PRELIMINARY
FOUNDATION INVESTIGATION AND DESIGN REPORT
E-S RAMP AND CONNECTOR STREET UNDER VICTORIA STREET
HIGHWAY 7-NEW, KITCHENER TO GUELPH
G.W.P. 408-88-00

Geocres Number: 40P8-158

Report to

Ministry of Transportation Ontario
West Region

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from a preliminary foundation investigation conducted at the site of the proposed E-S Ramp and Connector Street under Victoria Street in the Regional Municipality of Waterloo. The proposed E-S Ramp is part of the Highway 7-New project and the connector maintaining local traffic patterns.

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, records of boreholes, a stratigraphic profile, laboratory test results and a written description of the subsurface conditions. A model of the subsurface conditions under the potential foundation footprint was developed from the data obtained in the course of the investigation.

The information collected in the course of the investigation and presented in this report is intended for preliminary design purposes only. Additional site investigation, field testing and engineering analysis will be required at the detail design stage. The extent of the additional investigation will depend, in part, on the final location and General Arrangement of the structure.

Thurber carried out the investigation for the Ministry of Transportation Ontario, Southwestern Region (MTO) under Purchase Order Number 3006-E-0123.

In the preparation of this report, general reference has been made to information on subsurface conditions contained in a previous foundation report. The title of the report is listed as follows:

- Foundation investigation report for Victoria Street Underpass, Kitchener-Waterloo Expressway, District #4 (Hamilton), W.J. 66-F-36, W.P. 635-64, dated June 17, 1966. (Reference 1).

Records of boreholes from the previous report are attached in Appendix C for reference.

2 SITE DESCRIPTION

The site lies on the west side of Kitchener-Waterloo Expressway, approximately 350.0 m to the south of the existing Kitchener-Waterloo Expressway and Wellington Street interchange. At this location, the proposed E-S Ramp and the Connector Street will pass under existing Victoria Street, on the west side of Kitchener-Waterloo Expressway. The site lies within an area of industrial and commercial lands and is generally flat.

Based on the Ontario Geological Survey Special Volume 2, The Physiography of Southern Ontario, Third Edition by Chapman and Putnam, the site lies within the physiographic region known as the Waterloo Hills, characterized by ridges of sandy till and kames or kame moraines, with outwash sands occupying the intervening hollows.

Photographs of the site are included in Appendix F and show the general nature of the surrounding lands:

1. A view looking west along Victoria Street – East Abutment (Borehole 08-048).
2. A view looking east along Victoria Street – West Abutment (Borehole 08-047).

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing at this site was carried out on June 17, 25 and 26, 2008. Two boreholes, numbered 08-047 and 08-048, were drilled approximately at the west and east abutments of a possible single-span structure arrangement. The depths of Boreholes 08-047 and 08-048 were 18.7 m and 21.6 m (Elevations 305.0 and 301.7), respectively. The Record of Borehole sheets for the boreholes are included in Appendix A. The approximate locations of the two boreholes are shown on the attached Borehole Locations and Soil Strata Drawing in Appendix G.

Prior to commencing the site investigation, clearance was obtained from utility companies having plant in the area. Road occupancy permit was also obtained to complete the site investigation.

The boreholes were drilled using hollow stem auger equipment operated by a CME75 truck-mounted drill rig. Samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT 'N') in the overburden soils.

Groundwater conditions in the open boreholes were observed throughout the drilling operations. The borehole completion details are shown in Table 3.1.

Table 3.1 – Borehole Completion Details

Foundation Unit	Borehole Location	Completion Details
West Abutment	08-047	Grout to 1.8 m, holeplug to 1.2 m, concrete to 0.1 m then asphalt patch to surface.
East Abutment	08-048	Grout to 0.9 m, holeplug to 0.05 m, then auger cuttings to surface.

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

4 LABORATORY TESTING

The 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 also subjected to gradation analysis (sieve and hydrometer) and Atterberg Limits testing where appropriate. The results of this testing program are shown on the Record of Borehole sheets in Appendix A and on the figures contained in Appendix B.

5 DESCRIPTION OF SUBSURFACE CONDITIONS

Reference is made to the Record of Borehole sheets in Appendix A. Details of the encountered soil stratigraphy along the proposed alignment are presented in this appendix and on the "Borehole Locations and Soil Strata" drawing in Appendix G. An overall description of the stratigraphy is given in the following paragraphs. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions.

In general, the site is underlain by topsoil or pavement structure and granular fill overlying native loose to dense sand, very stiff to hard silty clay till and silty clay and very dense silt till.

5.1 Topsoil

A 200-mm thick layer of topsoil was identified surficially in Borehole 08-048. The topsoil thickness may vary between and beyond the borehole location and the data is not intended for the purpose of estimating quantities

5.2 Pavement structure

Pavement structure consisting of approximately 65 mm of asphalt overlying granular (sand and gravel) fill was encountered in Borehole 08-047 drilled on a residential drive way, in close proximity to the Victoria Street lane.

5.3 Fill

Fill was encountered below the topsoil and below the pavement structure. The fill consists of sand, gravel and silt containing trace gravel to gravelly, trace clay to clayey, occasional organics and numerous cobbles.

Thicknesses of the fill were 2.9 m and 4.1 m. The depths to the base of the fill were 3.0 m and 4.3 m (Elevations 320.7 and 319.1) in Boreholes 08-047 and 08-048, respectively.

The cohesionless fill is classified as very loose to very dense based on SPT 'N' value of 4 to 70 blows for 0.3 m of penetration. The natural moisture content ranged from 5 to 21%.

Grain size distribution curve for a gravelly sand fill sample is presented on the Record of Borehole sheets and on Figure B1 of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	44
Sand	42
Silt & Clay	14

5.4 Sand

Native brown sand containing trace silt and trace gravel was encountered below the fill in both boreholes. The depths to the base of the native sand were 5.6 m and 8.1 m (Elevations 318.2 and 315.3), in Boreholes 08-047 and 08-048, respectively.

A 300-mm layer of sand was encountered in Borehole 08-048 at 10.7 m depth (Elevation 312.7).

The sand is classified as loose to dense, based on SPT 'N' values of 6 to 37 blows for 0.3 m of penetration. The natural moisture content ranged from 8 to 19%.

Grain size distribution curves for three selected samples of sand are presented on the Record of Borehole sheets and on Figure B2 of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	0 to 1
Sand	89 to 94
Silt & Clay	6 to 11

5.5 Silty Clay Till and Silty Clay

Native brown to grey silty clay till and silty clay containing some sand to sandy, trace gravel and occasional sand seams were contacted below the native sand. The silty clay and silty clay till extended to 17.8 m and 21.6 m (Elevations 306.0 and 301.7) in Boreholes 08-047 and 08-048, respectively. Borehole 08-048 was terminated within the silty clay till layer.

The cohesive layer is very stiff to hard in consistency, based on SPT 'N' values ranging from 22 to 48 blows per 0.3 m of penetration. SPT 'N' values higher than 100 blows per 0.3 m of penetration were measured below 15.2 m and 18.3 m depth (Elevations 308.6 and 305.1) in Boreholes 08-047 and 08-048, respectively. The moisture content varied from 10% to 21%.

Grain size distribution curves for selected samples of silty clay and silty clay till are presented on the Record of Borehole sheets and on Figure B3 of Appendix B. Atterberg Limits test results are presented on Figure B5 of Appendix B.

The results of the laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	0 to 2
Sand	0 to 24
Silt	40 to 78
Clay	20 to 57

Liquid Limit	21 to 41
Plastic Limit	10 to 19

The above results show that the silty clay and silty clay till are of medium plasticity with a group symbol of CL-CI.

Although not encountered in the boreholes, this glacial till layer may contain cobbles and boulders which may account for some high SPT 'N' values and resistance to augering.

5.6 Silt Till

Grey silt till was contacted below the silty clay in Borehole 08-047, at 17.8 m (Elevation 306.0). Borehole 08-047 was terminated within the silt till at 18.7 m depth (Elevation 305.0).

SPT 'N' value was 103 blows per 0.3 m of penetration, indicating a very dense relative density. Moisture content was 18%.

Grain size distribution curve for a silt till sample is presented on the Record of Borehole sheets and on Figure B4 of Appendix B. The results of the laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	0
Sand	5
Silt	89
Clay	6

Although not encountered in the boreholes, this glacial till layer may contain cobbles and boulders which may account for the high SPT 'N' value and resistance to augering.

5.7 Groundwater Conditions

Water levels were observed during and upon completion of drilling at 16.8 m and 5.5 m depth (Elevations 307.0 and 317.9) in Boreholes 08-047 and 08-048, respectively.

Previous geotechnical investigation conducted in 1966 (Reference 1), indicates that groundwater level is near Elevation 320.1.

Seasonal fluctuations of the groundwater level are to be expected, in particular, the groundwater level may be at a higher elevation after the spring snowmelt or after periods of heavy rainfall.

6 MISCELLANEOUS

All-Terrain Drilling of Waterloo, Ontario supplied a truck-mounted CME75 drill rig and conducted the drilling, sampling and in-situ testing operations.

The drilling and sampling operations in the field were supervised on a full time basis by Mr. Stephane Loranger, C.E.T. of Thurber, under the direction of Mr. Alastair E. Gorman, P.Eng and Mr. Mark Farrant, P. Eng.

The coordinates for the boreholes and the ground surface elevations were determined by Thurber Engineering Ltd. using GPS equipment.

Overall supervision of the field program was conducted by Mr. Alastair E. Gorman, P.Eng. and Mr. M. Farrant, P. Eng. Interpretation of the data and preparation of the report were carried out by Mr. Alastair E. Gorman, P.Eng. and Ms. R. Palomeque Reyna, P.Eng.

Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations projects, reviewed the report.

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PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

7 GENERAL

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

Based on the Plates 2A and 2B of the E.A:

- The proposed E-S Ramp will connect Highway 7-New to KWE. The proposed Connector Street will connect Edna Street to Wellington Street; both will pass under the existing Victoria Street.
- Victoria Street is currently near Elevation 323.6.
- The proposed grade of the E-S Ramp will be in a cut approximately 7 m deep at Elevation 316.6.

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 this investigation.

8 STRUCTURE FOUNDATIONS

The stratigraphy identified in the preliminary investigation consisted primarily of topsoil or asphalt and granular fill overlying a native layer of loose to dense sand, very stiff to hard silty clay till and silty clay and very dense silt till.

Based on previous data (Reference 1), groundwater level was observed at Elevation 320.1. During the present investigation, water level measured in a piezometer installed in Borehole 08-046 (50 m south of Borehole 08-047) was at 6.3 m depth (Elevation 318.5). For design purposes, water level elevation of 320.0 is considered in this report.

In the preparation of the preliminary geotechnical design recommendations, consideration was given to the following foundation types:

- Spread footings bearing on native soil
- Spread footings on engineered fill
- Steel H-piles driven into the very dense soil

A comparison of the foundation alternatives based on advantages and disadvantages of each is included in Appendix D.

8.1 Spread Footings on Native Soil

Spread footings bearing on native soil generally are the least expensive form of construction.

The existing fill is not considered to be suitable for the support of spread footings and the footings must be placed on the underlying native soils.

The design of spread footings bearing on native undisturbed compact sand or very stiff silty clay till must be in accordance with the elevations and bearing resistances given in Table 8.1.

Table 8.1 – Bearing Resistances for Spread Footings

Element	Depth (m)	Elev.	ULS_f (kPa)	SLS (kPa)	Soil
West Abutment (BH 08-047)	3.2	320.6	300	200	Compact sand
	Below 7.6	Below 316.2	450	300	Hard silty clay till
East Abutment (BH 08-048)	Below 6.4	Below 317.5	450	300	Dense sand

The bearing resistances in Table 8.1 are for vertical, concentric loading. In the case of eccentric or inclined loading, the bearing resistance must be adjusted as shown in the CHBDC (2006) Clause 6.7.3 and Clause 6.7.4.

The geotechnical SLS resistance values given above are based on an estimated total settlement not exceeding 25 mm. This settlement is expected to be substantially complete by the end of construction. Differential settlement is not expected to exceed 20 mm across the width of the structure or between foundation elements.

Founding elevations presented in Table 8.1 are below groundwater level observed during present and previous investigation. For temporary excavations required to construct these footings extending in cohesionless soils below the water table, groundwater control will be required prior to excavation to construct the footings in the dry, to prevent sloughing of the sides and to prevent disturbance of the footing bases due to the inflow of groundwater.

8.2 Spread Footings on Engineered Fill

Spread footings can also be founded on Granular "A" engineered fill pads. These would be most useful in the case of perched abutments on footings.

If an engineered fill pad is used, all topsoil, or other deleterious materials must be stripped from the footprint of the foundation to expose competent native subgrade material. The engineered fill must bear on native compact sand and very stiff to hard silty clay till. The highest permitted founding elevations at which engineered fill pads may be placed, are given in Table 8.2.

Table 8.2 –Founding Elevations for Engineered Fill Pads

West Abutment (BH 08-047)	East Abutment (BH 08-048)
320.6	317.5

Typically, spread footings on pads of engineered granular fill at least 2 m thick may be designed for the following geotechnical resistances:

- Factored ULS 900 kPa
- SLS 350 kPa

These resistance values are for concentric, vertical loads only. 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.

For footings designed on the basis of the geotechnical resistance values given above, total settlement under a footing is expected to not exceed 25 mm. Differential settlements are not expected to exceed 20 mm across the width of the structure or between foundation elements.

The Granular A pad must be compacted to 100% of Standard proctor maximum dry density (SPMDD) at optimum moisture content of ±2%. The geometry of the fill pad must conform to the general requirements shown in Figure 1 in Appendix E.

8.3 Steel H-Piles

The soil stratigraphy encountered at this site is considered to be suitable for the support of foundations on driven steel piles.

It is recommended that the H-piles be driven to achieve resistance in the hard silty clay and silty clay till encountered at this site. The depths and elevations at which the H-piles are expected to develop the required resistance are given in Table 8.3.

Table 8.3 – Estimated Pile Tip Elevation

Foundation Unit	Pile Tip Depth (m)	Highest Pile Tip Elevation
West Abutment (BH 08-047)	16.8	307.0
East Abutment (BH 08-048)	19.6	303.5

8.3.1 Axial Resistance

For preliminary design, the vertical, axial, factored geotechnical resistance at Ultimate Limit States (ULS) and geotechnical resistance at Serviceability Limit States (SLS) for two pile sections when driven into the hard silty clay and silty clay till are presented in Table 8.4.

Table 8.4 – Axial Resistance of Two Pile Sections Founded on Hard Soils

Pile Section	Geotechnical Resistance (kN)	
	Factored ULS	SLS
HP 310 X 110	1,600	1,400
HP 360 X 132	1,800	1,600

The structural resistance of the pile must be checked by the structural designer.

Installation of the piles must be in accordance with SP 903S01 and must be controlled using the Hiley Formula and an ultimate resistance of 3,200 kN for an HP 310 X 110 pile and 3,600 kN for the HP 360 X 132 pile.

These are preliminary recommendations and may change during detail design based on the final alignment, final bridge arrangement and the results of the site investigation and field testing to be completed at that time.

Due to the possible presence of cobbles and boulders in the silty clay till at the expected founding layer, the tips of all driven piles should be fitted with steel H-Pile driving shoes in accordance with OPSD 3000.100.

8.3.2 Downdrag

Downdrag on the piles is not an issue at this site.

8.4 Abutment Design Considerations

From a geotechnical perspective, the conditions at this site are considered to be suitable for the design of conventional, semi-integral or integral abutments.

8.5 Frost Cover

The design depth of frost penetration for this site is 1.4 m. All footing bases and undersides of pile caps/abutment stems must be provided with at least 1.4 m of soil cover.

8.6 Recommended Foundation

From a geotechnical perspective, and based on current information, the recommended abutment foundation consists of steel H-piles driven into the hard silty clay and silty clay till, despite the higher cost noted in Appendix D.

9 BRIDGE APPROACHES AND EMBANKMENTS

Based on the two boreholes drilled at the site, the approach embankments will be constructed over very stiff to hard silty clay till or compact sand and may incorporate the sand fill of the existing embankment.

The base of the proposed cut under Victoria Street shown on EA Plates 2A and 2B, may be at approximately elevation 316.6. Water was observed at 3.5 m (Elevation 320.0) above the proposed base of the cut in the site during previous and present investigations. During detail design, when the grade has been finalized, permanent drainage and slope protection requirements must be addressed. Subject to depressing the groundwater level below the base of the cut and implementing permanent drainage, the cut slopes will be stable at slopes with a maximum inclination of 2H: 1V. MTO policy requires a mid-height bench in cut slopes higher than 6.0 m.

10 CONSTRUCTION CONCERNS

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

1. Pile refusal at higher elevation.

   Although there was little direct evidence of their presence during drilling, glacial till deposits inherently contain boulders. It is possible that a pile will achieve refusal at a higher elevation than anticipated due to encountering a boulder. If it is suspected that this is happening, the QVE must immediately bring it to the attention of the CA. If the CA cannot resolve the issue, it must be referred to the design team for resolution.

2. Pile fails to develop specified resistance.

   If a pile has not developed the specified resistance after being driven 3 m beyond the anticipated pile tip elevation, stop driving and check the Hiley calculation and all input values. If the calculation still shows that the pile has not reached the specified resistance, the following procedure should be implemented:

a) Stop driving in that pile group for 48 hours (minimum)
b) After 48 hours, warm up the hammer on another pile then commence redriving the subject pile and measure the resistance.
c) If the pile still does not reach the specified resistance, the QVE must immediately advise the CA who, in turn, should refer the issue to the design team.

3. Destabilization of excavations

If excavation is carried out in cohesionless soil without prior implementation of adequate measures to control groundwater and surface water, there is a risk that the sides and or base of the excavation will be destabilized. This could lead to a risk to personnel working on site, or to a loss of bearing resistance in the soil.

Accordingly, it must be emphasized to the contractor that proper groundwater and surface water control measures must be in place prior to commencing excavation.

11 INVESTIGATION FOR DETAIL DESIGN

During the detail design phase of the project, additional site investigation and field testing will be required. The following minimum program is recommended:

1. Boreholes for structure foundations.

Additional boreholes may be required for the structure foundations, especially if the structure is built off the current E-S Ramp connector over Victoria Street alignment and thus removed from the alignment of the current investigation.

2. Cut stability

At least one borehole is required in the roadway cut to either side of the structure. The boreholes in the cut must include piezometers for groundwater monitoring. Stability of cuts must be investigated during detail design phase.

3. Groundwater impacts.

The potential impact of drainage of the cuts on the local groundwater table must be addressed by a hydrogeologist, who should also consider the need to apply for an MOE Permit to Take Water.

4. Impacts to adjacent structure or traffic lanes

Detail design must address potential impacts on adjacent structures and roads.

12 CLOSURE

Engineering analysis and preparation of the report were carried out by Mr. Alastair E. Gorman, P.Eng and Ms. R. Palomeque Reyna, P.Eng.

The report was reviewed by Dr. P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.

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Appendix A

Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

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

NOTE: Hierarchy of Soil Strength Prediction

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

4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

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

5. LEGEND FOR RECORDS OF BOREHOLES

SYMBOLS AND ABBREVIATIONS FOR SAMPLE TYPE

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

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

$\overline{\blacktriangledown}$ 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

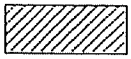
MAJOR DIVISIONS		GROUP SYMBOL	TYPICAL DESCRIPTION
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well-graded gravels or gravel-sand mixtures, little or no fines.
		GP	Poorly-graded gravels or gravel-sand mixtures, little or no fines.
		GM	Silty gravels, gravel-sand-silt mixtures.
		GC	Clayey gravels,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

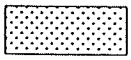
ROCK WEATHERING CLASSIFICATION

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 0.3 m 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

THURBER

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 08-047 1 OF 2 METRIC

G.W.P. 408-88-00 LOCATION N 4 814 014.67 E 226 147.74 ORIGINATED BY GA
HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SA
DATUM Geodetic DATE 2008.06.25 - 2008.06.26 CHECKED BY RPR

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
323.8											
0.0	**ASPHALT**, (65mm)										
0.2 / 323.2	**SAND** and **GRAVEL** Dense Brown Moist (FILL)		1	SS	48		323	○	○		
0.6	**SAND**, trace gravel, trace silt Very Loose to Compact Brown Moist to Damp (FILL)		2	SS	10						
			3	SS	4		322		○		
320.7			4	SS	4		321		○		
3.0	**SAND**, fine grained, trace silt Compact Brown Damp		5	SS	27				○		0 94 6 (SI+CL)
318.2			6	SS	24		320				
5.6	Silty **CLAY**, trace to some sand, trace gravel Very Stiff Brown (TILL)		7	SS	25		319		○		
	Hard		8	SS	44		318		○		
	occasional sandy silt seams Brown to Grey		9	SS	43		317				0 24 53 23
							316		⊢●⊣		
							315				
							314		○		

Continued Next Page

+ ³ , × ³ : Numbers refer to Sensitivity

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

ONTMT4S 6417R.GPJ 8/27/08

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 08-047 2 OF 2 METRIC

G.W.P. 408-88-00 LOCATION N 4 814 014.67 E 226 147.74 ORIGINATED BY GA
HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SA
DATUM Geodetic DATE 2008.06.25 - 2008.06.26 CHECKED BY RPR

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
	Continued From Previous Page										
	Silty **CLAY**, trace to some sand, trace gravel Very Stiff to Hard Brown (TILL)										
			10	SS	38		313				
312.1											
11.7	Silty **CLAY**, occasional sand Very Stiff Grey						312				
			11	SS	22						0 1 44 55
							311				
			12	SS	27		310				
	Hard										
			13	SS	107		309				
							308				
	occasional silty sand seams					▽					
			14	SS	101		307				0 0 52 48
306.0											
17.8	**SILT**, trace sand Very Dense Grey Wet (TILL)						306				
			15	SS	103						0 5 89 6
305.0											
18.7	END OF BOREHOLE AT 18.7m. WATER LEVEL OBSERVED AT 16.8m DURING DRILLING. BOREHOLE BACKFILLED WITH GROUT TO 1.8m, HOLEPLUG TO 1.2m, CONCRETE TO 0.1m THEN ASPHALT PATCH TO SURFACE.										

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 6417R.GPJ 11/12/09

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 08-048 1 OF 3 METRIC

G.W.P. 408-88-00 LOCATION N 4 814 022.96 E 226 174.52 ORIGINATED BY SA
HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SA
DATUM Geodetic DATE 2008.06.17 - 2008.06.17 CHECKED BY RPR

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
323.4											
0.0	**TOPSOIL**, occasional roots (200mm)										
0.2	**SAND** and **SILT**, some gravel, trace clay Loose to Very Dense Brown to Grey Moist		1	SS	20		323				
			2	SS	7						
	asphalt and gravel layer (200mm)						322				
	Brown to Dark Brown		3	SS	70						
	gravelly, numerous cobbles		4	SS	24		321				44 42 14 (SI+CL)
	Clayey, occasional black stains, organics		5	SS	7		320				
319.1											
4.3	**SAND**, trace gravel, trace silt Loose Brown Moist		6	SS	6		319				
							318				
	Dense Wet		7	SS	37		317				1 93 6 (SI+CL)
315.3			8	SS	25		316				
8.1	Silty **CLAY**, some sand to sandy, trace gravel Very Stiff to Hard Grey (TILL)						315				
	occasional silty sand seams		9	SS	31		314				2 20 51 27

Continued Next Page

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

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

ONTMT4S 6417R.GPJ 8/27/08

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 08-048 2 OF 3 METRIC

G.W.P. 408-88-00 LOCATION N 4 814 022.96 E 226 174.52 ORIGINATED BY SA
HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SA
DATUM Geodetic DATE 2008.06.17 - 2008.06.17 CHECKED BY RPR

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/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	Silty **CLAY**, some sand to sandy, trace gravel Hard Grey (TILL) Layer of sand (300mm)						313				
			10	SS	33				o		0 89 11 (SI+CL)
							312				
			11	SS	30		311		o		
							310				
			12	SS	48				o—⊢		0 3 40 57
							309				
			13	SS	45		308		o		
							307				
			14	SS	46				o		
							306				
	Layer of clayey silt		15	SS	103		305		o—⊢		0 2 78 20
							304				
	occasional cobbles		16	SS	104/						

Continued Next Page

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

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

ONTMT4S 6417R.GPJ 8/27/08

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No 08-048 3 OF 3 METRIC

G.W.P. 408-88-00 LOCATION N 4 814 022.96 E 226 174.52 ORIGINATED BY SA

HWY 7 BOREHOLE TYPE Hollow Stem Augers COMPILED BY SA

DATUM Geodetic DATE 2008.06.17 - 2008.06.17 CHECKED BY RPR

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa 20 40 60 80 100 (○ UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE)	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
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	Silty **CLAY**, trace sand Hard Grey (TILL)				.200		303				
301.7			17	SS	112		302		○		
21.6	END OF BOREHOLE AT 21.6m. BOREHOLE OPEN AND DRY TO BOTTOM UPON COMPLETION. WATER LEVEL OBSERVED AT 5.5m DURING DRILLING. BOREHOLE BACKFILLED WITH GROUT TO 0.9m, HOLE PLUG TO 0.05m THEN AUGER CUTTINGS TO SURFACE.										

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

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

ONTMT4S 6417R.GPJ 8/27/08

Appendix B

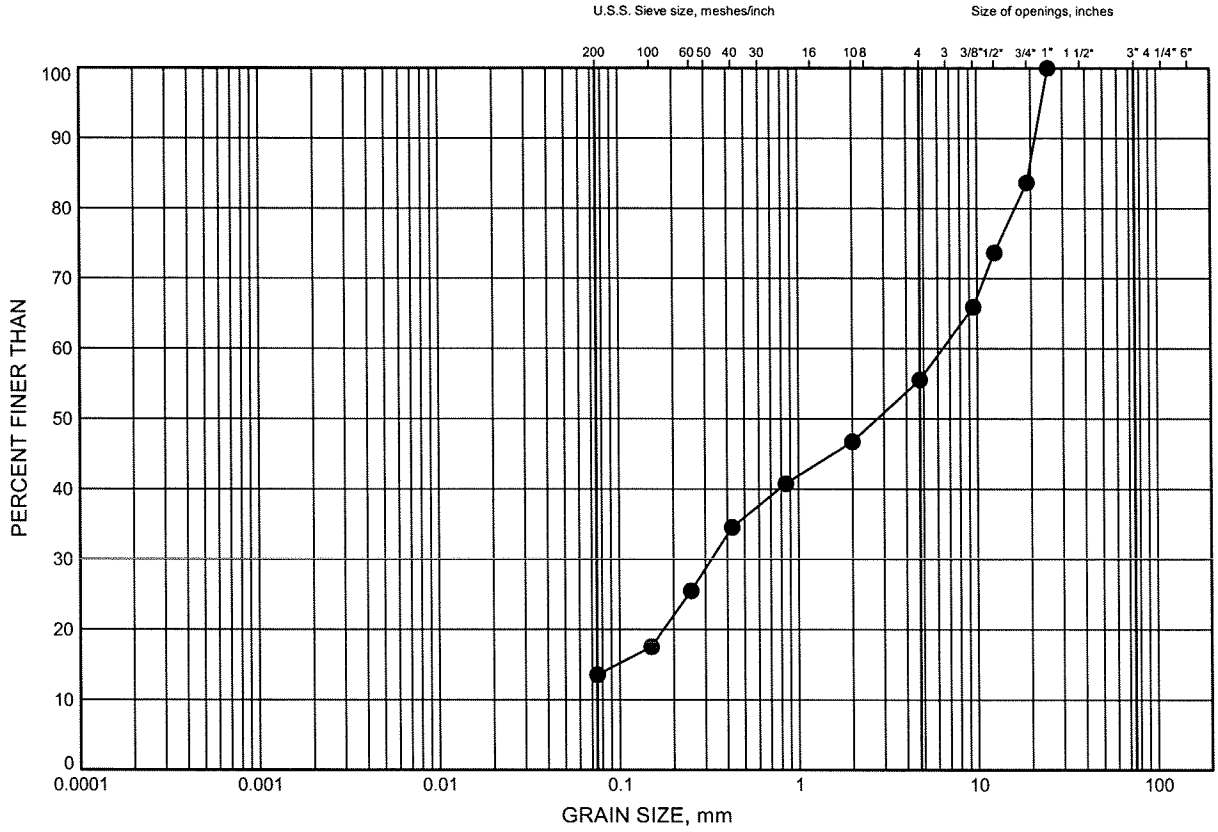
Laboratory Test Results

Highway 7 - New

GRAIN SIZE DISTRIBUTION

FIGURE B1

Gravelly Sand Fill



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-048	2.47	320.88

W.P.# 408-88-00

Prepared By AN

Checked By RPR

THURBER

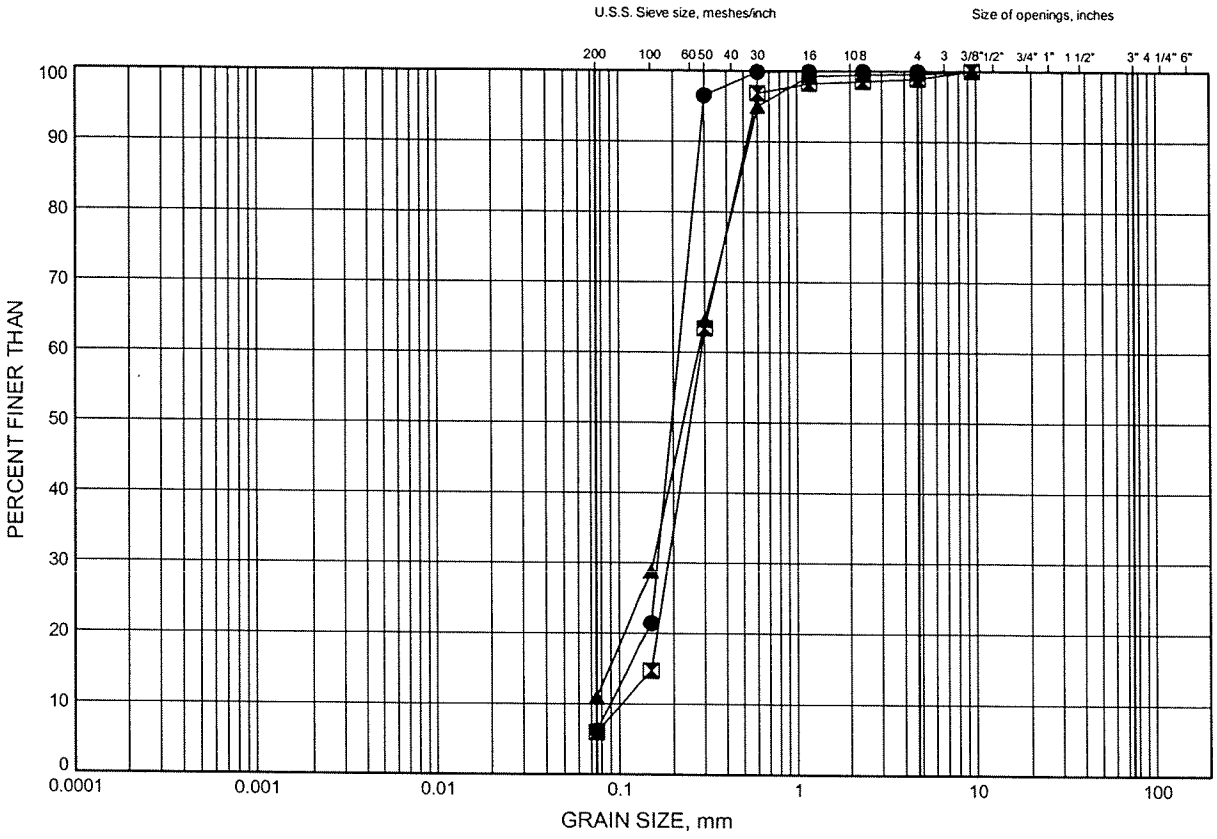
GRAIN SIZE DISTRIBUTION - THURBER 6417R.GPJ 11/12/09

Highway 7 - New

GRAIN SIZE DISTRIBUTION

FIGURE B2

Sand



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-047	3.35	320.44
⊠	08-048	6.40	316.95
▲	08-048	10.90	312.46

W.P.# 408-88-00
Prepared By SA
Checked By RPR

THURBER

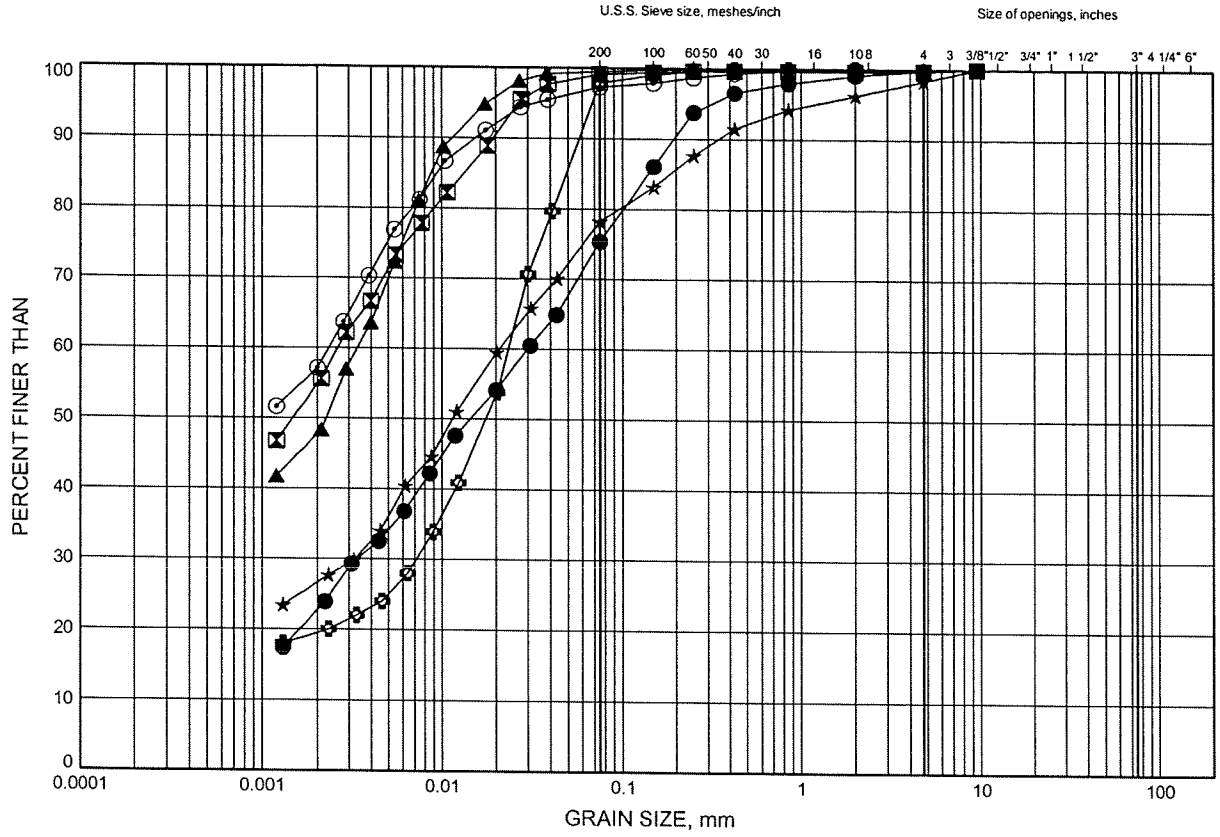
GRAIN SIZE DISTRIBUTION - THURBER 6417R.GPJ 31/7/08

Highway 7 - New

GRAIN SIZE DISTRIBUTION

FIGURE B3

Silty Clay and Silty Clay Till



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-047	7.92	315.86
⊠	08-047	12.50	311.29
▲	08-047	17.07	306.72
☆	08-048	9.45	313.90
⊙	08-048	14.02	309.33
✿	08-048	18.52	304.84

W.P.# 408-88-00
Prepared By SA
Checked By RPR

THURBER

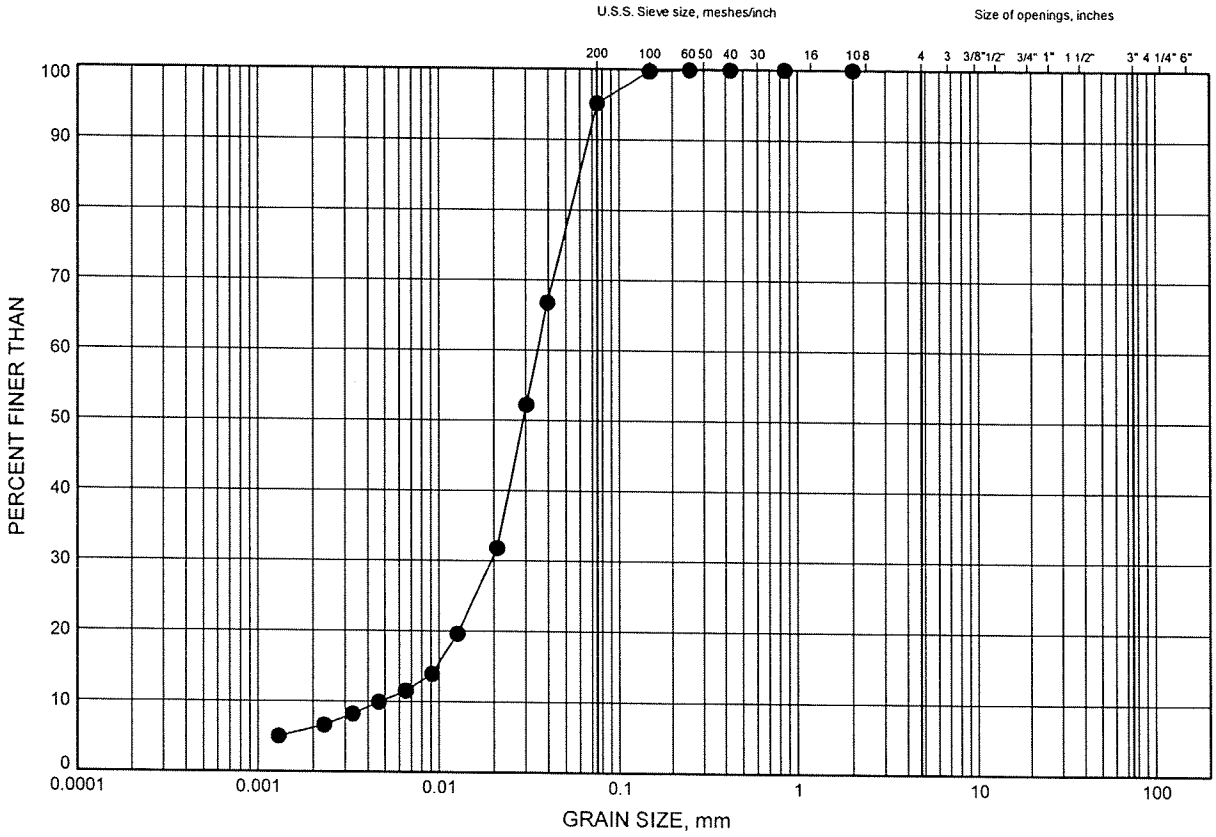
GRAIN SIZE DISTRIBUTION - THURBER 6417R.GPJ 31/7/08

Highway 7 - New

GRAIN SIZE DISTRIBUTION

FIGURE B4

Silt Till



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	08-047	18.59	305.20

W.P.# 408-88-00
Prepared By MFA
Checked By RPR

THURBER

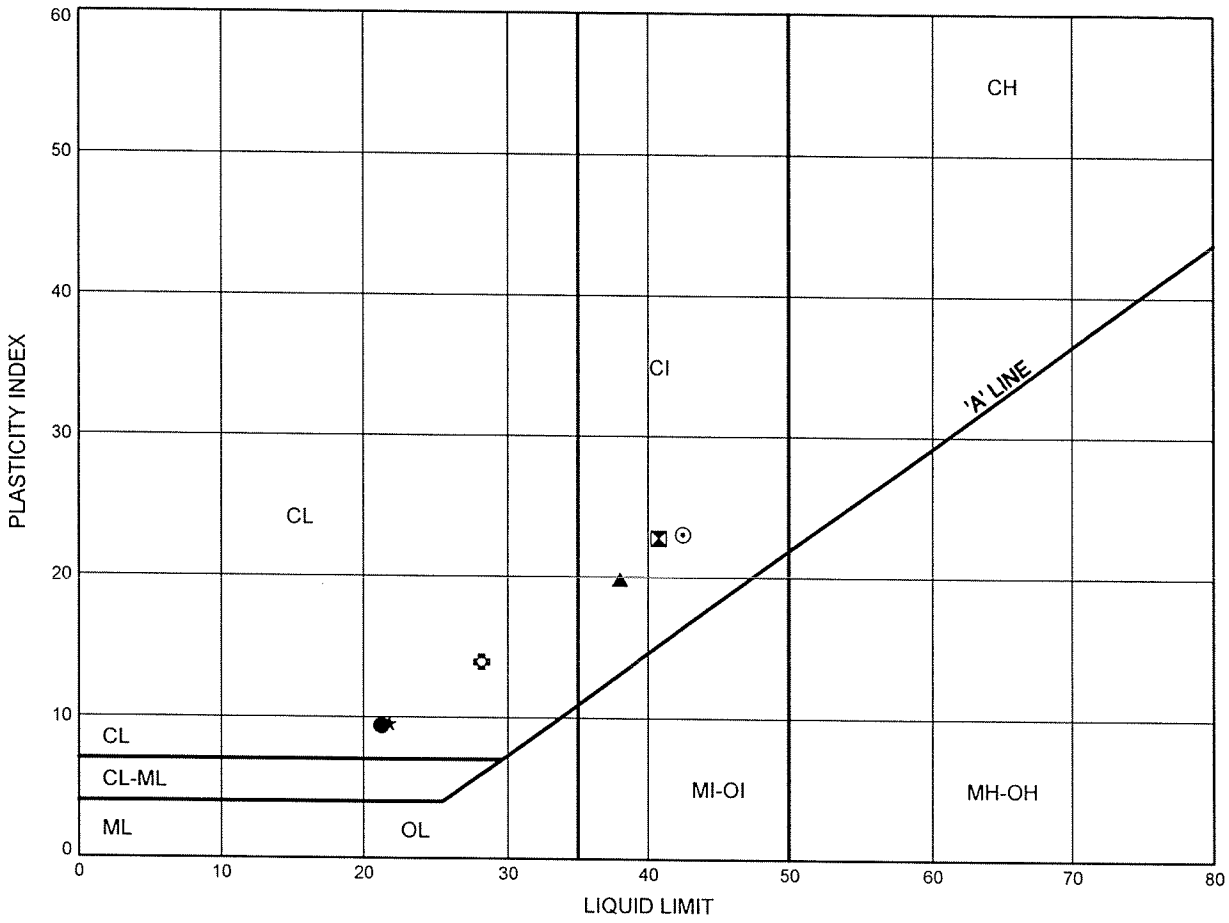
GRAIN SIZE DISTRIBUTION - THURBER 6417R.GPJ 8/27/08

Highway 7 - New

ATTERBERG LIMITS TEST RESULTS

FIGURE B5

Silty Clay and Silty Clay Till



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	08-047	7.92	315.86
⊠	08-047	12.50	311.29
▲	08-047	17.07	306.72
★	08-048	9.45	313.90
⊙	08-048	14.02	309.33
✿	08-048	18.52	304.84

Date August 2008

Project 408-88-00

THURBER

Prep'd MFA

Chkd. RPR

THURBALT 6417R.GPJ 8/27/08

Appendix C

Record of Borehole Sheets (Previous Investigation)

FORM DB-MT-126 (FORMERLY DB-ML-126)
65-1831

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS – ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 1

FOUNDATION SECTION

JOB 66-F-36 LOCATION N 201, 943.152; E 210, 780-802 ORIGINATED BY W.W.K.
W. P. 635-64 BORING DATE April 25, 1966 COMPILED BY W.E.
DATUM 1057.00 BOREHOLE TYPE WashBoring NX Casing CHECKED BY

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE
1057.0	Ground Level					
1054.5	Soft Org. Muck					
2.5	Silty Sand Very Loose to Very Dense		1	SS	1.5	
			2	SS	1.	1050
			3	SS	12	
			4	SS	35	1040
1036.0			5	SS	22	
21.0	Silty Clay With traces of Sand Very Stiff to Hard		6	SS	24	1030
			7	SS	47	
						1020
1015.5			8	SS	70	
41.5	End of Borehole					

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT 20 40 60 80 100
SHEAR STRENGTH P.S.F.

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT —— w
w_P w w_L
WATER CONTENT % 10 20 30

BULK DENSITY γ P.C.F.

REMARKS

Sand 87%
Silt 13%
▼W.L.
El. 1052.9
Observed in Casing

Sand 4%
Silt 46%
Clay 50%

FORM OB-MT-126 (FORMERLY OB-ML-126)
5-1831

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 2

FOUNDATION SECTION

JOB 66-F-36
W. P. 635-64
DATUM 1059.10
LOCATION N202,019-244; E210,780.990
BORING DATE April 26, 1966
BOREHOLE TYPE Penetration Only
ORIGINATED BY W.W.K.
COMPILED BY W.E.
CHECKED BY

SOIL PROFILE			SAMPLES				DYNAMIC PENETRATION RESISTANCE	LIQUID LIMIT — w_L		
ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	BLOWS / FOOT 20 40 60 80 100	PLASTIC LIMIT — w_P	WATER CONTENT — w	BULK DENSITY γ P.C.F.	REMARKS
1059.10	Ground Level						SHEAR STRENGTH P.S.F.	w_P w w_L			
0.0	Penetration Only					1050.0		WATER CONTENT %			
1048.10											
11.0	End of Penetration					1040.0					

FORM OB-MT-126 (FORMERLY OB-ML-126)
65-1831

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 3

FOUNDATION SECTION

JOB 66-F-36
W.P. 635-64
DATUM 1059.17

LOCATION N201, 956.644; E210, 820.195
BORING DATE April 25, 1966
BOREHOLE TYPE Penetration Only

ORIGINATED BY W.W.K.
COMPILED BY W.E.
CHECKED BY HL

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS / FOOT	ELEV. SCALE	DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT (20, 40, 60, 80, 100) / SHEAR STRENGTH P.S.F.	LIQUID LIMIT w_L / PLASTIC LIMIT w_P / WATER CONTENT w / WATER CONTENT %	BULK DENSITY γ P.C.F.	REMARKS
1059.17 0.0	Ground Level									
	Penetration Only					1050				
1043.17 16.0	End of Penetration					1040				

ORM OB-MT-126 (FORMERLY OB-ML-126)
S-1831

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS – ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 4

FOUNDATION SECTION

JOB 66-F-36 LOCATION N202, 035.485; E210, 817.127 ORIGINATED BY W.W.K.
W.P. 635-64 BORING DATE April 26, 1966 COMPILED BY W.E
DATUM 1058.14 BOREHOLE TYPE Washboring NX Casing CHECKED BY

LEV. / DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE
1058.14	Ground Level					
	Fill-Sand, Gravel Silt some rubbish Compact		1	SS	15	
1051.14 7.0	Silty Sand Very Loose to very Dense		2	SS	38	1050
			3	SS	70/6"	
1039.14 19.0	Clayey Silt with traces of Gravel and Sand Hard		4	SS	44	1040
			5	SS	50	1030
			6	SS	97	1020
1011.64			7	SS	92	
46.5	End of Borehole					1010

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT — 20 40 60 80 100
SHEAR STRENGTH P.S.F.

LIQUID LIMIT — w_L
PLASTIC LIMIT — w_P
WATER CONTENT — w
w_P w w_L
WATER CONTENT % 10 20 30

BULK DENSITY γ P.C.F.

REMARKS

Observed in casing
W.L. El. 1055.9
Gravel 1%
Sand 68%
Silt 30%
Clay 1%

Gravel 15%
Sand 31%
Silt 36%
Clay 18%

FORM OB-MT-126 (FORMERLY OB-ML-126)
55-1831

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS – ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 5

FOUNDATION SECTION

JOB 66-F-36 LOCATION N201. 982-013; E210,876.200 ORIGINATED BY W.W.K.
W.P. 635-64 BORING DATE April 26, 1966 COMPILED BY W.E.
DATUM 1055.83 BOREHOLE TYPE Washboring NX Casing CHECKED BY

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE
55.83	Ground Level					
	Fill - Dirt with Org. matter Loose		1	SS	6	1050
			2	SS	4	
45.63						
10.2	Clayey Silt with traces of Sand Hard		3	SS	45	
			4	SS	133	1040
			5	SS	64	
						1030
			6	SS	71	
						1020
14.3			7	SS	93	
41.5	End of Borehole					1010

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT 20 40 60 80 100
SHEAR STRENGTH P.S.F.

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT —— w
w_P w w_L
WATER CONTENT % 10 20 30

BULK DENSITY γ P.C.F.

REMARKS

W.L. El. 1050.6 Observed in casing
Gravel 2%
Sand 16%
Silt 55%
Clay 26%

FORM OB-MT-126 (FORMERLY OB-ML-126)
5-1831

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 6

FOUNDATION SECTION

JOB 66-F-36 LOCATION N202,072.140; E210,867.300 ORIGINATED BY W.W.K.

W.P. 635-64 BORING DATE April 27, 1966 COMPILED BY W.E.

DATUM 1052.31 BOREHOLE TYPE Penetration Only CHECKED BY

SOIL PROFILE			SAMPLES				DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100 SHEAR STRENGTH P.S.F.	LIQUID LIMIT w_L PLASTIC LIMIT w_P WATER CONTENT w w_P w w_L WATER CONTENT %	BULK DENSITY γ P.C.F.	REMARKS
ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE				
1052.31 0.0	Ground Level					1050				
	Penetration Only									
1042.31 10.0	End of Penetration					1040				

FORM 08-MT-126 (FORMERLY 08-ML-126)
65-1831

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS – ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 7

FOUNDATION SECTION

JOB 66-F-36 LOCATION N202,008.745 ; E210,928.182 ORIGINATED BY W.W.K.
W.P. 635-64 BORING DATE April 25, 1966 COMPILED BY W.E
DATUM 1055.45 BOREHOLE TYPE Penetration Only CHECKED BY

SOIL PROFILE			SAMPLES				DYNAMIC PENETRATION RESISTANCE	LIQUID LIMIT / PLASTIC LIMIT / WATER CONTENT		
ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	BLOWS / FOOT: 20 40 60 80 100 — SHEAR STRENGTH P.S.F.	w_L — w_P — w — WATER CONTENT %	BULK DENSITY γ P.C.F.	REMARKS
1055.45 0.0	Ground Level									
	Penetration Only					1050				
						1040				
1035.45 20.0	End of Penetration					1030				

FORM OB-MT-126 (FORMERLY OB-ML-126)
5-1831

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 8

FOUNDATION SECTION

JOB 66-F-36 LOCATION N202,097.448 ; E210,924.627 ORIGINATED BY W.W.K.
W.P. 635-64 BORING DATE April 27, 1966 COMPILED BY W.T.E.
DATUM 1050.32 BOREHOLE TYPE Washboring NX Casing CHECKED BY

LEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE
1050.32	Ground Level					
0.0	Fill - dirt, Sand Gravel, Silt Org. matter		1	SS	17	1050
			2	SS	8	
1040.12						
10.2	Silty Sand		3	SS	44	1040
1037.62	Dense					
12.7	Clayey Silt to Silty Clay		4	SS	60	
	With Traces of Sand		5	SS	52	1030
	Hard		6	SS	67	
			7	SS	83	1020
			8	SS	77	
						1010
1003.7			9	SS	83	
46.5	End of Borehole					

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT 20 40 60 80 100
SHEAR STRENGTH P.S.F.

LIQUID LIMIT — w_L
PLASTIC LIMIT — w_P
WATER CONTENT — w
w_P w w_L
WATER CONTENT % 10 20 30

BULK DENSITY γ P.C.F.

REMARKS

▼W.L. El. 1048.1 Observed in Casing
Gravel 1%
Sand 55%
Silt 42%
Clay 2%

FORM OB-MT-126 (FORMERLY OB-ML-126)
65-1831

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 9

FOUNDATION SECTION

JOB 66-F-36 LOCATION N202,027.085 ; E210,978.412 ORIGINATED BY W.W.K.
W.P. 635-64 BORING DATE April 22, 1966 COMPILED BY W.T.E.
DATUM 1054.65 BOREHOLE TYPE Washboring NX Casing CHECKED BY

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE	REMARKS
1054.65	Ground Level						
0.0	Fill - Dirt, Sand Gravel, Silt, Clay and Org. Matter		1	SS	4	1050	
			2	SS	3		W.L. El. 1049.1 Observed in casing
			3	SS	90Rock		
1039.65						1040	
15.0	Clayey Silt to Silty Clay with Traces of Sand Very Stiff to Hard		4	SS	25		Gravel 4% Sand 6% Silt 31% Clay 59%
			5	SS	45	1030	
			6	SS	46		Sand 15% Silt 59% Clay 26%
			7	SS	43		
			8	SS	62	1020	
1008.7						1010	
46.5	End of Borehole		9	SS	75		

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT — 20 40 60 80 100
SHEAR STRENGTH P.S.F.

LIQUID LIMIT — w_L
PLASTIC LIMIT — w_P
WATER CONTENT — w
w_P w w_L
WATER CONTENT % 10 20 30

BULK DENSITY P.C.F.

FORM OB-MT-126 (FORMERLY OB-ML-126)
15-1831

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 10

FOUNDATION SECTION

JOB 66-F-36
W.P. 635-64
DATUM 1047.16

LOCATION N202,127.811 ; E210,968.988
BORING DATE April 27, 1966
BOREHOLE TYPE Penetration Test Only

ORIGINATED BY W.K.
COMPILED BY W.E.
CHECKED BY HL

SOIL PROFILE			SAMPLES				DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100 SHEAR STRENGTH P.S.F.	LIQUID LIMIT w_L PLASTIC LIMIT w_P WATER CONTENT w WATER CONTENT %	BULK DENSITY γ P.C.F.	REMARKS
ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE				
1047.16 0.0	Ground Level									
	Penetration Only					1040				
1035.16 12.0	End of Penetration					1030				

ORM OB-MT-126 (FORMERLY OB-ML-126)
5-1831

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 11

FOUNDATION SECTION

JOB 66-F-36 LOCATION N 202,047.765 ; E 211,023.985 ORIGINATED BY W.W.K.
W.P. 635-64 BORING DATE April 22, 1966 COMPILED BY W.E.
DATUM 1055.14 BOREHOLE TYPE Penetration Test Only CHECKED BY

LEV. / EPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS / FOOT	ELEV. SCALE
55.14	Ground Level					
0.0	Penetration Only					1050
						1040
37.14						
8.0	End of Penetration					1030

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT 20 40 60 80 100
SHEAR STRENGTH P.S.F.

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT —— w
w_P w w_L
WATER CONTENT %

BULK DENSITY γ P.C.F.

REMARKS

)RM OB-MT-126 (FORMERLY OB-ML-126)
5-1831

OFFICE REPORT ON SOIL EXPLORATION

)EPARTMENT OF HIGHWAYS - ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 12

FOUNDATION SECTION

)OB 66-F-36 LOCATION N 202, 137.137 ; E 211, 029.292 ORIGINATED BY W.W.K.
W.P. 635-64 BORING DATE April 28, 1966 COMPILED BY W.E.
)ATUM 1055.20 BOREHOLE TYPE Washboring NX Casing CHECKED BY

LEV. / EPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE
55.20 / 0.0	Ground Level					
49.7 / 5.5	Fill - Dirt with Org. matter Loose		1	SS	10	1050
44.7 / 10.5	Silty Sand Compact		2	SS	11	
	Clayey Silt to Silty Clay With traces of Sand Very Stiff to Hard		3	SS	30	1040
			4	SS	88	
			5	SS	85	1030
			6	SS	52	
)13.7			7	SS	105	1020
41.5	End of Borehole					1010

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT — 20 40 60 80 100
SHEAR STRENGTH P.S.F.

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT —— w
w_P w w_L
WATER CONTENT % 10 20 30

BULK DENSITY γ P.C.F.

REMARKS

W.L. El 1050.9 Observed in Casing

Gravel 3%
Sand 30%
Silt 43%
Clay 24%

FORM OB-MT-126 (FORMERLY OB-ML-126)
65-1831

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS – ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 13

FOUNDATION SECTION

JOB 66-F-36 LOCATION N 202,076.079 ; E 211, 099.123 ORIGINATED BY W.W.K.
W.P. 635-64 BORING DATE April 21, 1966 COMPILED BY W.E.
DATUM 1056.18 BOREHOLE TYPE Washboring NX Casing CHECKED BY

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE
1056.18	Ground Level					
1056.18	Black Org. Topsoil					
1.0	Silty Sand Loose to Compact		1	SS	8	1050
			2	SS	30	
1042.18						
14.0	Clay Silt to Silty Clay With Traces of Sand Hard		3	SS	35	1040
			4	SS	96	
			5	SS	103	1030
			6	SS	67	
			7	SS	91	1020
1014.5			8	SS	89	
41.5	End of Borehole					1010

DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100
SHEAR STRENGTH P.S.F.

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT —— w
w_P w w_L
WATER CONTENT % 10 20 30

BULK DENSITY γ P.C.F.

REMARKS

Observed in Casing
W.L. El. 1051.1

Gravel 1%
Sand 90%
Silt 9%
Clay

Sand 2%
Silt 35%
Clay 63%

FORM OB-MT-126 (FORMERLY OB-ML-126)
5-1831

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS – ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 14

FOUNDATION SECTION

OB 66-F-36 LOCATION N 202,169.581 ; E 211, 097.176 ORIGINATED BY W.W.K.
W.P. 635-64 BORING DATE April 29, 1966 COMPILED BY W.E
DATUM 1055 - 68 BOREHOLE TYPE Penetration Test Only CHECKED BY

SOIL PROFILE			SAMPLES				DYNAMIC PENETRATION RESISTANCE BLOWS / FOOT 20 40 60 80 100 SHEAR STRENGTH P.S.F.	LIQUID LIMIT w_L PLASTIC LIMIT w_P WATER CONTENT w w_P w w_L WATER CONTENT %	BULK DENSITY γ P.C.F.	REMARKS
ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	BLOWS / FOOT	ELEV. SCALE				
55.68 / 0.0	Ground Level									
	Penetration Only					1050				
						1040				
37.43 / 18.25	End of Penetration									
						1030				

ORM OB-MT-126 (FORMERLY OB-ML-126)
5-1831

OFFICE REPORT ON SOIL EXPLORATION

DEPARTMENT OF HIGHWAYS – ONTARIO
MATERIALS & TESTING DIVISION

RECORD OF BOREHOLE NO. 15

FOUNDATION SECTION

JOB 66-F-36 LOCATION N 202,142.976 ; E 210,823.216 ORIGINATED BY W.W.K.
W.P. 635-64 BORING DATE April 26, 1966 COMPILED BY W.E.
DATUM 1049.47 BOREHOLE TYPE Washboring NX Casing CHECKED BY

ELEV. / DEPTH	DESCRIPTION	STRAT. PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS / FOOT	ELEV. SCALE
1049.47	Ground Level					
1048.47	Black Org. Topsoil					
1.0						
	Silty Sand Compact to very Dense		1	SS	40	
			2	SS	25	1040
1036.47			3	SS	80	
13.0						
	Clayey Silt to Silty Clay with Traces of Sand Hard		4	SS	80	
						1030
			5	SS	60/4"	
			6	SS	100	
						1020
1012.8			7	SS	97	
36.6	End of Borehole					1010

DYNAMIC PENETRATION RESISTANCE
BLOWS / FOOT 20 40 60 80 100
SHEAR STRENGTH P.S.F.

LIQUID LIMIT —— w_L
PLASTIC LIMIT —— w_P
WATER CONTENT —— w
w_P w w_L
WATER CONTENT % 10 20 30

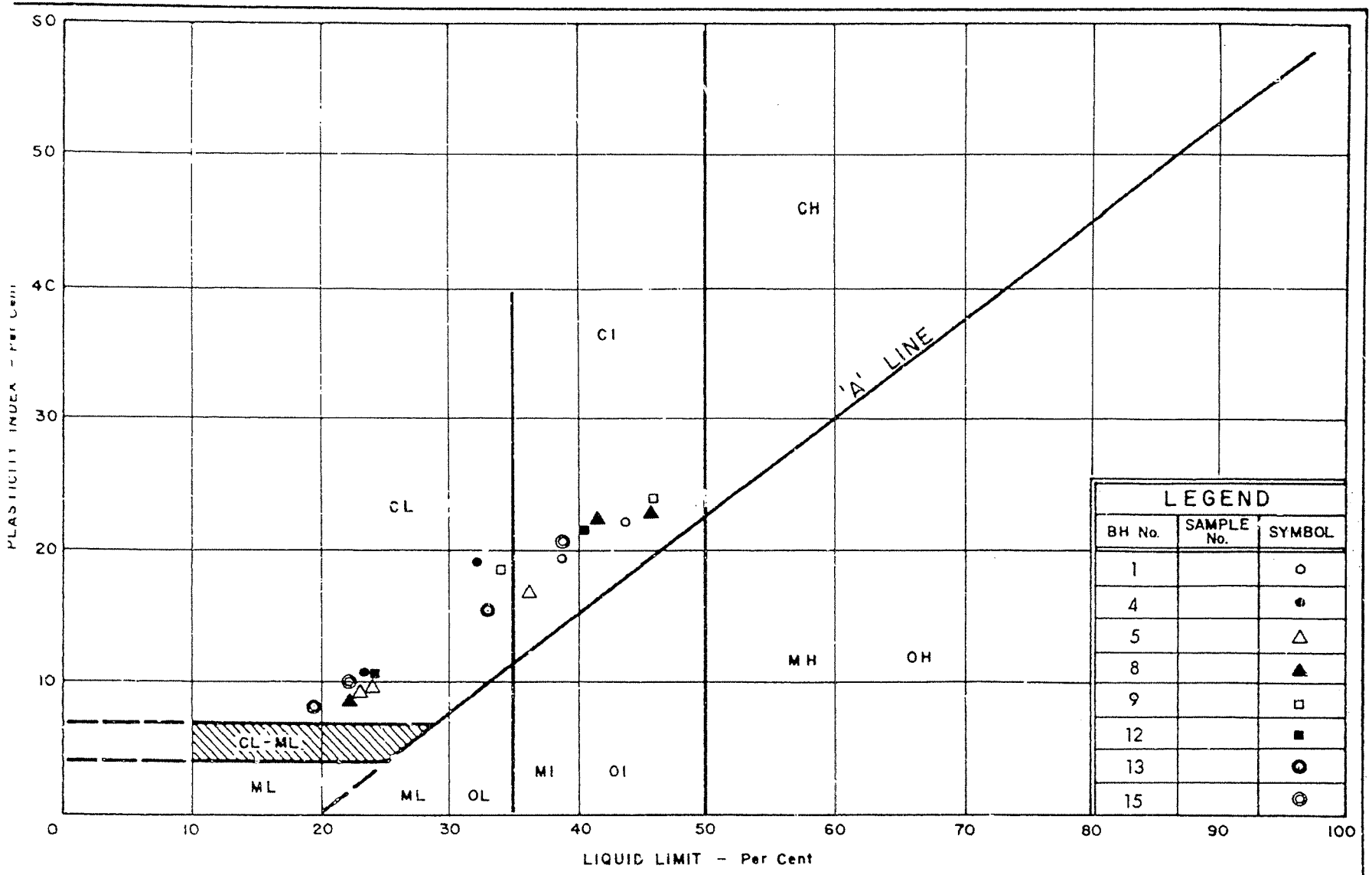
BULK DENSITY γ P.C.F.

REMARKS

W.L. El. 1047.7 Observed in Casing

Gravel 3%
Sand 36%
Silt 40%
Clay 21%

M 08-MT-252
(JUNE 1965)



DEPARTMENT OF HIGHWAYS
MATERIALS and TESTING DIVISION
ONTARIO

PLASTICITY CHART

W.P. No. 635-64
JOB No. 66-F-36

Appendix D

Foundation Comparison

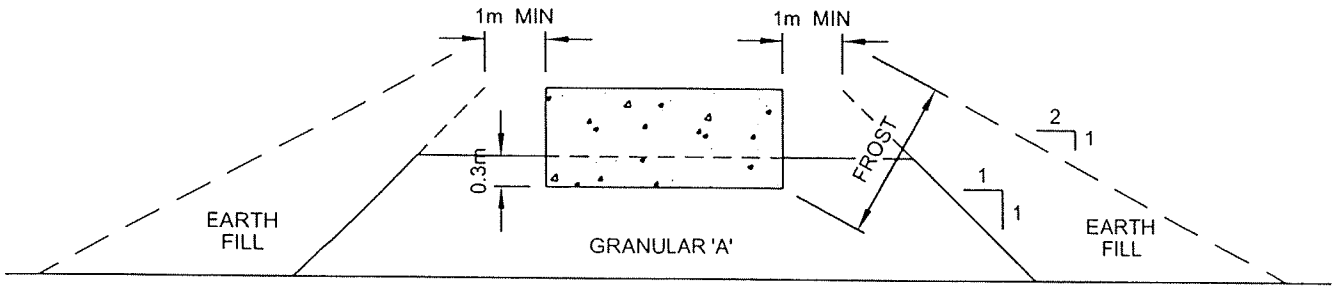
COMPARISON OF FOUNDATION ALTERNATIVES FOR EACH FOUNDATION ELEMENT

Foundation Element	Spread Footings	Spread Footings on Engineered Fill	Driven Piles
Abutments	*Advantages:* i. Generally less costly construction than deep foundation elements. *Disadvantages:* i. Lower geotechnical resistance available due to founding on compact soils near the surface. ii. Dewatering may be required, depending on depth of excavation. **NOT RECOMMENDED**	*Advantages:* i. Generally less costly construction than deep foundation elements. *Disadvantages:* i. Better geotechnical resistance than spread footings on native, but still influenced by the compact soils at the surface. ii. Dewatering may be required, depending on depth of excavation. **NOT RECOMMENDED**	*Advantages:* i. High geotechnical resistance may be developed by driving the piles into hard soils. ii. Comparatively short abutment stem possible iii. Permits integral abutment design *Disadvantages:* i. Higher unit cost compared to footings. **RECOMMENDED**

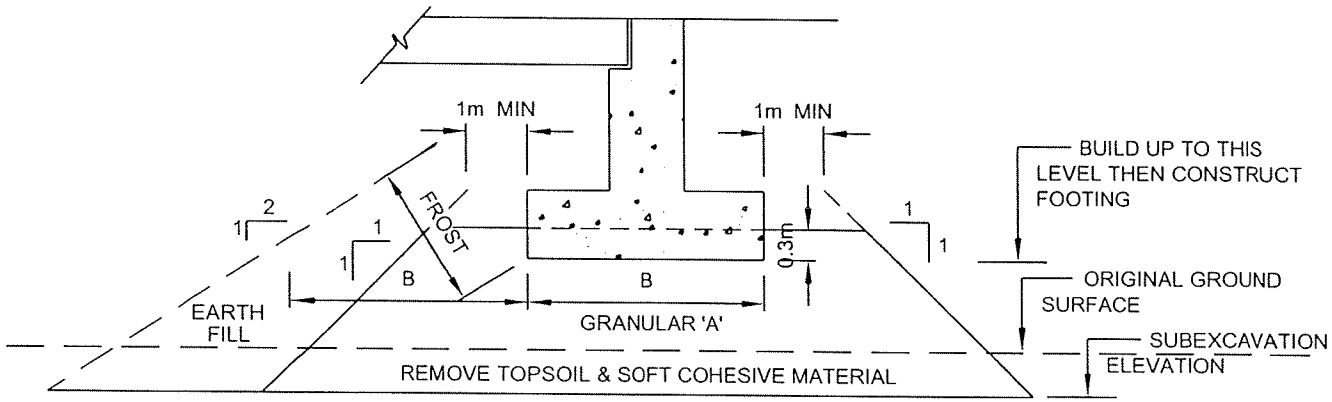
Appendix E

Figure

March , 2004



CROSS-SECTION



LONGITUDINAL SECTION

NOT TO SCALE

NOTES:

1. REMOVE TOPSOIL AND SOFT SILTY CLAY SUBSOIL UNDER FOOTPRINT OF COMPACTED GRANULAR 'A'.
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		DWG. NO. FIGURE 1
APPROVED PKC		
SCALE NTS		

TED35146.DWG

Appendix F

Site Photographs

Photo 1. Looking west along Victoria Street – East Abutment (Borehole 08-048)

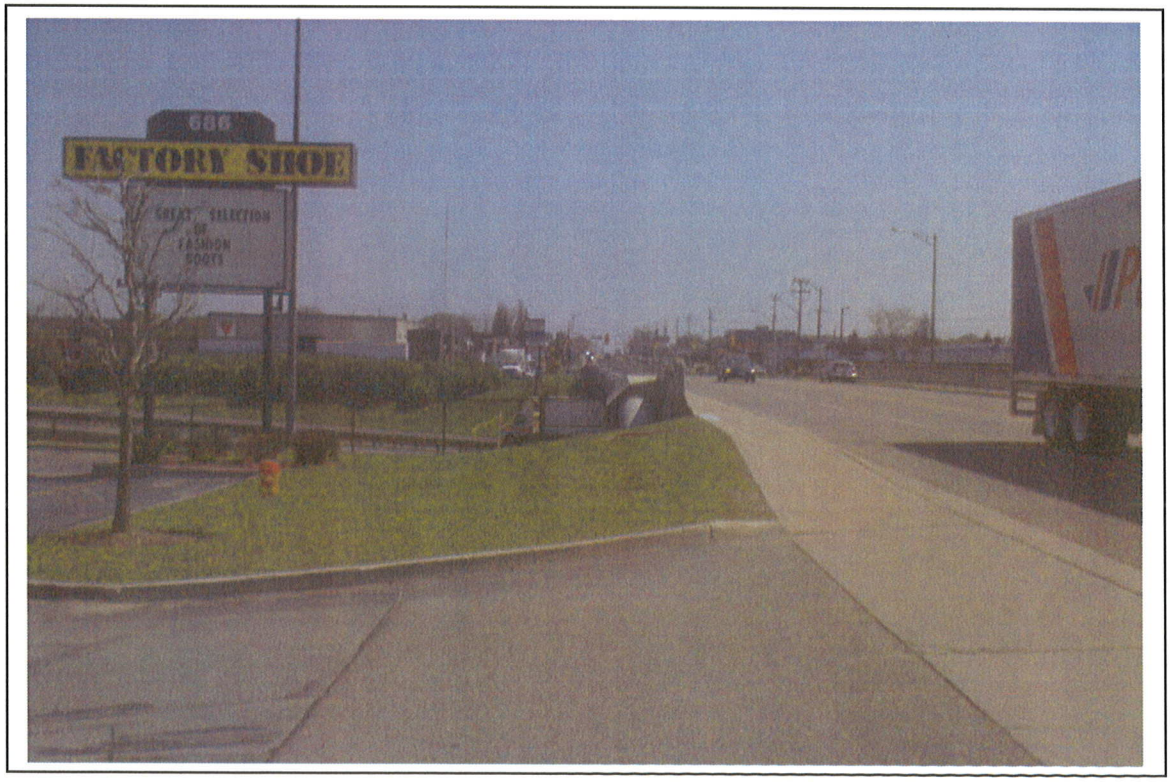
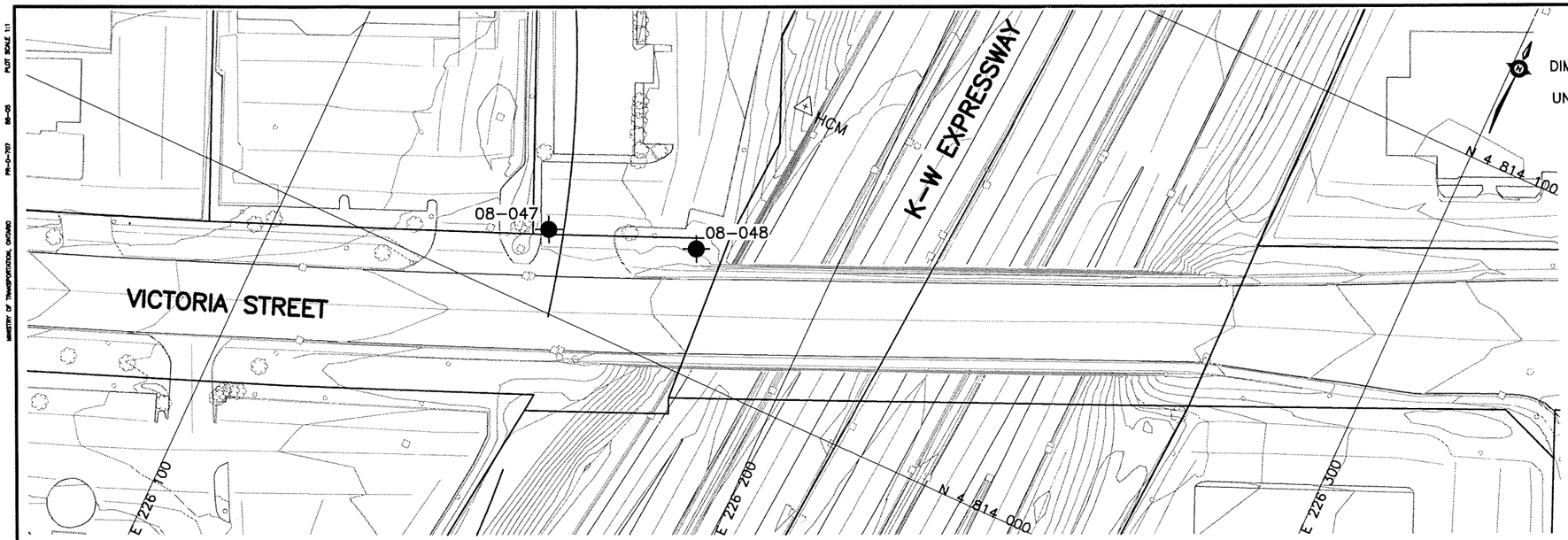


Photo 2. Looking east along Victoria Street – West Abutment (Borehole 08-047)

Appendix G

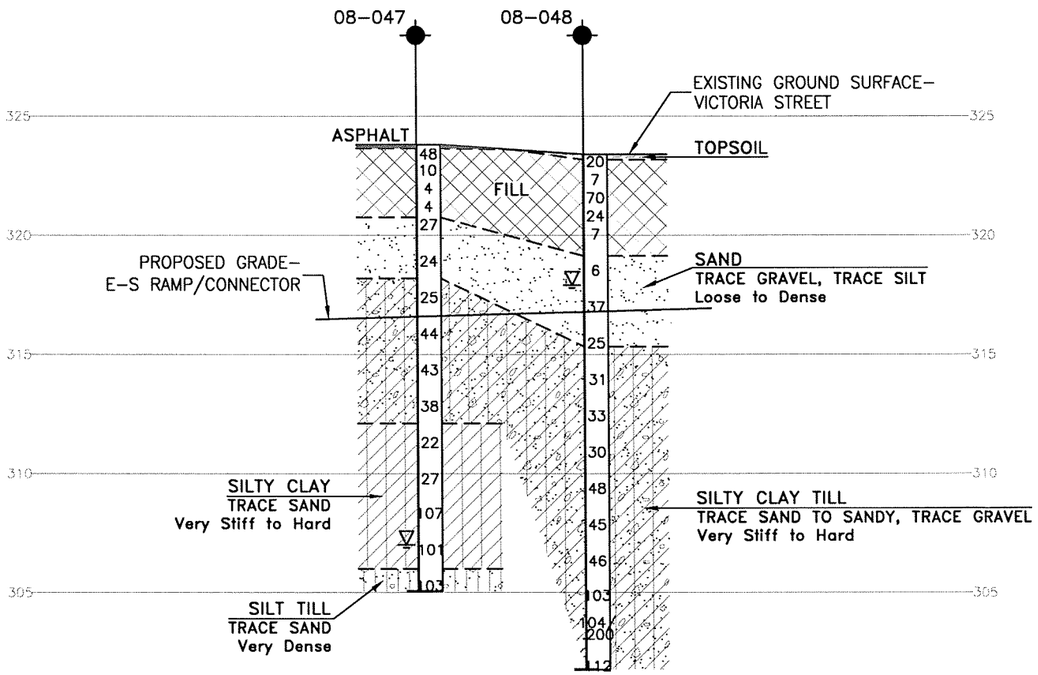
Drawing titled "Borehole Locations and Soil Strata"



PLAN

0 20 40 60m

SCALE 1:1000



PROFILE ALONG ℄ OF VICTORIA STREET

0 20 40 60m HOR 1:1000

0 5 10 15m VER 1:250

DRAWING NOT TO BE SCALED
100 mm ON ORIGINAL DRAWING

METRIC

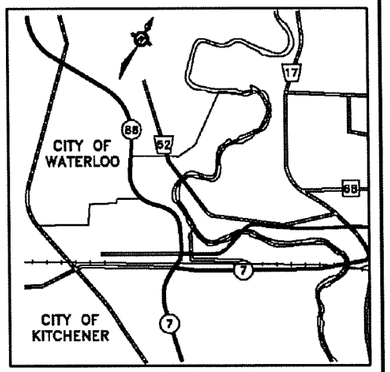
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

CONT No
GWP No 408-88-00

SHEET

HIGHWAY 7
RECOMMENDED ROUTE
E-S RAMP/CONNECTOR UNDER VICTORIA ST.
BOREHOLE LOCATIONS AND SOIL STRATA

THURBER ENGINEERING LTD.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS



KEYPLAN

LEGEND

●	Borehole
⊕	Borehole and Cone
N	Blows /0.3m (Std Pen Test, 475J/blow)
CONE	Blows /0.3m (60° Cone, 475J/blow)
PH	Pressure, Hydraulic
▽	Water Level
▼	Head Artesian Water
	Piezometer
90%	Rock Quality Designation (RQD)
A/R	Auger Refusal

NO	ELEVATION	NORTHING	EASTING
08-047	323.8	4 814 014.7	226 147.7
08-048	323.4	4 814 023.0	226 174.5

-NOTES-

1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
3) Proposed grades are from Plate 2B of the E.A. Study.

GEOCRES No. 40P8-158

REVISIONS		
DATE	BY	DESCRIPTION

DESIGN	AEG	CHK	PKC	CODE	LOAD	DATE NOV. 2009
DRAWN	MFA	CHK	AEG	SITE	STRUCT	DWG

MINISTRY OF TRANSPORTATION, ONTARIO PH-D-707 08-05 PLOT SCALE 1:1

FILENAME: H:\Drafting\15\64\17\1ed6417-Ramps(047,048).dwg
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