS 501 and conforming to the geometry illustrated in Figure 1.

Bearing Resistance on Engineered Fill

Provided a minimum footing width of 2 m is maintained, a footing bearing on the engineered fill may be designed for the following concentric, vertical geotechnical resistance:

Factored ULS: 900kPa

SLS: 400kPa

In the case of eccentric or inclined loading, the geotechnical resistance must be calculated as illustrated in the CHBDC Clause 6.7.3 and Clause 6.7.4.

Horizontal Resistance on Engineered Fill

The sliding resistance of mass concrete poured on a compacted Granular "A" pad may be computed on the basis of an ultimate friction factor of 0.7.

8.4 Frost Cover

The provision of frost cover for footings founded on sound bedrock is not required.

If footings are founded on engineered fill, or native earth material, frost protection should be provided. This may take the form of 1.9 m of earth cover over the footing base (founding elevation).

9 EXCAVATION AND BACKFILL

9.1 General

All excavation must be carried out in accordance with the Occupational Health and Safety Act (OHSA). For the purposes of the OHSA, the native sand at this site is classed as Type 2 soil above the water table and Type 4 soil if below the water table.

9.2 Foundations

The excavation and backfilling for foundations must be carried out in accordance with SP 902S01. A copy of this special provision is included in Appendix D

9.3 Earth Excavation

In addition to SP 902S01, a NSSP should be included in the contract alerting the Contractor to the possible presence of cobbles and boulders in the overburden.

9.4 Rock Excavation

Where quantities of rock have to be removed, it is anticipated that the Contractor may elect to use blasting methods. The rock excavation should be carried out in accordance with the NSSP included in Appendix D.

It is important that the blasting procedures incorporate methods of reducing damage to the founding surfaces. Such methods may include, though not necessarily be limited to, line drilling, pre-splitting and cushion blasting.

Any damage to the founding surfaces on bedrock must be made good prior to constructing the foundation. Section 10 below, Rock Cut, discusses inspection and repair.

10 ROCK CUTS

A rock cut in the order of 4 to 6 m high will be required along the west side of Hwy11-SLB and in front of the West Abutment.

The rock cut in front of the West Abutment should conform to OPSD 201.020. The cut face may be inclined either vertically or at a slope of 1H:4V.

Depending on the location, orientation and height of the rock cut with respect to the pattern of joints or fractures in the rock mass, potentially unstable rock wedges may exist below the abutment foundation.

After excavation of the rock cut in the vicinity of the structure, the Contractor should scale all loosened rock from the face and should retain a rock slope stability expert to examine the cut. Where the wall of the rock cut below the foundation develops potentially unstable wedges or where over-break occurs, the Contractor should place mass concrete fill or install rock bolts as required. The remedial work should be designed by and carried out under the direction of the rock slope stability expert hired by the Contractor. The contract should include an NSSP to this effect.

11 GROUNDWATER CONTROL

The excavation for the foundation elements will be carried out below the groundwater levels observed in the standpipe piezometers at the west abutment and at the pier. The construction of the footings must be carried out in the dry and the base of the excavation must not be disturbed prior to pouring of concrete. Therefore unwatering of the excavations will be required. The unwatering should be carried out in accordance with OPSS 902S01.

The design of unwatering systems is the responsibility of the Contractor, but systems that could be considered are described below.

West Abutment

The footing base will lie on bedrock, thus disturbance of the footing base is not an issue but there must be no ponded water in the footing base when the concrete is poured. Thus, the Contractor should consider a scheme to intercept and divert seepage from the overburden and to remove any water that does accumulate in the footing base.

Pier

At the pier, the excavation will penetrate 3 to 6 m below the water table, depending on the foundation option that is selected.

If a footing bearing on earth is selected, it will be important for the Contractor to implement a scheme that will draw the groundwater level down below the footing level prior to excavation and maintain a dry footing base during construction. Drawdown of the groundwater is also required in order to maintain stable excavation slopes. A suitable system may consist of vacuum well-points.

If a footing bearing on bedrock is selected, disturbance of the founding surface will not be an issue, but the footing base must be unwatered prior to concreting. Also, to maintain stable sides in the excavation, it will be necessary for the Contractor to either draw down the groundwater or to constructed a supported excavation.

Drawing the groundwater down to the rock surface using wellpoints may not be feasible and the Contractor may elect to install sheeting.

If the Contractor elects to install wellpoints from the existing ground surface, eductor wells may be required on account on the depth to which the water must be drawn down.

The soils at this site will become unstable and may boil or heave if excavation is carried out under the groundwater table without prior unwatering. Consequences of excavating below the groundwater level include but are not limited to: loss of base stability and the loss of soil bearing resistance, loss of stability in the slopes and consequent sloughing and flow into the excavation. An NSSP should be included in the Bid Documents to alert Bidders to the fact that the soils will be unstable below the groundwater table and to advise them of the potential consequences.

Suggested wording for inclusion in the NSSP is given in Appendix E.

12 APPROACH EMBANKMENTS

The approach embankments for this structure will be constructed on either exposed bedrock or deposits of dense to very dense non-cohesive soils overlying bedrock. These soils will satisfactorily support the approach fills at this site, which are not expected to exceed 9 m in height. The foundation materials will provide adequate protection against global stability failure of earth fill and rock fill embankments constructed with side slopes of 2H:1V and 1.25H:1V, respectively.

The immediate approach embankments should be constructed using non-cohesive fill. The tops of the embankments will also experience settlement resulting from consolidation of the fill and settlement in the underlying soils. At the west approach, the embankment should not exceed 4.4 m in height and is constructed over shallow overburden on bedrock, the total settlement of the top of the embankment is estimated to be 50 mm. At the east approach, the embankment will be up to 8 m high and will be constructed over sand deposits up to 15 m deep. In this case the settlement under the embankment is estimated to be approximately 20 mm and the consolidation of the fill is estimated to lead to a further settlement of 80 mm. In both cases, if non-cohesive fill is used, the settlement s will be immediate in nature and should be complete shortly after construction of the embankments has been completed. Long term consolidation settlement will not be an issue at this site.

The global, internal and surficial stability of the approach embankment fill will depend on the slope geometry but also to a large degree on the material used to construct the embankment. If the embankment is constructed of blast rock fill, it may be assumed that the side slopes will be stable at inclinations no steeper than 1.25H:1V. Embankments constructed using granular material, select subgrade material and most earth materials will have stable side slopes at inclinations no steeper than 2H:1V.

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

Where earth fill embankments are higher than 6 m, berms must be incorporated in the slopes in accordance with OPSD 202.010. According to current MTO Northeastern Region policies, where rock fill embankments are higher than 6 m, mid-height berms must be included in the design. The berms should be a minimum of 2 m wide and extend for the length of the embankment where the height exceeds the stipulated maximum.

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

13 RETAINED SOIL SYSTEMS

Retained soil system (RSS) walls may be used at this site. A conventional concrete abutment will be required for the contemplated design but RSS could be used for wing walls and other retaining structures.

RSS walls should be specified to be "High Performance" and "High Appearance". The contract drawings should 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 levelling pad for the RSS wall may be formed directly on the exposed bedrock, mass concrete fill, dense to very dense sand or on a pad of engineered fill. Engineered fill should be designed in the same manner as the engineered fill to support foundations as described elsewhere in this report. The geotechnical resistance of the bedrock, dense to very dense sand or engineered fill is as stated elsewhere in this report.

The foundation under the RSS wall will be bedrock, or engineered fill overlying bedrock. In either case, the global stability of the wall will be satisfactory. If the RSS levelling pad may span from bedrock to native soil or engineered fill, the designers should be alerted to the possibility of differential settlement.

The internal stability of the RSS should be analyzed by the supplier/designer of the proprietary product selected for this site.

For walls founded on bedrock, settlements will be negligible. The settlement of a wall founded on the native sand or on engineered fill pad is expected to be less than 25 mm and to occur essentially as the RSS is constructed.

14 BACKFILL TO ABUTMENTS

In the case of semi-integral abutments (integral abutment is not a feasible option for this site), backfill to the abutment should be granular material. In cases where the approach embankment consists of rock fill, the backfill to the abutment wall should consist of OPSS Granular "B" Type II.

In the case of a conventional abutment rock backfill can be permitted. A NSSP is required to specify grading limits for the rock fill. The rock fill used as backfill to the abutment should be limited to fragments no greater than 300 mm and including adequate spalls to fill voids in the rock fill.

In all cases where the approach embankment consists of rock fill and granular backfill to the abutment wall is used, the granular backfill should consist of OPSS Granular "B" Type II.

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

Compaction equipment to be used adjacent to retaining structures should be restricted in accordance with OPSS 501.06.

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

15 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 13.1.

In conventional design, the use of a material with a high friction angle and low active pressure coefficient (e.g. Granular A, Granular B Type II) might be preferred as it results in lower earth pressures acting on the wall. In the case of integral or semi-integral abutments, material with a lower passive pressure coefficient (e.g. Granular B Type I) might be preferred as it results in lower forces acting on the ballast wall as the wall moves toward the soil mass.

The factors in the table above 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 13.1 – Earth Pressure Coefficient (K)

Condition	Earth Pressure Coefficient (K)					
	OPSS Granular A or OPSS Granular B Type II $\phi = 35°, \gamma = 22.8$ kN/m^3		OPSS Granular B Type I $\phi = 32°, \gamma = 21.2$ kN/m^3		Rock Fill (Limited to 300 mm size) $\phi = 42°, \gamma = 19$ 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 SEISMIC CONSIDERATIONS

For design purposes, the site is treated as lying in Seismic Zone 2.

16.1 Seismic Design Parameters

The following seismic parameters should be used for design::

- Velocity Related Seismic Zone 2
- Zonal Velocity Ratio 0.1
- Acceleration Related Seismic Zone 2
- Zonal Acceleration Ratio 0.1
- Peak Horizontal Acceleration 0.11

The Soil Profile Type at this site has been classified as Type I. Thus, according to Table 4.4.6.1 of the CHBDC, a Site Coefficient "S" of 1.0 should be used in seismic design.

16.2 Embankment Stability and Spread

The structure foundations and approach embankments will bear either on bedrock or on dense to very dense sand and there is no potential for soil liquefaction of the foundation soils.

The embankments themselves will be constructed above groundwater and are not considered to be in danger of liquefaction.

Some toe failure may occur but it is expected to be of limited nature and readily repairable.

16.3 Retaining Wall Dynamic Earth Pressures

In accordance with Clause 4.6.4 of the CHBDC, retaining structures should be designed using active (K_{AE}) and passive (K_{PE}) earth pressure coefficients that incorporate the effects of earthquake loading.

In calculating the values of (K_{AE}) and (K_{PE}), the following geotechnical parameters were used:

ϕ = 35° for OPSS Granular A or Granular B Type II

ϕ = 32° for OPSS Granular B Type I

ϕ = 42° for rock fill

δ = 50% of ϕ

Where ϕ = the angle of internal friction of the backfill and δ = the angle of friction between the wall and the backfill.

The seismic earth pressure coefficients to be used in design at this site are shown in Table 16.1 at the end of the text.

17 CONSTRUCTION CONCERNS

During construction, the Contract Administrator should employ experienced geotechnical staff to observe construction activities related to foundation construction.

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

- The potential for the development of unstable rock wedges under the west abutment footing
- Lowering of the groundwater for excavation and construction of the foundation elements will be required. It is critical that the base of the excavation remain undisturbed throughout the excavation and construction of the footings.

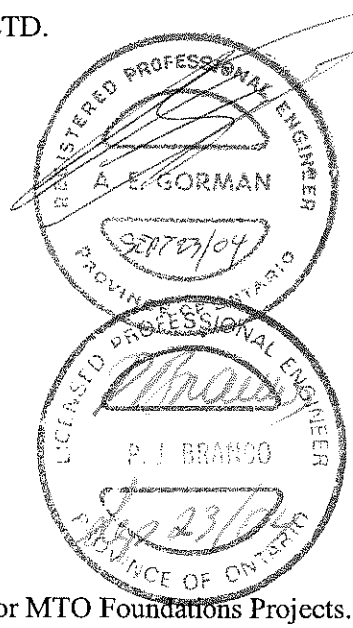
18 CLOSURE

This report has been prepared based on the factual geotechnical data presented in the first Part 1 of the report, on Thurber's understanding of the project requirements and on the preliminary General Arrangement drawing provided by Marshall Macklin Monaghan.

Engineering analysis and report preparation were carried out by Alastair E. Gorman, P.Eng.

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 Foundations Engineer.

Paulo J. Branco, P.Eng.

Designated Principal Contact for MTO Foundations Projects.

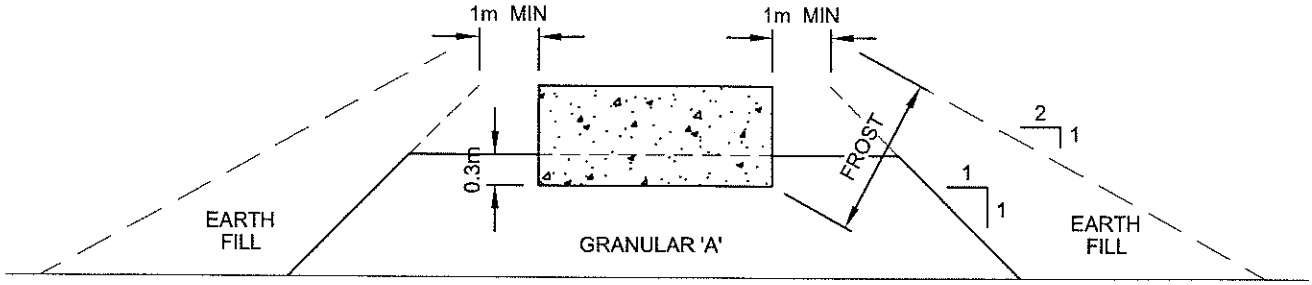
Table 16.1

Earth pressure Coefficients for Seismic Design

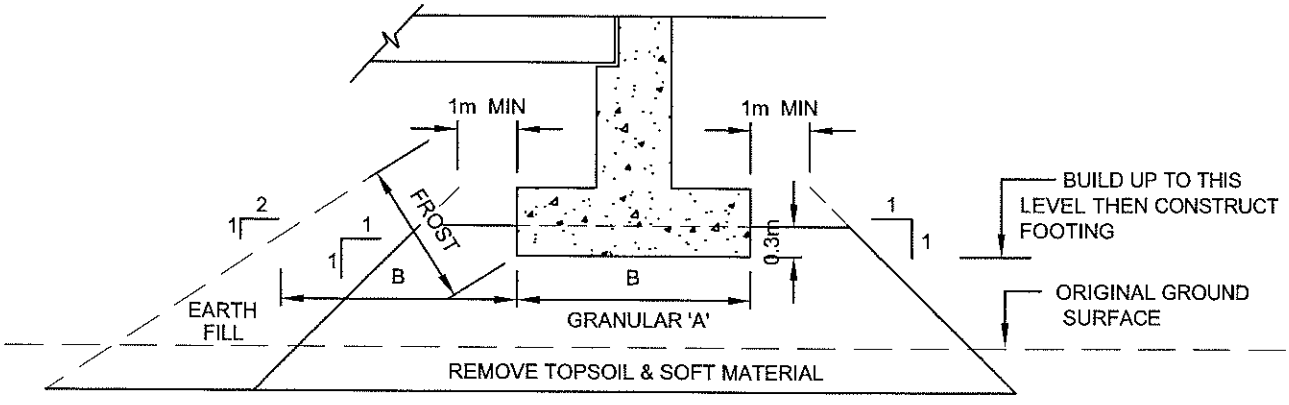
Condition	Earth Pressure Coefficient (K) for Earthquake Loading					
	Granular A or Granular B Type II $\phi = 35°,\ \delta = 17°$		OPSS Granular B Type I $\phi = 32°,\ \delta = 16°$		Rock Fill $\phi = 42°,\ \delta = 21°$	
	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)
Active (K_{AE})*	0.30	0.45	0.33	0.54	0.23	0.31
Passive (K_{PE})*	6.3	6.3	5.4	5.4	12.0	12.0
At Rest (K_{OE})**	0.59		0.63		0.33	

* After Mononobe and Okabe, passive case assumes a horizontal surface in front of the wall.
** After Woods

March , 2004



CROSS-SECTION



LONGITUDINAL SECTION

NOT TO SCALE

NOTES:

1. REMOVE TOPSOIL AND OR SOFT SUBSOIL UNDER AREA OF COMPACTED GRANULAR 'A' AND EARTH FILL.
2. PLACE GRANULAR 'A' AND EARTH FILL TO BOTTOM OF FOOTING LEVEL, COMPACTED ACCORDING TO O.P.S.S. 501.
3. CONSTRUCT CONCRETE FOOTING.
4. PLACE REMAINDER OF GRANULAR 'A' AND EARTH FILL AS REQUIRED.
5. SOURCE M.T.C. 1982.

ENGINEER AEG		
DRAWN SS	ABUTMENT ON COMPACTED FILL SHOWING GRANULAR A CORE	THURBER
DATE April , 2004		
APPROVED PKC		DWG. NO. FIGURE 1
SCALE NTS		

TED35146.DWG

Site Number 44-412 - Service Road I/C Underpass
Borehole Information

Location	BH	Coordinates		Ground Surface	Top of Bedrock			Groundwater Level					
								20-Jun-03		15-Sep-03		14-Nov-03	
		N	E	Elevation (m)	Depth (m)	Elevation (m)	Notes	Depth (m)	Elevation (m)	Depth (m)	Elevation (m)	Depth (m)	Elevation (m)
West Approach	412-1	5079885.73	314383.96	368.63	3.70	364.90	2	-	-	-	-	-	-
West Abutment	412-2	5079876.71	314395.94	368.79	2.50	366.29	1	-	-	-	-	0.51	368.28
	412-3	5079875.22	314394.50	368.72	1.70	367.02	2	-	-	-	-	-	-
	412-4	5079872.75	314393.66	368.72	2.10	366.62	2	-	-	-	-	-	-
	412-5	5079867.35	314389.94	368.62	1.50	367.12	2	-	-	-	-	-	-
	412-6	5079862.2	314389.14	368.87	1.30	367.57	2	-	-	-	-	-	-
	412-7	5079860.72	314388.88	368.78	1.80	366.98	1	-	-	-	-	-	-
Centre Pier	412-8	5079837.68	314413.68	368.55	10.70	357.85	2	-	-	-	-	-	-
	412-9	5079833.01	314416.17	368.23	10.50	357.73	2	-	-	-	-	-	-
	412-10	5079830.94	314411.57	368.17	9.60	358.57	2	-	-	-	-	-	-
	412-11	5079827.67	314409.49	368.02	9.70	358.32	2	-	-	-	-	-	-
	412-12	5079825.32	3144.5.18	368.18	9.90	358.28	2	-	-	-	-	-	-
	412-13	5079822.69	314407.12	368.05	10.30	357.75	2	3.69	364.36	-	-	3.78	364.27
East Abutment	412-14	5079796.93	314430.56	364.78	14.80	349.98	2	2.06	362.72	-	-	1.91	362.87
	412-17	5079784.08	314425.39	362.34	11.20	351.14	2	-	-	-	-	-	-
East Approach	412-20	5079772.66	314436.77	362.00	N/A	N/A		-	-	-	-	-	-

Notes:
1 Top of bedrock confirmed by coring
2 Top of bedrock inferred by auger refusal

TABLE 1

Site Number 44-412 - Service Road I/C Underpass
Point Load Test Results

Depth				UCS					
feet	Inches	m	Is50	MPa					
BH412-11									
32	10	10.59	13.61	326.64					
33	6	10.56	11.06	265.44		Average	Minimum	Maximum	
35	0	10.67	12.76	306.24		254	117	327	MPa
36	0	10.97	4.89	117.36					
BH412-12									
33	6	10.56	13.18	316.32					
37	0	11.28	12.97	311.28		Average	Minimum	Maximum	
						314	311	316	MPa
BH412-9									
35	6	11.17	1.7	40.8					
37	4	11.61	13.61	326.64		Average	Minimum	Maximum	
39	0	11.89	13.4	321.6		230	41	327	MPa
BH412-10									
33	6	10.56	12.33	295.92					
35	0	10.67	11.48	275.52		Average	Minimum	Maximum	
37	2	11.44	12.55	301.2		291	276	301	MPa
BH412-13									
35	0	10.67	12.76	306.24					
38	0	11.58	12.12	290.88					
42	6	13.30	14.46	347.04		Average	Minimum	Maximum	
44	9	14.16	6.8	163.2		279	163	347	MPa
45	3	13.97	11.91	285.84					
BH412-14									
51	0	15.54	7.87	188.88					
54	6	16.96	13.82	331.68		Average	Minimum	Maximum	
55	9	17.51	4.47	107.28		209	107	332	MPa

PLT

TABLE 2

Table 16.1

Earth pressure Coefficients for Seismic Design

Condition	Earth Pressure Coefficient (K) for Earthquake Loading					
	Granular A or Granular B Type II $\phi = 35°$, $\delta = 17°$		OPSS Granular B Type I $\phi = 32°$, $\delta = 16°$		Rock Fill $\phi = 42°$, $\delta = 21°$	
	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)	Horizontal Surface Behind Wall	Sloping Surface Behind Wall (2H:1V)
Active (K_{AE})*	0.30	0.45	0.33	0.54	0.23	0.31
Passive (K_{PE})*	6.3	6.3	5.4	5.4	12.0	12.0
At Rest (K_{OE})**	0.59		0.63		0.33	

* After Mononobe and Okabe, passive case assumes a horizontal surface in front of the wall.
** After Woods

Appendix A

Record of Borehole Logs

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

C_{pen} 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

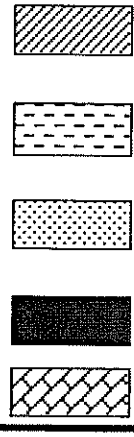
MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels, 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

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

SYMBOLS



CLAYSTONE

SILTSTONE

SANDSTONE

COAL

Bedrock (general)

DISCONTINUITY SPACING

Bedding	**Bedding Plane Spacing**
Very thickly bedded	Greater than 2m
Thickly bedded	0.6 to 2m
Medium bedded	0.2 to 0.6m
Thinly bedded	60mm to 0.2m
Very thinly bedded	20 to 60mm
Laminated	6 to 20mm
Thinly Laminated	Less than 6mm

TERMS

Total Core Recovery: (TCR)	Core recovered as a percentage of total core run length.
Solid Core Recovery: (SCR)	Percent Ratio of solid core of full cylindrical shape recovered. Expressed with respect to the total length of core run.
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.

STRENGTH CLASSIFICATION

Rock Strength	**Approximate Uniaxial Compressive Strength (MPa)**	**(psi)**	**Field Estimation of Hardness***
Extremely Strong	Greater than 250	Greater than 36,000	Specimen can only be chipped with a geological hammer
Very Strong	100-250	15,000 to 36,000	Requires many blows of geological hammer to break
Strong	50-100	7,500 to 15,000	Requires more than one blow of geological hammer to break
Medium Strong	25.0 to 50.0	3,500 to 7,500	Breaks under single blow of geological hammer.
Weak	5.0 to 25.0	750 to 3,500	Can be peeled by a pocket knife with difficulty
Very Weak	1.0 to 5.0	150 to 750	Can be peeled by a pocket knife, crumbles under firm blows of geological pick.
Extremely Weak (Rock)	0.25 to 1.0	35 to 150	Indented by thumbnail

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RECORD OF BOREHOLE No BH 412-1 1 OF 1 METRIC

W.P. 5321-03-01 LOCATION N 5 079 885.7 E 314384.0 (SERVICE ROAD I/C Underpass) ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SS

DATUM Geodetic DATE 25.09.03 - 25.09.03 CHECKED BY PJB/JL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
368.6									
0.0	Sandy **TOPSOIL**								
368.3	Dark								
	Wet								
0.4	**SILT**, some sand to sandy, some clay, trace organics						368		
	Compact to Very Dense		1	SS	51				
	Grey								
	Moist								
	(ML-nonplastic)						367		
			2	SS	24				
	Brown								0 4 81 15
366.4	Wet								
2.2	**SAND**, very fine to fine grained, some gravel, trace silt								
	Compact		3	SS	22		366		13 62 25 (SI+CL)
	Brown								
	Wet								
			4	SS	24				
364.9							365		
3.7	END OF BOREHOLE AT 3.73m. AUGER REFUSAL AT 3.73m. WATER LEVER AT 0.3m ABOVE GROUND SURFACE UPON COMPLETION. PROBABLE BEDROCK BOREHOLE OPEN TO 2.13m. BOREHOLE BACKFILLED WITH DRILL CUTTINGS TO SURFACE.								

DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100

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

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60

+ ³, × ³: Numbers refer to Sensitivity

20 15 10 5 (%) STRAIN AT FAILURE

ONTMT4 412SERVICE.GPJ 22/09/04

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Ontario

THURBER

RECORD OF BOREHOLE No BH 412-2 1 OF 1 METRIC

W.P. 5321-03-01 LOCATION N 5 079 876.7 E 314 395.9 (SERVICE ROAD I/C Underpass) ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ COMPILED BY SS

DATUM Geodetic DATE 22.09.03 - 22.09.03 CHECKED BY PJB/JL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
368.8											
0.0	Sandy **TOPSOIL**										
368.3	Dark Wet										
0.5	**SILT**, some clay, trace sand, trace gravel Very Dense to Compact Grey to Brown Moist (ML-nonplastic)		1	SS	50		368		○		
			2	SS	21		367		○		1 9 77 12
366.6											
2.2	**SAND**, very fine to fine grained, some gravel Very Dense Grey Wet		3	SS	50/.05				○		
366.3			1	RUN			366				RUN#1 TCR=98%, SCR=98%, RQD=78%
2.5	**BEDROCK, GRANITIC GNEISS,** white, orange and black, fresh to slightly weathered, very strong to extremely strong		2	RUN			365				RUN#2 TCR=98%, SCR=81%, RQD=71%
			3	RUN			364				RUN#3 TCR=100%, SCR=100%,
363.3											
5.5	END OF BOREHOLE AT 5.46m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) 14/11/ 03 0.51										RQD=95%

$+^3$, $\times^3$: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

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Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH 412-3 1 OF 1 METRIC

W.P. 5321-03-01 LOCATION N 5 079 875.2 E 314 394.5 (SERVICE ROAD I/C Underpass) ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SS

DATUM Geodetic DATE 25.09.03 - 25.09.03 CHECKED BY PJB/JL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
368.7											
0.0 / 368.5	Sandy **TOPSOIL**										
0.2	Dark Wet **SILT**, some clay, trace sand Dense Grey Moist (ML-nonplastic)						368				
			1	SS	41				○		0 5 83 13
367.3											
1.5	Silty **SAND**, very fine grained, some wood		2	SS	50/ .025						
367.0 / 1.7	Very Dense Brown Moist										
	END OF BOREHOLE AT 1.7m. AUGER REFUSAL AT 1.7m. PROBABLE BEDROCK BOREHOLE DRY ON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

ONTMT4 412SERVICE.GPJ 22/09/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH 412-4 1 OF 1 METRIC

W.P. 5321-03-01 LOCATION N 5 079 872.8 E 314 393.7 (SERVICE ROAD I/C Underpass) ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SS

DATUM Geodetic DATE 25.09.03 - 25.09.03 CHECKED BY PJB/JL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
368.7											
0.0	**TOPSOIL**										
	Dark										
368.3	Wet										
0.5	**SILT**, sandy to some sand, trace clay, trace gravel, trace organics						368				
	Dense to Very Dense										
	Brown		1	SS	41				○ 135		1 32 58 10
	Moist										
	(ML-nonplastic)										
367.0							367				
1.8	**SAND**, some gravel, trace silt		2	SS	58				○		
366.6	Very Dense										
2.1	Brown										
	Moist										
	END OF BOREHOLE AT 2.08m.										
	AUGER REFUSAL AT 2.08m.										
	PROBABLE BEDROCK										
	BOREHOLE OPEN TO 1.22m.										
	WATER LEVEL IN OPEN BOREHOLE AT 0.91m DEPTH UPON COMPLETION.										
	BOREHOLE BACKFILLED WITH DRILL CUTTINGS TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

ONTMT4 412SERVICE.GPJ 22/09/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH 412-5 1 OF 1 METRIC

W.P. 5321-03-01 LOCATION N 5 079 867.4 E 314 389.9 (SERVICE ROAD I/C Underpass) ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SS

DATUM Geodetic DATE 25.09.03 - 25.09.03 CHECKED BY PJB/JL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
368.6											
0.0	**TOPSOIL**										
368.3	Dark										
0.4	Wet										
	SILT, some sand						368				
	Very Dense										
	Brown										
	Moist		1	SS	58				○		
	(ML-nonplastic)										
367.1											
1.5	END OF BOREHOLE AT 1.52m. AUGER REFUSAL AT 1.52m. PROBABLE BEDROCK BOREHOLE DRY AND OPEN ON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS TO SURFACE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15}\oplus\frac{5}{10}$ (%) STRAIN AT FAILURE

ONTMT4 412SERVICE.GPJ 22/09/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH 412-6 1 OF 1 METRIC

W.P. 5321-03-01 LOCATION N 5 079 862.2 E 314 389.1 (SERVICE ROAD I/C Underpass) ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SS

DATUM Geodetic DATE 25.09.03 - 25.09.03 CHECKED BY PJB/JL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
368.9											
0.0 / 368.6	**TOPSOIL**										
0.2	Dark Wet Sandy **SILT**, trace gravel Loose Brown Wet						368				
367.6	(ML-nonplastic)		1	SS	10				○		
1.3	END OF BOREHOLE AT 1.27m. AUGER REFUSAL AT 1.27m. WATER LEVEL AT GROUND SURFACE . BOREHOLE OPEN ON COMPLETION. PROBABLE BEDROCK BOREHOLE BACKFILLED WITH DRILL CUTTINGS TO SURFACE.										

+ 3, × 3 : Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

ONTMT4 412SERVICE.GPJ 22/09/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH 412-7 1 OF 1 METRIC

W.P. 5321-03-01 LOCATION N 5 079 860.7 E 314 388.9 (SERVICE ROAD I/C Underpass) ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ COMPILED BY SS

DATUM Geodetic DATE 23.09.03 - 23.09.03 CHECKED BY PJB/JL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
368.8											
368.6	Sandy **TOPSOIL**										
0.2	Silty **SAND**, very fine to fine grained, trace organics Compact Brown Moist (SP)		1	SS	14		368				
367.0			2	SS	50/						
1.8	**BEDROCK, GRANITIC GNEISS,** white, orange and black, fresh to slightly weathered, very strong to extremely strong		1	RUN	.076		367				RUN#1 TCR=90%, SCR=85%, RQD=60%
			2	RUN			366				RUN#2 TCR=95%, SCR=96%, RQD=93%
			3	RUN			365				RUN#3 TCR=100%, SCR=88%, RQD=65%
364.0							364				
4.8	END OF BOREHOLE AT 4.78m. BOREHOLE BACKFILLED WITH DRILL CUTTINGS AND BENTENITE TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

15-20-5-10 (%) STRAIN AT FAILURE

ONTMT4 412SERVICE.GPJ 22/09/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH 412-8 1 OF 2 METRIC

W.P. 5321-03-01 LOCATION N 5 079 837.7 E 314 413.7 (SERVICE ROAD I/C Underpass) ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ COMPILED BY SS

DATUM Geodetic DATE 08.09.03 - 08.09.03 CHECKED BY PJB/JL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
368.6											
0.0 / 368.3	Sandy **TOPSOIL**										
0.3	**SAND**, very fine to coarse grained, some gravel Very Dense Brown Dry		1	SS	78/ .100		368	○	○		
	Possible cobble / boulder at 1.17m, 1.52m, 1.80m, 2.08m.		1	GS			367		○		
			2	SS	50/ .100		366		○		
	Possible cobble / boulder at 2.99m, 3.73m.		2	GS			365		○		
			3	SS	83		364		○		
	Possible cobble / boulder at 4.98m, 5.38m.		3	GS			363		○		
			4	SS	50/ .100		362		○		
	Possible cobble / boulder at 6.50m, 6.86m.		4	GS					○		
	Possible cobble / boulder at 7.11m, 8.23m.		5	SS	50/ .100		361		○		
			5	GS			360				
	Possible cobble / boulder at 8.92m, 9.75m.		6	SS	50/ .076		359		○		
			6	GS							

Continued Next Page

+ ³ . × ³ : Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

ONTMT4 412SERVICE.GPJ 22/09/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH 412-8 2 OF 2 METRIC

W.P. 5321-03-01 LOCATION N 5 079 837.7 E 314 413.7 (SERVICE ROAD I/C Underpass) ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ COMPILED BY SS

DATUM Geodetic DATE 08.09.03 - 08.09.03 CHECKED BY PJB/JL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
357.9			7	SS	50/.050		358		○		
10.7	**BEDROCK, GRANITIC GNEISS,** white, orange and black, fresh to slightly weathered, strong to extremely strong		7	GS					○		
			1	RUN			357				RUN#1 TCR=94%, SCR=43%, RQD=30%
356.2											
12.4	**BEDROCK, GABBRO,** grey, black and white, slightly weathered, strong to extremely strong		2	RUN			356				RUN#2 TCR=90%, SCR=40%, RQD=27%
							355				
			3	RUN							RUN#3 TCR=100%, SCR=56%, RQD=86%
353.7							354				
14.8	END OF BOREHOLE AT 14.81m. BOREHOLE OPEN TO 14.81m. BOREHOLE BACKFILLED WITH DRILL CUTTINGS AND BENTONITE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

ON'TMT4 412SERVICE.GPJ 22/09/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH 412-9 1 OF 2 METRIC

W.P. 5321-03-01 LOCATION N 5 079 833.0 E 314 416.2 (SERVICE ROAD I/C Underpass) ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ COMPILED BY SS

DATUM Geodetic DATE 17.09.03 - 17.09.03 CHECKED BY PJB/JL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
368.2											
368.0	Sandy **TOPSOIL**										
0.2	**SAND**, fine to very fine grained, some silt to silty, trace gravel, Compact to Very Dense Brown Moist Cobble encountered at 0.84m to 1.02m. Cobble/ Boulder encountered at 1.30m to 1.50m.		1	SS	50/ .08		368	○	○		
			1	GS			367		○		
	Cobble encountered at 2.34m to 2.54m.		2	SS	12/ .076		366		○		9 52 39 (SI+CL)
	Boulder encountered at 3.35m to 3.56m.		2	GS			365		○		
	Boulders encountered at 4.32m to 3.52m, 4.65m to 4.88m, 5.03m to 5.23m.		3	SS	50		364				
			3	GS			363		○		
	Cobbles encountered at 5.94m to 6.10m, 6.35m to 6.55m, 7.01m to 7.11m.		4	SS	50/ .076		362		○		
			4	GS			361		○		
	Cobbles encountered at 7.67m to 7.77m, 7.92m to 8.03m, 8.23m to 8.33m.		5	SS	50/ .076		360		○		
			5	GS			359		○		
			6	SS	50/ .076						
			6	GS							

Continued Next Page

+ ^{3}, × ^{3}: Numbers refer to Sensitivity

15 (20 / 10) 5 (%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH 412-9 2 OF 2 METRIC

W.P. 5321-03-01 LOCATION N 5 079 833.0 E 314 416.2 (SERVICE ROAD I/C Underpass) ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ COMPILED BY SS

DATUM Geodetic DATE 17.09.03 - 17.09.03 CHECKED BY PJB/JL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
357.8			7	SS	50		358				
10.5	**BEDROCK, GABBRO**, grey, black and white, slightly weathered, strong to extremely strong		7	GS					○		RUN#1 TCR=96%, SCR=54%, RQD=41% UCS (PLT) MIN: 41MPa, MAX: 327MPa, AVE: 230MPa
356.2			1	RUN			357				
12.0	END OF BOREHOLE AT 12.04m. BOREHOLE OPEN TO 4.57m. BOREHOLE BACKFILLED WITH DRILL CUTTINGS AND BENTONITE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15}\oplus\frac{5}{10}$ (%) STRAIN AT FAILURE

ONTMT4 412SERVICE.GPJ 22/09/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH 412-10 1 OF 2 METRIC

W.P. 5321-03-01 LOCATION N 5 079 830.9 E 314 411.6 (SERVICE ROAD I/C Underpass) ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ COMPILED BY SS

DATUM Geodetic DATE 11.09.03 - 15.09.03 CHECKED BY PJB/JL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
368.2											
368.0	Sandy **TOPSOIL**										
0.2	**SAND**, fine to very fine grained, some silt to silty, some gravel to gravelly Compact to Very Dense Brown Moist to Wet Boulder encountered at 0.15m to 0.38m. Cobbles/ Boulders encountered at 1.07m to 1.12m, 1.12m to 1.27m, 1.32m to 1.62m, 2.13m to 2.29m, 2.34m to 2.49m.		1	SS	12		368		○		
			1	GS			367				
							366		○		
			2	SS	50/ .025				○		26 50 24 (SI+CL)
	Cobbles encountered at 2.9m to 3.0m, 3.2m to 3.66m, 3.96m to 4.11m		2	GS			365		○		
			3	SS	89		364		○		
	Cobbles encountered at 5.03m to 5.13m, 5.33m to 5.44m.		3	GS			363		○		
	Boulder encountered at 5.76m to 6.48m.		4	SS	50						
			4	GS			362		○		
			5	SS	50/ .102		361		○		
	Cobbles encountered at 7.7m to 7.8m, 8m to 8.1m, 8.23m to 8.43m.		5	GS			360		○		
			6	SS	122		359		○		
358.6											
9.6	**BEDROCK, GABBRO**, grey, black and white, fresh to slightly weathered,										

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4 412SERVICE.GPJ 22/09/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH 412-10 2 OF 2 METRIC

W.P. 5321-03-01 LOCATION N 5 079 830.9 E 314 411.6 (SERVICE ROAD I/C Underpass) ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ COMPILED BY SS

DATUM Geodetic DATE 11.09.03 - 15.09.03 CHECKED BY PJB/JL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	very strong to extremely strong						358				
			1	RUN							RUN#1 TCR=98%, SCR=89%, RQD=78% UCS (PLT)
356.8							357				
11.4	END OF BOREHOLE AT 11.38m. BOREHOLE OPEN TO 4.57m. WATER LEVEL IN OPEN BOREHOLE AT 4.57m DEPTH UPON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS AND BENTONITE.										MIN: 276MPa, MAX: 301MPa, AVE: 291MPa

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

ONTMT4 412SERVICE.GPJ 22/09/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH 412-11 1 OF 2 METRIC

W.P. 5321-03-01 LOCATION N 5 079 827.7 E 314 409.5 (SERVICE ROAD I/C Underpass) ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ COMPILED BY SS

DATUM Geodetic DATE 16.09.03 - 16.09.03 CHECKED BY PJB/JL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
368.0							368				
368.0	Sandy **TOPSOIL**										
0.2	**SAND**, fine to very fine grained, some gravel to gravelly, some silt to silty Very Dense Brown Moist Boulder encountered at 0.76m to 1.22m.		1	GS			367				
	Boulder encountered at 1.83m to 2.03m.						366				
			1	SS	50/.076		365				18 58 25 (SI+CL)
	Boulder encountered at 3.05m to 3.35m. Moist to Wet										
	Boulder encountered at 3.81m to 4.01m.		2	GS			364				
			2	SS	86						
	Boulder encountered at 4.88m to 5.49m.		3	GS			363				
			3	SS	79/.127		362				30 51 19 (SI+CL)
	Boulder encountered at 6.25m to 6.71m.		4	GS			361				
			4	SS	72						
	Cobble encountered at 8.23m to 8.43m.		5	GS			360				
			5	SS	50/.102		359				
358.3			6	GS							
9.7	**BEDROCK, GABBRO**, grey, black and white, slightly weathered, strong to										RUN#1

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

ONTMT4 412SERVICE.GPJ 22/09/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH 412-11 2 OF 2 METRIC

W.P. 5321-03-01 LOCATION N 5 079 827.7 E 314 409.5 (SERVICE ROAD I/C Underpass) ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ COMPILED BY SS

DATUM Geodetic DATE 16.09.03 - 16.09.03 CHECKED BY PJB/JL

SOIL PROFILE ELEV/DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	extremely strong		1	RUN			358				TCR=100%, SCR=53%, RQD=53% RUN#2
	green mineral lamination		2	RUN			357				TCR=100%, SCR=78%, RQD=69% UCS (PLT) MIN: 117MPa, MAX: 327MPa, AVE: 254MPa
356.6											
11.4	END OF BOREHOLE AT 11.38m. BOREHOLE OPEN TO 4.57m. WATER LEVEL IN OPEN BOREHOLE AT 4.57m DEPTH UPON COMPLETION. BOREHOLE BACKFILLED WITH DRILL CUTTINGS AND BENTONITE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

ONTMT4 412SERVICE.GPJ 22/09/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH 412-12 1 OF 2 METRIC

W.P. 5321-03-01 LOCATION N 5 079 825.3 E 314 405.2 (SERVICE ROAD I/C Underpass) ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ COMPILED BY SS

DATUM Geodetic DATE 16.09.03 - 17.09.03 CHECKED BY PJB/JL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
368.2							368				
368.0	Sandy **TOPSOIL**										
0.2	**SAND**, fine to very fine grained, some silt to silty, some gravel Compact to Very Dense Brown Boulders encountered at 0.76m, 1.37m.		1	GS	50/.000						
	Moist to Wet		2	SS	67		367		○		11 59 31 (SI+CL)
			3	SS	38		366		○		
	Possible cobble from 4.83m to 5.03m		1	GS			365		○		
			4	SS	22		364		○		
			2	GS			363		○		
			5	SS	58		362		○		13 68 19 (SI+CL)
	Wet		3	GS			361		○		
			6	SS	50/.101		360		○		
358.3							359				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

ONTM4T4 412SERVICE.GPJ 22/09/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH 412-12 2 OF 2 METRIC

W.P. 5321-03-01 LOCATION N 5 079 825.3 E 314 405.2 (SERVICE ROAD I/C Underpass) ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ COMPILED BY SS

DATUM Geodetic DATE 16.09.03 - 17.09.03 CHECKED BY PJB/JL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
9.9	**BEDROCK, GABBRO**, grey, black and white, fresh stained, very strong to extremely strong		1	RUN			358				RUN#1 TCR=100%, SCR=100%, RQD=100% UCS (PLT) MIN: 311MPa, MAX: 316MPa, AVE: 314MPa
356.7							357				
11.5	END OF BOREHOLE AT 11.48m. BOREHOLE OPEN TO 4.57m. BOREHOLE BACKFILLED WITH DRILL CUTTINGS AND BENTONITE.										

$+^3$, $\times^3$: Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

ONTMT4 412SERVICE.GPJ 22/09/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH 412-13 1 OF 2 METRIC

W.P. 5321-03-01 LOCATION N 5 079 822.7 E 314 407.1 (SERVICE ROAD I/C Underpass) ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ COMPILED BY SS

DATUM Geodetic DATE 27.05.03 - 27.05.03 CHECKED BY PJB/JL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
368.1											
368.0	**TOPSOIL**						368				
0.1	**SAND**, fine grained, some silt to silty, trace gravel to gravelly, occ. cobbles and boulders Dense to very dense Wet Boulder 0.46m to 0.69m		1	SS	43		367	○	○		
	Cobble 1.3m to 1.37m		2	SS	50/						
	Boulder 1.7m to 2.4m		1	GS	.05		366		○		
			1	RUN							
							365				
			2	RUN			364				
							363				
			3	SS	8/ .076		362				
			4	SS	58		361		○		
							360				
			5	SS	87		359		○		9 73 18 (SI+CL)

Continued Next Page

+ 3, × 3 : Numbers refer to Sensitivity

20 / 15 5 / 10 (%) STRAIN AT FAILURE

ONTMT4 412SERVICE.GPJ 22/09/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH 412-13 2 OF 2 METRIC

W.P. 5321-03-01 LOCATION N 5 079 822.7 E 314 407.1 (SERVICE ROAD I/C Underpass) ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ COMPILED BY SS

DATUM Geodetic DATE 27.05.03 - 27.05.03 CHECKED BY PJB/JL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
357.7			6	SS	100/ .076		358		○		
10.3	**BEDROCK, GABBRO**, grey, black and white, fresh stained, very strong to extremely strong		3	RUN							Run#3: TCR=83%, SCR=83%, RQD=63%
			4	RUN			357				Run#4: TCR=98%, SCR=97%, RQD=87%
			5	RUN			356				Run#5: TCR=100%, SCR=95%, RQD=68% UCS (PLT) MIN: 163MPa, MAX: 347MPa, AVE: 279MPa
354.0							355				
14.1	END OF BOREHOLE AT 14.07m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen.						354				

DATE DEPTH (m)
20/06/03 3.69
14/11/03 3.78

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE

ONTMT4 412SERVICE.GPJ 22/09/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH 412-14 1 OF 2 METRIC

W.P. 5321-03-01 LOCATION N 5 079 796.9 E 314 430.6 (SERVICE ROAD I/C Underpass) ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ COMPILED BY SS

DATUM Geodetic DATE 28.05.03 - 29.05.03 CHECKED BY PJB/JL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
364.8											
364.6 / 0.1	**TOPSOIL**										
	SAND, fine grained, trace to some silt, trace gravel to gravelly, occ. cobbles and boulders Compact to very dense Brown above 0.5m Grey below 0.5m		1	SS	51		364	○		20 49 31 (SI+CL)
	Wet below 1.6m		2	SS	50/.076	▼	363	○		
			3	SS	50/.05		362	○		
	Brown below 3.0m						361			
			4	SS	26			○		83 16 1 (SI+CL)
	Possible cobbles and boulders at 4.72m						360			
			5	SS	50/			○		
	Boulder 5.6m to 6.3m		1	GS	.025		359			
			1	RUN						
			2	RUN			358			
	Boulder 7.1m to 7.3m									
							357	○		
	Boulder 8.2m to 8.8m		3	RUN			356			9 73 18 (SI+CL)
			3	GS			355	○		

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20 / 15 ⊕ 5 / 10 (%) STRAIN AT FAILURE

ONTMT4 412SERVICE.GPJ 22/09/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH 412-14 2 OF 2 METRIC

W.P. 5321-03-01 LOCATION N 5 079 796.9 E 314 430.6 (SERVICE ROAD I/C Underpass) ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ COMPILED BY SS

DATUM Geodetic DATE 28.05.03 - 29.05.03 CHECKED BY PJB/JL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
			6	SS	47		354	○			28 59 13 (SI+CL)
			7	SS	45		353	○			
	Becoming grey		8	SS	34		352	○			
350.0			9	SS	60/ .203		351				
14.8	**BEDROCK, GRANITIC GNEISS,** orange and black, moderately weathered, fractured, very strong to extremely strong Gabbro pieces from 14.8m to 15.1m.		4	RUN			350				Run#4: TCR=80%, SCR=55%, RQD=0%
			5	RUN			349				Run#5: TCR=98.3%, SCR=81.7%, RQD=68.3%
			6	RUN			348				Run#6: TCR=96.7%, SCR=71.7%, RQD=41.7%
346.4							347				UCS (PLT) MIN: 107MPa, MAX: 332MPa, AVE: 209MPa
18.4	END OF BOREHOLE AT 18.39m. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. DATE DEPTH (m) 20/06/03 2.06 14/11/03 1.91										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15 \oplus 5}$ (%) STRAIN AT FAILURE
10

ONTMT4 412SERVICE.GPJ 22/09/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH 412-17 1 OF 2 METRIC

W.P. 5321-03-01 LOCATION N 5 079 784.1 E 314 415.3 (SERVICE ROAD I/C Underpass) ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ COMPILED BY SS

DATUM Geodetic DATE 22.09.03 - 22.09.03 CHECKED BY PJB/JL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
362.3											
362.0	**PEAT**, rootlets										
0.2	**SAND**, very fine to coarse grained, some organics Compact to Very Dense Brown						362				
			1	SS	15				132		
	some granite fragments Wet below 1.1m						361				
			2	SS	99						
							360				
			3	SS	39						
	some silt										
	trace gravel below 3.0m										
			4	SS	6		359				9 82 10 (SI+CL)
			5	SS	47		358				
							357				
			6	SS	31						
			1	GS			356				
			7	SS	49		355				
	cobbles from 8.08m to 8.18m, 8.41m to 8.53m.		2	GS			354				
			8	SS	92						28 51 21 (SI+CL)
	cobbles from 9.45m to 9.55m, 9.75m to 9.85m.		3	GS			353				

Continued Next Page

$+^3$, $\times^3$: Numbers refer to Sensitivity

$15\frac{20}{10}5$ (%) STRAIN AT FAILURE

ONTMT4 412SERVICE.GPJ 22/09/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH 412-17 2 OF 2 METRIC

W.P. 5321-03-01 LOCATION N 5 079 784.1 E 314 415.3 (SERVICE ROAD I/C Underpass) ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers/NW Casing/NQ COMPILED BY SS

DATUM Geodetic DATE 22.09.03 - 22.09.03 CHECKED BY PJB/JL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	possible cobbles		9	SS	100/ .025		352		○		
351.2			4	GS							
11.2	**BEDROCK,GRANITIC GNEISS,** orange and black, fresh to moderately weathered , fractured, very strong to extremely strong		5	GS			351		○		
			10	SS	100/ .050						
			6	GS			350		○		
			1	RUN			349				Run#1: TCR=89%, SCR=70%, RQD=28%
			2	RUN			348				Run#2: TCR=97%, SCR=70%, RQD=48%
347.2											
15.2	END OF BOREHOLE AT 15.19m. BOREHOLE OPEN TO 4.57m. BOREHOLE BACKFILLED WITH DRILL CUTTINGS AND BENTONITE										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15}\oplus\frac{5}{10}$ (%) STRAIN AT FAILURE

ONTMT4 412SERVICE.GPJ 22/09/04

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BH 412-20 1 OF 1 METRIC

W.P. 5321-03-01 LOCATION N 5 079 772.7 E 314 436.8 (SERVICE ROAD I/C Underpass) ORIGINATED BY DP

HWY 11 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SS

DATUM Geodetic DATE 29.05.03 - 29.05.03 CHECKED BY PJB/JL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
362.0							362				
0.0 / 361.6	**PEAT** Wet										
0.4	**SAND and SILT**, trace clay, trace gravel Very loose to dense Brown Wet		1	SS	3		361				
			2	SS	39		360				2 49 44 5
359.8											
2.2	END OF BOREHOLE AT 2.21m. AUGER REFUSAL AT 2.21m. PROBABLE BOULDERS										

$+^3$, $\times^3$: Numbers refer to Sensitivity

$\frac{20}{15}\oplus\frac{5}{10}$ (%) STRAIN AT FAILURE

ONTMT4 412SERVICE.GPJ 22/09/04

Appendix B

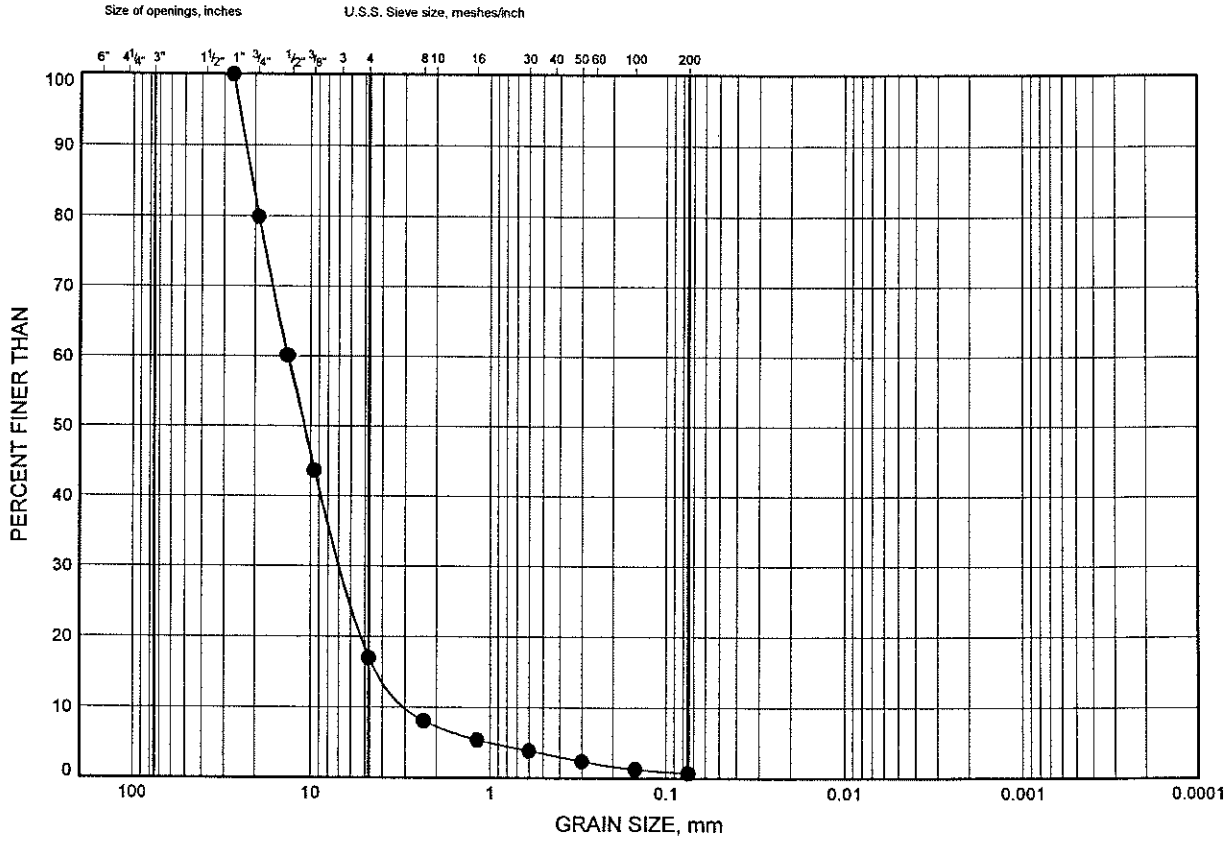
Laboratory Test Results

Hwy 11 Four Laning

GRAIN SIZE DISTRIBUTION

FIGURE B1

GRAVEL, some sand



COBBLE SIZE	GRAVEL		SAND			SILT and CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	BH 412-14	4.22	360.56

Date November 2003

Project 759-93-00

THURBER

Prep'd WM

Chkd. PJB

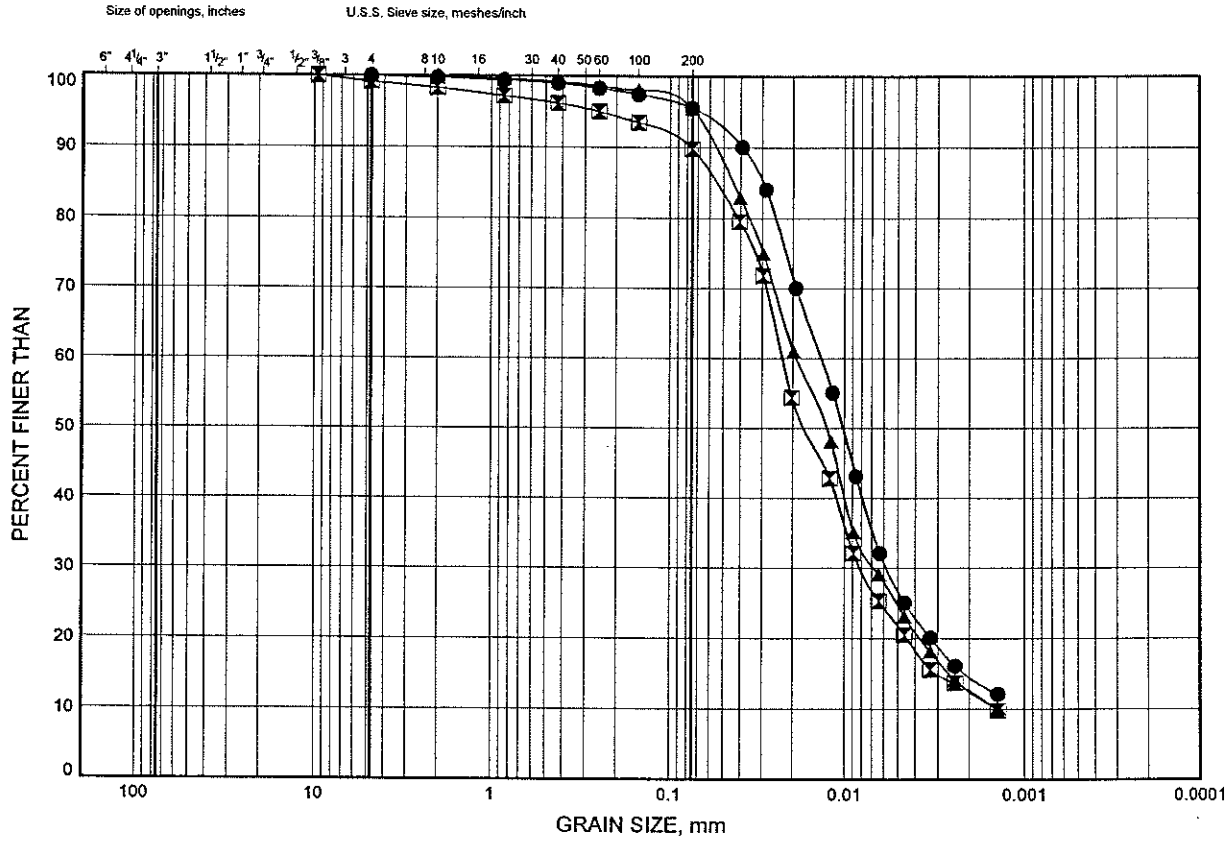
THURBGSD 412SERVICE.GPJ 20/11/03

Hwy 11 Four Laning

GRAIN SIZE DISTRIBUTION

FIGURE B2

SILT, some clay, trace sand



COBBLE SIZE	GRAVEL		SAND			SILT and CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	BH 412-1	1.98	366.65
⊠	BH 412-2	1.83	366.96
▲	BH 412-3	1.07	367.65

Date November 2003

Project 759-93-00

THURBER

Prep'd WM

Chkd. PJB

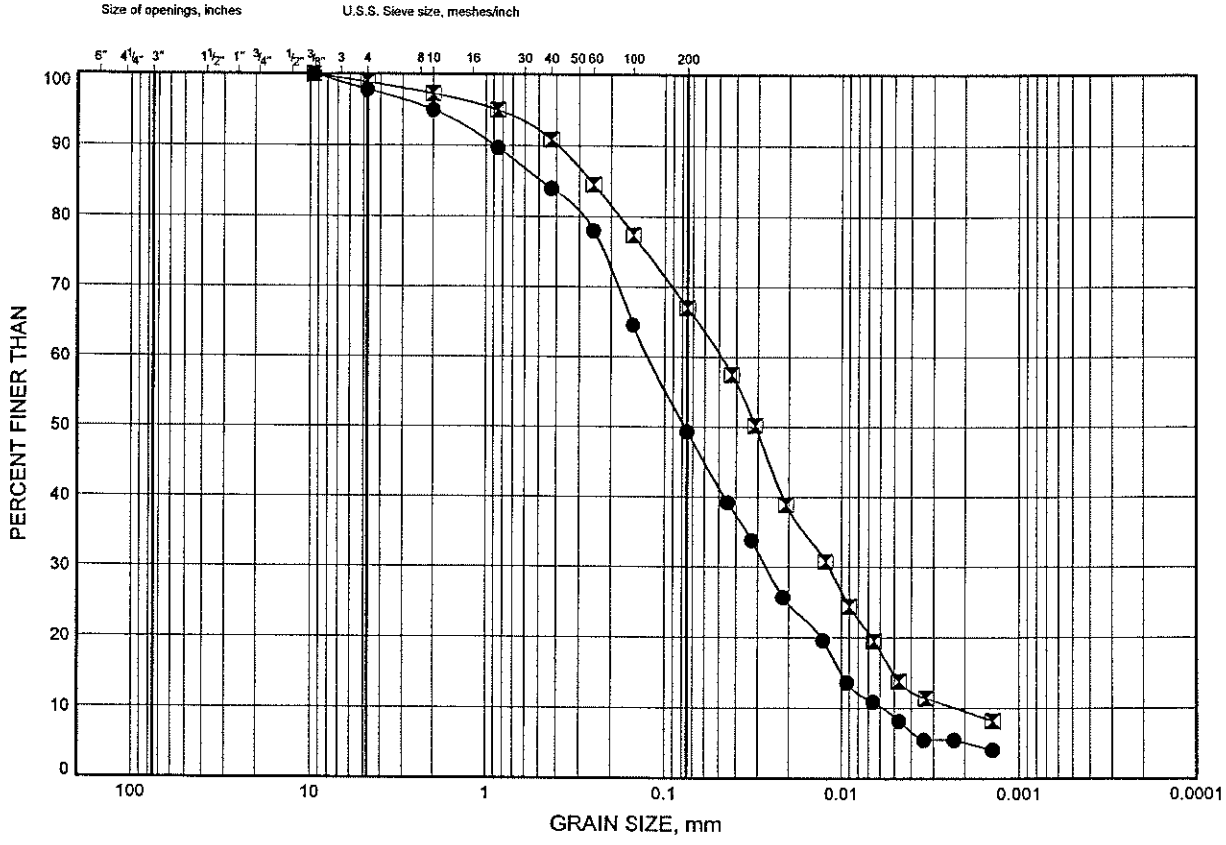
THURBGSD 412SERVICE.GPJ 20/11/03

Hwy 11 Four Laning

GRAIN SIZE DISTRIBUTION

FIGURE B3

SILT, sandy to some sand, trace clay



COBBLE SIZE	GRAVEL		SAND			SILT and CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	BH 412-20	1.83	360.17
⊠	BH 412-4	1.07	367.65

Date November 2003

Project 759-93-00

THURBER

Prep'd WM

Chkd. PJB

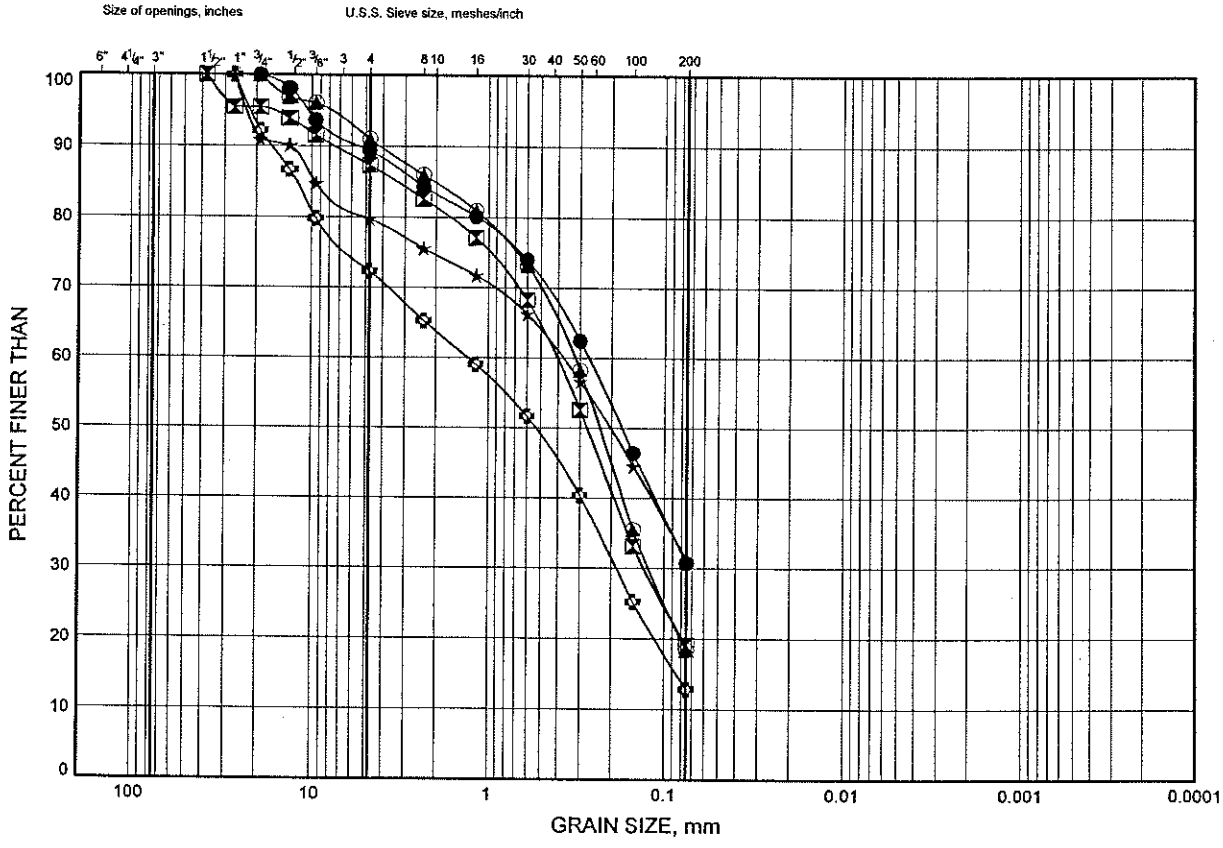
THURBGSD 412SERVICE.GPJ 20/11/03

Hwy 11 Four Laning

GRAIN SIZE DISTRIBUTION

FIGURE B4

SAND, some gravel, some silt



COBBLE SIZE	GRAVEL		SAND			SILT and CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	BH 412-12	2.74	365.44
⊠	BH 412-12	7.32	360.86
▲	BH 412-13	8.84	359.21
★	BH 412-14	1.07	363.71
⊙	BH 412-14	8.84	355.94
✿	BH 412-14	10.21	354.57

Date November 2003

Project 759-93-00

THURBER

Prep'd WM

Chkd. PJB

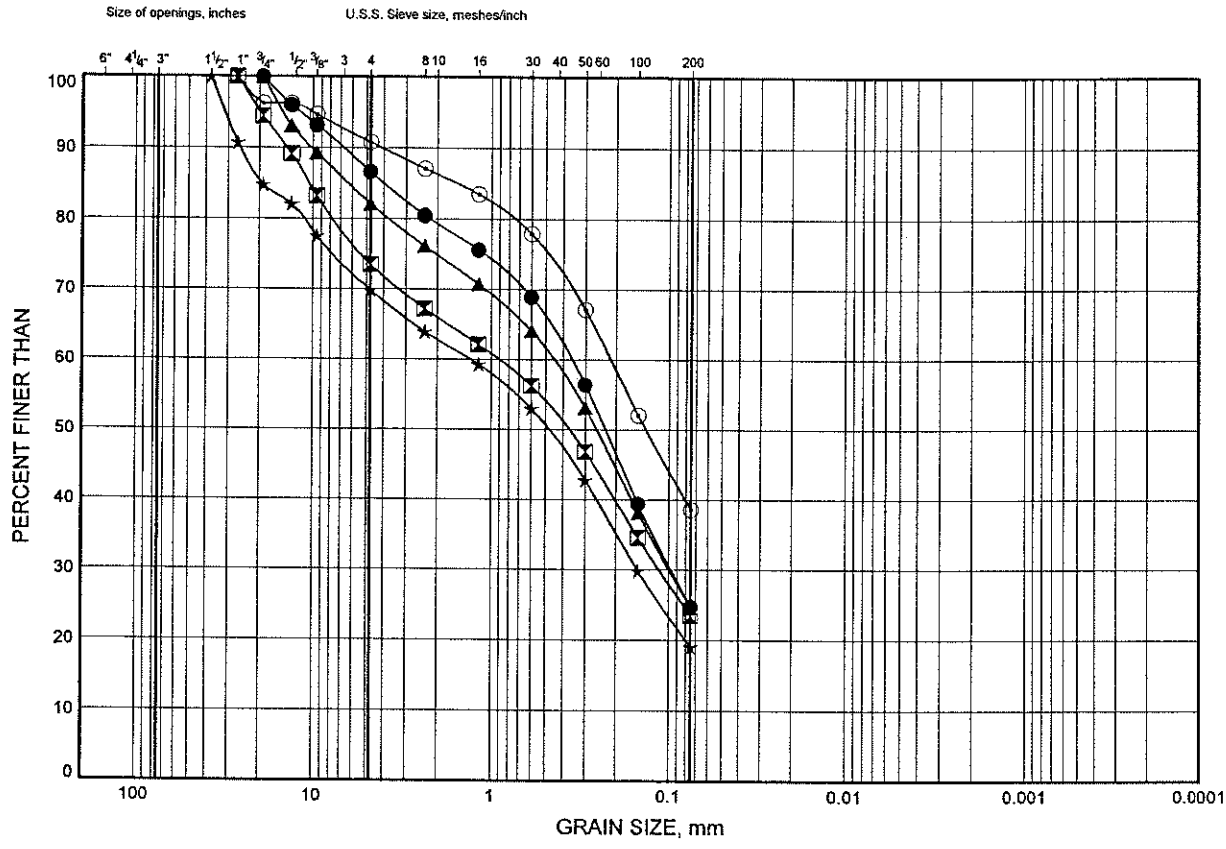
THURBGSD 412SERVICE.GPJ 20/11/03

Hwy 11 Four Laning

GRAIN SIZE DISTRIBUTION

FIGURE B5

SAND, some gravel, some silt



COBBLE SIZE	GRAVEL		SAND			SILT and CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	BH 412-1	2.59	366.04
⊠	BH 412-10	3.05	365.12
▲	BH 412-11	3.05	364.97
★	BH 412-11	6.10	361.92
⊙	BH 412-9	3.05	365.18

Date November 2003

Project 759-93-00

THURBER

Prep'd WM

Chkd. PJB

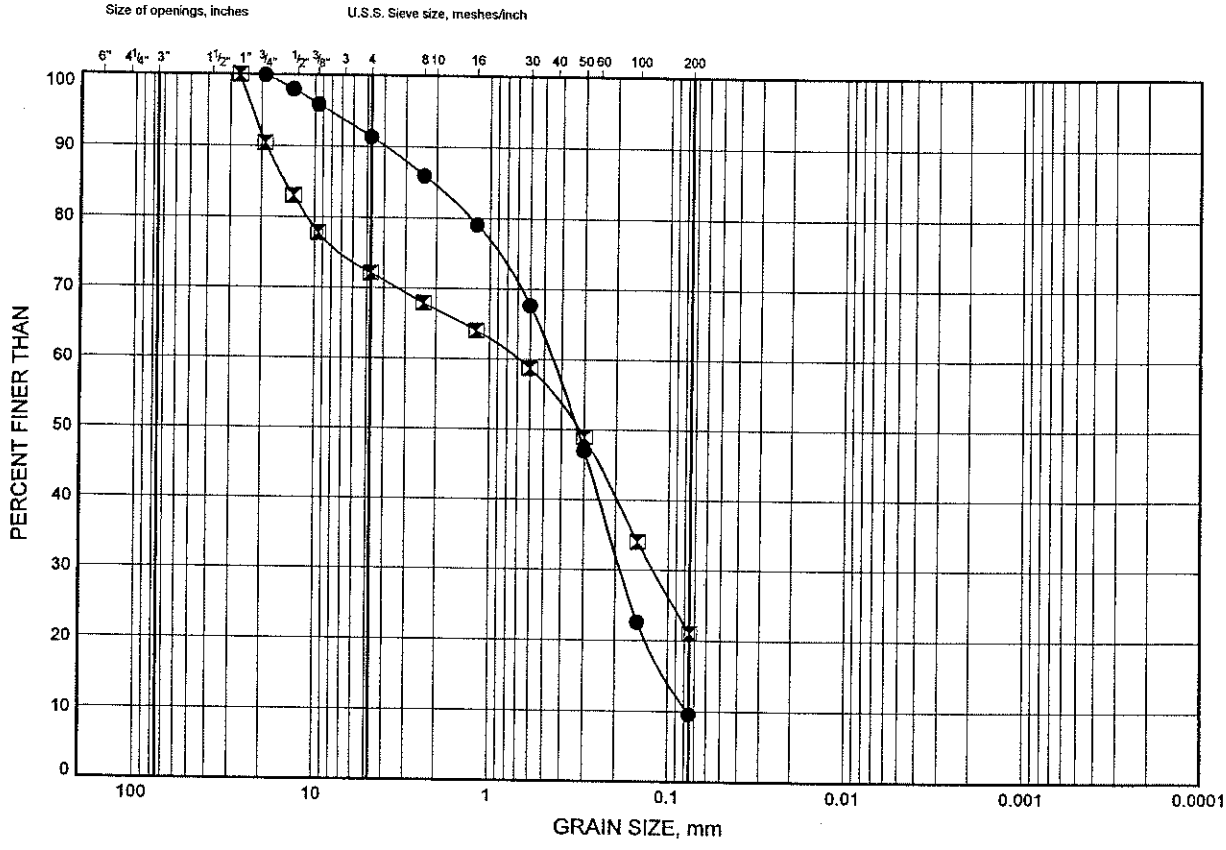
THURBGSD 412SERVICE.GPJ 20/11/03

Hwy 11 Four Laning

GRAIN SIZE DISTRIBUTION

FIGURE B6

SAND, some gravel, some silt



COBBLE SIZE	GRAVEL		SAND			SILT and CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	FINE GRAINED

SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	BH 412-17	3.35	358.99
⊠	BH 412-17	8.84	353.50

Date November 2003

Project 759-93-00

THURBER

Prep'd WM

Chkd. PJB

THURBGSD 412SERVICE.GPJ 20/11/03

Appendix C

Factual Data from Golder's Report

PROJECT 991-1193

RECORD OF BOREHOLE No 17-1 1 OF 1 METRIC

W.P. 335-98-00 LOCATION N 5079838; E 314475 ORIGINATED BY SB

DIST 54 HWY 11 BOREHOLE TYPE 108mm I.D. HOLLOW STEM AUGERS COMPILED BY DKB

DATUM GEODETIC DATE March 7/00 CHECKED BY ASP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED + FIELD VANE; ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_p / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
366.00	GROUND SURFACE										
0.00	Topsoil										
0.89	Silty Sand, some gravel, occ. cobbles and/or boulders Compact to very dense Brown Moist		1	SS	23		365				
364.29			2	SS	75/.03				o		
1.71	END OF BOREHOLE Refusal to further auger penetration; probable boulder or bedrock										
	Note: Open borehole dry upon completion of drilling.										
	Northing and Easting co-ordinate and elevation accurate to nearest metre.										

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

PROJECT 991-1193

RECORD OF BOREHOLE No 17-2 1 OF 2 METRIC

W.P. 335-98-00 LOCATION N 5079808; E 314455 ORIGINATED BY SB

DIST 54 HWY 11 BOREHOLE TYPE 108mm I.D. HOLLOW STEM AUGERS COMPILED BY DKB

DATUM GEODETIC DATE March 5/00 CHECKED BY ASP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_p / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
364.00	GROUND SURFACE										
0.00	Topsoil										
0.15	Silty Sand, some gravel, occ cobbles and/or boulders Compact to very dense Brown Moist to wet		1	SS	18		363				
			2	SS	36		362				
			3	SS	40	▽	361				
			4	SS	28						16 56 31 0
			5	SS	21		360				
			6	SS	50		359				
			7	SS	31		358				
356.84							357				
7.16	Gravelly Sand, trace to some silt, occ. cobbles and/or boulders Compact to very dense Brown Wet		8	SS	72		356				
			9	SS	75		355				
			10	SS	30		354				
			11	SS	25		353				
			12	SS	100/10		352				
							351				
							350				16 64 20 0
349.05											

Continued Next Page

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

PROJECT 991-1193

RECORD OF BOREHOLE No 17-2 2 OF 2 METRIC

W.P. 335-98-00 LOCATION N 5079808; E 314455 ORIGINATED BY SB

DIST 54 HWY 11 BOREHOLE TYPE 108mm I.D. HOLLOW STEM AUGERS COMPILED BY DKB

DATUM GEODETIC DATE March 5/00 CHECKED BY ASP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	— CONTINUED FROM PREVIOUS PAGE —										
14.95	Slightly weathered, dark grey with black speckles, moderately to closely jointed, medium to coarse grained, strong to very strong AMPHIBOLITE GNEISS.						348				
							347				
	Bedrock cored from 14.95m to 18.34m depth.										
345.66	For bedrock coring details refer to Record of Drillhole 17-2						346				
18.34	END OF HOLE										
	Note: Water level measured in open borehole at 2.3m (El.361.7m) depth upon completion of drilling.										
	Northing and Easting co-ordinate and elevation accurate to nearest metre.										

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

PROJECT: 991-1193

RECORD OF DRILLHOLE: 17-2

SHEET 1 OF 1

LOCATION: N 5079808; E 314455

DRILLING DATE: Mar.6/00

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: CME 55 Bombardier

DRILLING CONTRACTOR: Marathon

FR-FRACTURE F-FAULT SM-SMOOTH FL-FLEXURED BC-BROKEN CORE
CL-CLEAVAGE J-JOINT R-ROUGH UE-UNEVEN MB-MECH. BREAK
SH-SHEAR P-POLISHED ST-STEPPED W-WAVY B-BEDDING
VN-VEIN S-SLICKENSIDED PL-PLANAR C-CURVED

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	PENETRATION RATE (m/min)	COLOUR % RETURN / FLUSH	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT INDEX PER 0.3	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
		GROUND SURFACE		349.05												
15	NQ RC	Slightly weathered, dark grey with black speckles, moderately to closely jointed, medium to coarse-grained, strong to very strong AMPHIBOLITE GNEISS. Becomes slightly weathered to fresh 16.8m to 18.34m.		14.85	1								J,R,P J,RP (x3) J,S,P			
16					2								J,R,P (x2) J,R,P J,R,P J,R,P J,R,P (x2) J,R,P (x2)			
17					3								J,R,P J,R,P J,ST,UE J,R,P (x2) J,R,P			
18				345.66									J,R,P (x2)			1
		END OF HOLE		18.34												
19																
20																
21																
22																
23																
24																

DRILLHOLE 1193ROCK.GPJ GLDR_CAN.GDT 24/4/00 PS

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: SB

CHECKED: PD

PROJECT 991-1193

RECORD OF BOREHOLE No 17-3

1 OF 1 METRIC

W.P. 335-98-00 LOCATION N 5079747; E 314415 ORIGINATED BY SB

DIST 54 HWY 11 BOREHOLE TYPE 108mm I.D. HOLLOW STEM AUGERS COMPILED BY DKB

DATUM GEODETIC DATE March 6/00 CHECKED BY ASP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_p / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
361.00	GROUND SURFACE										
0.00	Fibrous Peat Soft Black Wet										
359.79	organic content = 17.9%		1	SS	4		360				
1.21	Silty Sand, some gravel, occ cobbles and/or boulders Compact to dense Brown Moist to wet		2	SS	18		359				
			3	SS	14		358				
			4	SS	18						18 60 22 0
			5	SS	37		357				
355.82			6	SS	19		356				
5.18	Slightly weathered to fresh, pinkish grey with black speckles, lightly foliated, moderately to widely jointed, coarse to very coarse grained, strong to very strong GNEISS. Bedrock cored from 5.18m to 8.08m depth. For bedrock coring details refer to Record of Drillhole 17-3						355				
352.92							354				
8.08	END OF HOLE Note: 1. Water level measured in piezometer at 0.2m above ground surface (El. 361.2m) upon completion of installation. 2. Water level measured at 0.1m above ground surface (El361.1m) on March 26, 2000. Northing and Easting co-ordinate and elevation accurate to nearest metre.						353				

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

PROJECT: 991-1193

RECORD OF DRILLHOLE: 17-3

SHEET 1 OF 1

LOCATION: N 5079747; E 314415

DRILLING DATE: Mar.6/00

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: CME 55 Bombardier

DRILLING CONTRACTOR: Marathon

FR-FRACTURE F-FAULT SM-SMOOTH FL-FLEXURED BC-BROKEN CORE
CL-CLEAVAGE J-JOINT R-ROUGH UE-UNEVEN MB-MECH. BREAK
SH-SHEAR P-POLISHED ST-STEPPED W-WAVY B-BEDDING
VN-VEIN S-SLICKENSIDED PL-PLANAR C-CURVED

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	PENETRATION RATE (m/min)	COLOUR OF RETURN WATER	FLUSH	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.3	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
		GROUND SURFACE		355.82													
6	NQ RC	Slightly weathered to fresh, pinkish grey with black speckles, lightly foliated, moderately to widely jointed, coarse to very coarse grained, strong to very strong GNEISS.		5.18	1												
7					2								45	J,R,P			
8				352.82	3								45	J,R,P (x2)			
		END OF HOLE		8.04													
9																	
10																	
11																	
12																	
13																	
14																	
15																	

DRILLHOLE 1193ROCK.GPJ GLDR_CAN.GDT 24/4/00 PS

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: SB

CHECKED: PD

RECORD OF BOREHOLE No 17-4 1 OF 1 METRIC

PROJECT 991-1193 LOCATION N 5079716; E 314395 ORIGINATED BY SB

W.P. 335-98-00 BOREHOLE TYPE 108mm I.D. HOLLOW STEM AUGERS COMPILED BY DKB

DIST 54 HWY 11 DATUM GEODETIC DATE March 7/00 CHECKED BY ASP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
358.90	GROUND SURFACE										
0.00 / 358.60	Topsoil										
0.30	Silty Sand, some gravel, occ. cobbles and/or boulders Very dense Brown Moist		1	SS	29/.13		358				
357.38											
1.52	END OF BOREHOLE Refusal to further auger penetration; probable boulder or bedrock Note: Open borehole dry upon completion of drilling. Northing and Easting co-ordinate accurate to nearest metre.										

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

PROJECT 991-1193 | RECORD OF BOREHOLE No 17-5 | 1 OF 1 | METRIC

W.P. 335-98-00 | LOCATION N 5079880; E 314455 | ORIGINATED BY SB

DIST 54 | HWY 11 | BOREHOLE TYPE 108mm I.D. HOLLOW STEM AUGERS | COMPILED BY DKB

DATUM GEODETIC | DATE March 7/00 | CHECKED BY ASP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_p / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
373.00	GROUND SURFACE										
0.00	Topsoil										
372.60	Silty Sand, some gravel Brown Moist										
0.40	END OF BOREHOLE Refusal to further auger penetration; probable boulder or bedrock										
	Note: Open borehole dry upon completion of drilling.										
	Northing and Easting co-ordinate and elevation accurate to nearest metre.										

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

ON_MOT 991-1193.GPJ ON_MOT.GDT 24/4/00

PROJECT 991-1193 | **RECORD OF BOREHOLE No 17-6** | 1 OF 1 | **METRIC**

W.P. 335-98-00 | LOCATION N 5079850; E 314435 | ORIGINATED BY SB

DIST 54 | HWY 11 | BOREHOLE TYPE 108mm I.D. HOLLOW STEM AUGERS | COMPILED BY DKB

DATUM GEODETIC | DATE March 5/00 | CHECKED BY ASP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED; 20 40 60 80 100)	PLASTIC LIMIT w_p / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
368.00	GROUND SURFACE										
0.00 / 367.54	Topsoil										
0.46	Silty Sand, some gravel, occ. cobbles and/or boulders Very dense to compact Brown Moist to wet		1	SS	51		367		○		
			2	SS	80		366				
			3	SS	67				○		13 57 30 0
364.34			4	SS	21		365				
3.66	Slightly weathered, grey-pink with black speckles, lightly foliated (30°), moderately to widely jointed, medium to coarse grained, strong to very strong GNEISS.						364				
	Bedrock cored from 3.66m to 6.81m depth.						363				
361.19	For bedrock coring details refer to Record of Drillhole 17-6						362				
6.81	END OF HOLE										

Note:
1. Water level measured in piezometer at 0.9m depth (El. 367.1m) upon completion of installation.
2. Water level measured in piezometer at 1.7m depth (El. 366.3m) on March 26, 2000.

Northing and Easting co-ordinate and elevation accurate to nearest metre.

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

ON_MOT 991-1193.GPJ ON_MOT.GDT 24/4/00

PROJECT: 991-1193

RECORD OF DRILLHOLE: 17-6

SHEET 1 OF 1

LOCATION: N 5079850; E 314435

DRILLING DATE: Mar.5/00

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: CME 55 Bombardier

DRILLING CONTRACTOR: Marathon

FR-FRACTURE F-FAULT SM-SMOOTH FL-FLEXURED BC-BROKEN CORE
CL-CLEAVAGE J-JOINT R-ROUGH UE-UNEVEN MB-MECH. BREAK
SH-SHEAR P-POLISHED ST-STEPPED W-WAVY B-BEDDING
VN-VEIN S-SLICKENSIDED PL-PLANAR C-CURVED

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	PENETRATION RATE (m/min)	COLOUR & % RETURN / FLUSH	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.3	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
		GROUND SURFACE		364.34												
4	NQ RC	Slightly weathered, grey-pink with black speckles, moderately to widely jointed, lightly foliated (30°), medium to coarse grained, strong to very strong GNEISS.		3.86	1								J,R,P J,R,P (x2) J,SM,P			
5					2								J,R,P,FeO stain J,R,P,FeO stain J,R,P			
6					3								J,R,P,FeO stain			
				361.19									J,R,P 3mm sand			
7		END OF HOLE		5.81												
8																
9																
10																
11																
12																
13																

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: SB

CHECKED: PD

DRILLHOLE 1193ROCK.GPJ GLDR_CAN.GDT 24/4/00 PS

PROJECT 991-1193

RECORD OF BOREHOLE No 17-7 1 OF 1 METRIC

W.P. 335-98-00 LOCATION N 5079789.63; E 314400.56 ORIGINATED BY SB

DIST 54 HWY 11 BOREHOLE TYPE 108mm I.D. HOLLOW STEM AUGERS COMPILED BY DKB

DATUM GEODETIC DATE March 7/00 CHECKED BY ASP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
362.00	GROUND SURFACE										
361.76 0.24	Topsoil										
	Silty Sand, some gravel Compact Brown Moist										
360.93 1.07	Gravelly Sand, trace to some silt, occ. cobbles and boulders Compact to dense Brown Moist to wet Boulders cored from 1.5m to 2.1m depth and from 3.1m to 3.4m depth		1	SS	17		361		○		
							360				
							359				
							358				
			2	SS	20		357				
							356				
			3	SS	20				○		26 61 13 0
							355				
353.77 8.23			4	SS	30		354				
	Fresh, pinkish grey with occasional black speckles, massive, moderately to widely jointed, coarse grained, strong to very strong GNEISS. Bedrock cored from 8.23m to 10.67m depth. For bedrock coring details refer to Record of Drillhole 17-7						353				
351.33 10.67							352				
	END OF HOLE Elevation accurate to nearest metre.										

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

PROJECT: 991-1193

RECORD OF DRILLHOLE: 17-7

SHEET 1 OF 1

LOCATION: N 5079789.63; E 314400.56

DRILLING DATE: Mar.7/00

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: CME 55 Bombardier

DRILLING CONTRACTOR: Marathon

FR-FRACTURE; CL-CLEAVAGE; SH-SHEAR; VN-VEIN; F-FAULT; J-JOINT; P-POLISHED; S-SLICKENSIDED; SM-SMOOTH; R-ROUGH; ST-STEPPED; PL-PLANAR; FL-FLEXURED; UE-UNEVEN; W-WAVY; C-CURVED; BC-BROKEN CORE; MB-MECH. BREAK; B-BEDDING

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	PENETRATION RATE (mm/m)	COLOUR & % RETURN / FLUSH	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.3 m	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY k, cm/sec	DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
		GROUND SURFACE		353.77												
9		Fresh, pinkish grey with occasional black speckles, massive, moderately to widely jointed, coarse grained, strong to to very strong GNEISS. Becomes slightly foliated (60°) from 9.1m to 10.67m depth.		8.23								60	J,R,ST			
												60	J,R,P (x2)			
												60	J,R,P			
10					2											
												60	J,R,P (x2)			
				351.33												
				10.67								60	J,R,P			
		END OF HOLE														
11																
12																
13																
14																
15																
16																
17																
18																

DRILLHOLE 1193ROCK.GPJ GLDR_CAN.GDT 24/4/00 PS

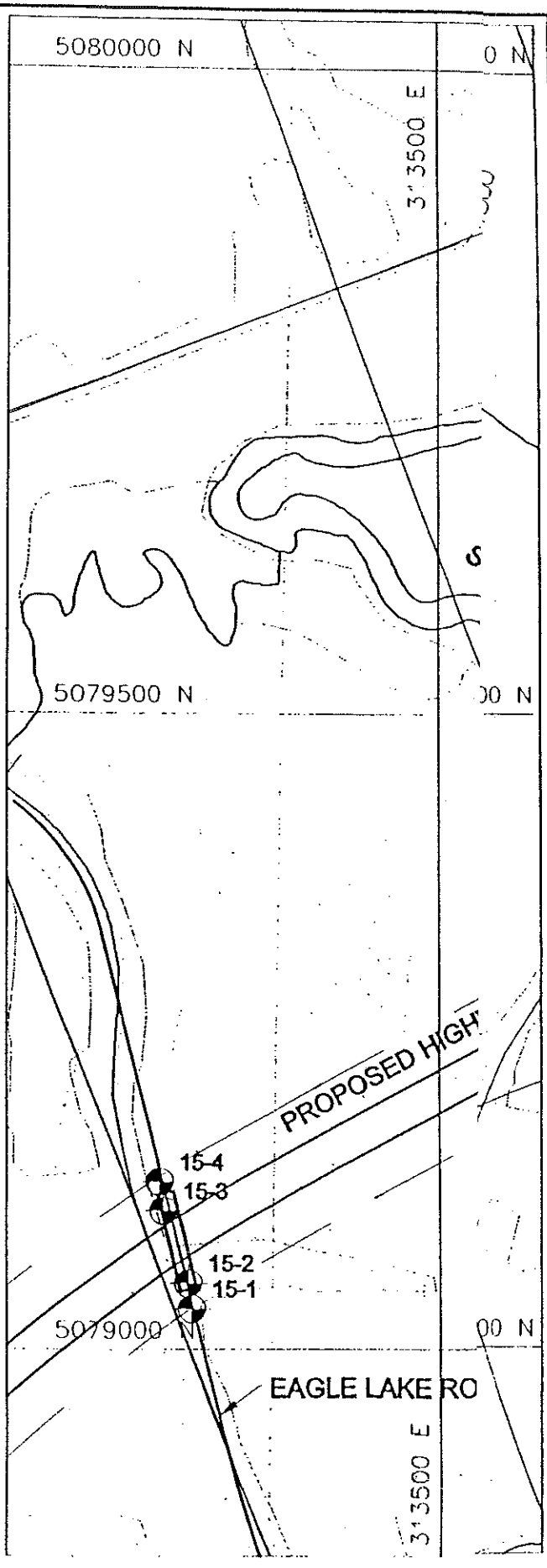
DEPTH SCALE

1 : 50

Golder Associates

LOGGED: SB

CHECKED: PD



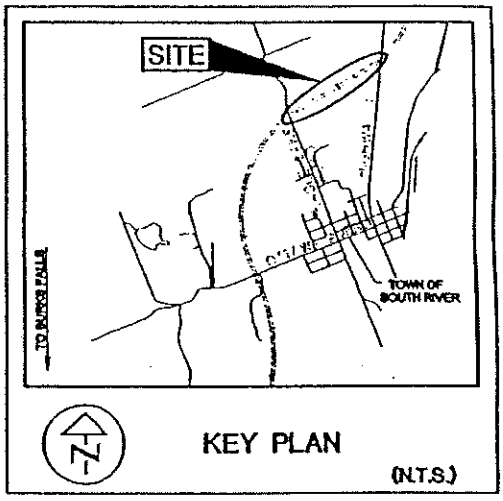
DIST No. 54 HWY 11
CONT No.
WP No. 335-98-00

EAGLE LAKE ROAD (SITE 15)
SOUTH RIVER (SITE 16)
SOUTH RIVER NORTH INTERCHANGE (SITE 17)
BOREHOLE LOCATION PLAN

SHEET

Golder Associates

Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN
(N.T.S.)

LEGEND

Borehole

No.	ELEVATION	NORTHING	EASTING
15-1	340.50	5079031.29	313304.69
15-2	339.76	5079051.29	313301.86
15-3	336	5079108.32	313282
15-4	336	5079131.23	313279
16-1	336	5079392	313887
16-2	335	5079383	313869
16-3	330.14	5079360.64	313837.62
16-4	330.14	5079353.11	313813.29
16-6	335.9	5079413.37	313846.67
16-7	329.77	5079385.79	313795.95
16-8	330.75	5079381.25	313776.32
17-1	366	5079838	314475
17-2	364	5079808	314455
17-3	361	5079747	314415
17-4	358.9	5079716	314395
17-5	373	5079880	314455
17-6	368	5079850	314435
17-7	362	5079789.63	314400.56

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

REFERENCE
This drawing was created from digital files OBH.DWG, ROWPSPSD.DWG AND SRIVER.DWG provided by COLE SHERMAN

NO.	DATE	BY	REVISION

METRES
TRES
SHOWN

Geocres No.

HWY 11		PROJECT NO.: 931-1193		DIST. 54
SUBM'D. DKB	CHKD: DKB	DATE: 2000 04 01		SITE
DRAWN: JFC	CHKD. ASP	APPD.		DWG. 8

1:93008.DWG

DIST No. 54 HWY 11
CONT No.
WP No. 335-98-00

EAGLE LAKE ROAD (SITE 15)
SOUTH RIVER (SITE 16)
SOUTH RIVER NORTH INTERCHANGE (SITE 17)
BOREHOLE LOCATION PLAN

SHEET

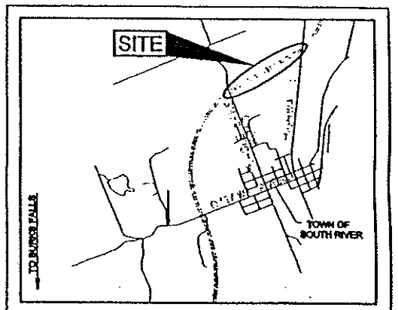
Golder Associates

Golder Associates Ltd.
MISSISSAUGA, ONTARIO, CANADA

5080000 N
5079500 N
5079000 N
3'3500 E
3'4000 E
3'4500 E
SOUTH RIVER
PROPOSED HIGHWAY 11
EAGLE LAKE ROAD
EXISTING HIGHWAY 11
PROPOSED HIGHWAY 11 CONNECTION
R=135
R=120
R=80
R=75
R=250
R=1500
R=450
15-1
15-2
15-3
15-4
16-1
16-2
16-3
16-4
16-6
16-7
16-8
17-1
17-2
17-3
17-4
17-5
17-6
17-7

PLAN

0 100 200 300 400 500 METRES
SCALE



KEY PLAN (N.T.S.)

LEGEND

Borehole

No.	ELEVATION	NORTHING	EASTING
15-1	340.50	5079031.29	313304.69
15-2	339.76	5079051.29	313301.86
15-3	336	5079108.32	313282
15-4	336	5079131.23	313279
16-1	336	5079392	313887
16-2	335	5079383	313869
16-3	330.14	5079360.64	313837.62
16-4	330.14	5079353.11	313813.29
16-6	335.9	5079413.37	313846.67
16-7	329.77	5079385.79	313795.95
16-8	330.75	5079381.25	313776.32
17-1	366	5079838	314475
17-2	364	5079808	314455
17-3	361	5079747	314415
17-4	358.9	5079716	314395
17-5	373	5079880	314455
17-6	368	5079850	314435
17-7	362	5079789.63	314400.56

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

REFERENCE
This drawing was created from digital files OBM.DWG, ROWPSPS0.DWG AND SRIVER.DWG provided by COLE SHERMAN

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

NO.	DATE	BY	REVISION

Geocres No.

HWY 11		PROJECT NO.: 991-1193		DIST. 54	
SUBM'D. DKB	CHKD: DKB	DATE: 2000 04 01		SITE	
DRAWN: JFC	CHKD. ASP	APPD.		DWG. 8	

I:\93\08.DWG

Appendix D

Foundation Comparison

COMPARISON OF FOUNDATION ALTERNATIVES FOR EACH FOUNDATION ELEMENT

Foundation Element	Driven Piles	Spread Footing	Caisson
West Abutment	***Advantages:*** i. None identified ***Disadvantages:*** i. Shallow bedrock precludes the use of driven piles ii. If integral abutment is selected for this structure, pre-drilling into the bedrock is required	***Advantages:*** i. Shallow and relatively uniform bedrock across the footing ii. High values of geotechnical resistance are available on the bedrock iii. Allows footing to be placed close to edge of the rock cut. ***Disadvantages:*** i. High cost of excavation, if any is required ii. Mass concrete fill required to create a level founding surface	***Advantages:*** i. None identified ***Disadvantages:*** i. Shallow bedrock practically precludes the use of caissons.
Centre Pier	***Advantages:*** i. None identified ***Disadvantages:*** i. The pier foundation will be from 1m to 2m above the top of bedrock effectively precluding the use of driven piles	***Advantages:*** i. Pier foundation founding level in competent sand layer and close to the top of bedrock ii. High values of geotechnical resistance are available on the sand layer and bedrock ***Disadvantages:*** i. There is potential for the presence of boulders at the footing founding level. Hence a 0.5m excavation below the U/S of footing will be required ii. Dewatering required during construction	***Advantages:*** i. None identified ***Disadvantages:*** i. The pier foundation will be from 1m to 2m above the top of bedrock practically precluding the use of caissons
East Abutment	***Advantages:*** i. Does not require engineered fill ***Disadvantages:*** i. Due to the presence of boulders in the sand layer, pile installation will require pre-drilling	***Advantages:*** i. Relatively high values of geotechnical resistance are available at shallow depths in the sand layer ii. Boulders present in the sand layer do not impact this alternative ***Disadvantages:*** i. Engineered fill probably required to shorten the abutment stem	***Advantages:*** i. High bearing capacity into bedrock ***Disadvantages:*** ii. Difficult installation due to the presence of boulders in the sand layer

Appendix E

Special Provisions

Suggested wording for inclusion in an NSSP dealing with groundwater control includes the following.

Bidders are alerted to the fact that a high groundwater level was recorded in the cohesionless, permeable soils known to exist at this site. If excavation penetrates below the level of the groundwater existing on site at the time of construction without prior unwatering, the possible consequences include but are not necessarily limited to:

- *Flow of groundwater into the excavation*
- *Loss of stability of the sides of the excavation with accompanying sloughing or flow of soil into the excavation*
- *Loss of stability of the base of the excavation with heaving or boiling of the soil*
- *Loss of bearing resistance due to heaving or boiling of the base soil*

Failure to control the stability of the excavation could result in property damage and personal injury.

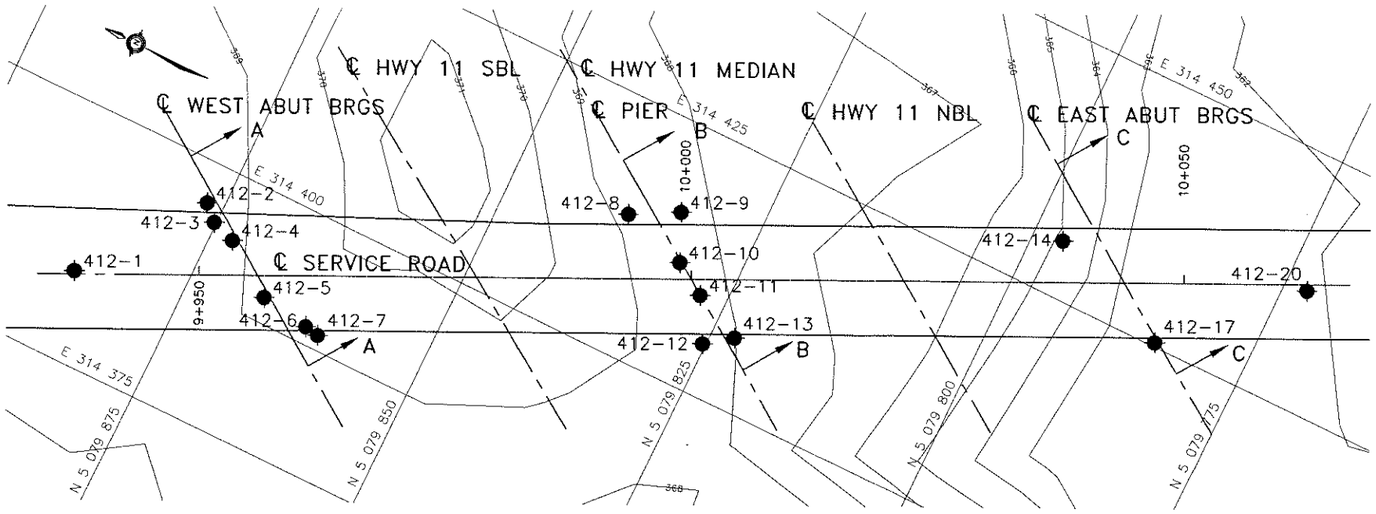
Failure to maintain the stability of the founding surface could result in the loss or reduction of the available bearing resistance and a requirement to redesign the foundation.

All costs associated with design changes resulting from the Contractor's failure to maintain the stability of the excavation will be to the Contractor's account.

Appendix F

Borehole Locations and Soil Strata

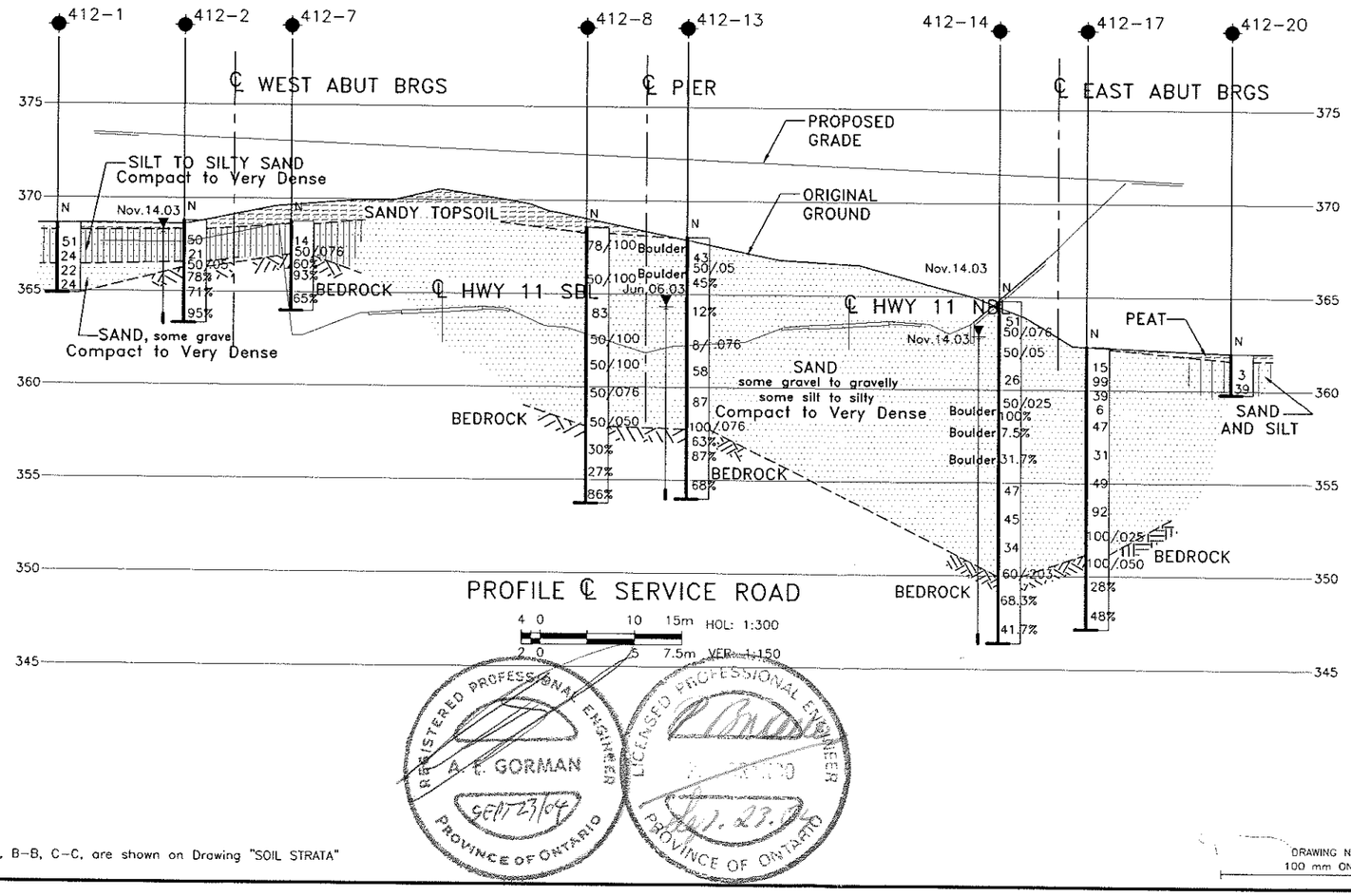
Soil Strata



PLAN

4 0 10 15m

SCALE: 1:300



PROFILE ℄ SERVICE ROAD

4 0 10 15m HOL: 1:300

2 0 5 7.5m VER: 1:150

REGISTERED PROFESSIONAL ENGINEER A.C. GORMAN SEPT 23/04 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER PROVINCE OF ONTARIO

BENCH MARK

NOTE:
Sections A–A, B–B, C–C, are shown on Drawing "SOIL STRATA"

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

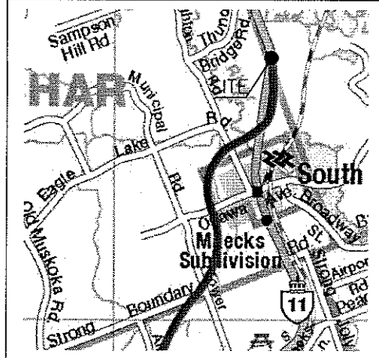
HWY 11
CONT No
WP No 5321-03-01

SERVICE ROAD
I/C UNDERPASS
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

Marshall Macklin Monaghan
CONSULTING ENGINEERS • SURVEYORS • PLANNERS

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

●	BoreHole by THURBER
⊕	Dynamic Cone Penetration Test (cone)
◆	BoreHole by GOLDER
N	Blows /0.3m (std pen Test,475J/blow)
CONE	Blows /0.3m (60° Cone ,475J/blow)
PH	Pressure, Hydraulic
▼	WL
▼	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)

NO	ELEVATION	NORTHING	EASTING
412-1	368.63	5 079 885.7	314 384.0
412-2	368.79	5 079 876.7	314 395.9
412-3	368.72	5 079 875.2	314 394.5
412-4	368.72	5 079 872.8	314 393.7
412-5	368.62	5 079 867.4	314 389.9
412-6	368.87	5 079 862.2	314 389.1
412-7	368.78	5 079 860.7	314 388.9
412-8	368.55	5 079 837.7	314 413.7
412-9	368.23	5 079 833.0	314 416.2
412-10	368.17	5 079 830.9	314 411.6
412-11	368.02	5 079 827.7	314 409.5
412-12	368.18	5 079 825.3	314 405.2
412-13	368.05	5 079 822.7	314 407.1
412-14	364.78	5 079 822.7	314 430.6
412-17	362.34	5 079 784.1	314 425.4
412-20	362.00	5 079 772.7	314 436.8

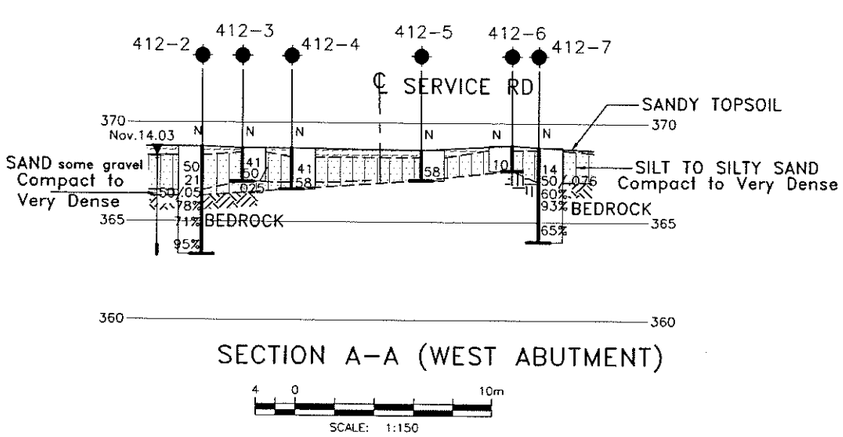
NOTE

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

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	PJB	CHK	PKC	CODE	CHBDC 2000	LOAD	OL-625-ONT
DRAWN	SS	CHK	PJB	SITE	44-412	STRUCT	SCHEME

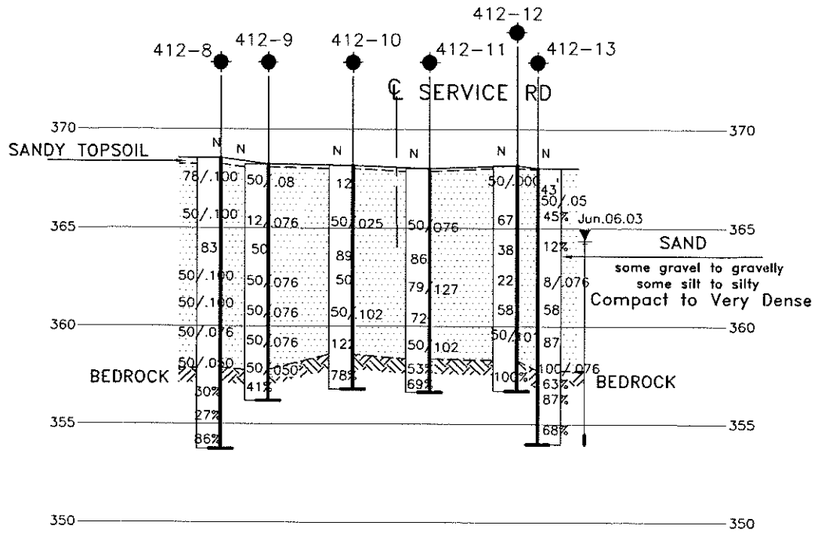
DATE MAR 2003
DWG 2



SECTION A–A (WEST ABUTMENT)

4 0 10m

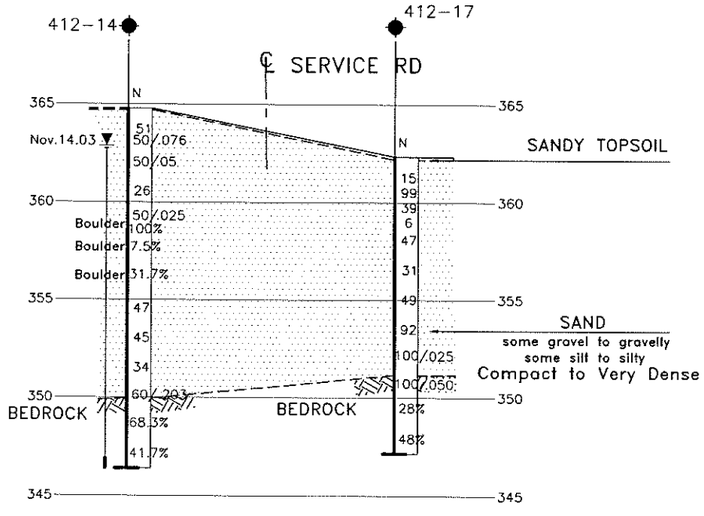
SCALE: 1:150



SECTION B–B (PIER)

4 0 10m

SCALE: 1:150

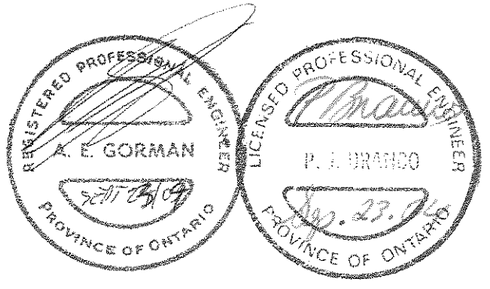


SECTION C–C (EAST ABUTMENT)

4 0 10m

SCALE: 1:150

NOTE:
Refer to drawing "BOREHOLE LOCATIONS AND SOIL STRATA" for location of sections.



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HWY 11
CONT No
WP No 5321-03-01

SERVICE ROAD
I/C UNDERPASS
SOIL STRATA

SHEET

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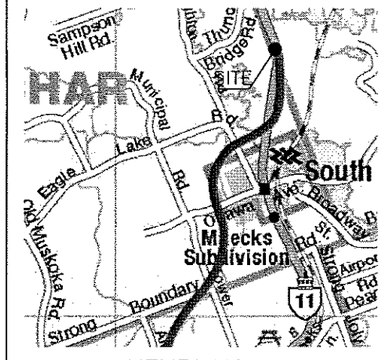
THURBER ENGINEERING LTD.



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DRAWN	SS	CHK	PJB	SITE	44-412	STRUCT	
DATE	MAR 2003	SCHEME		DWG	2a		