FOUNDATION INVESTIGATION AND DESIGN REPORT
BATCHAWANA RIVER BRIDGE REHABILITATION
Highway 17, Site 38S-007
G.W.P. 5112-05-00
Township of Fisher

Geocres Number: 41K-88

Report to

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PART 1: FACTUAL INFORMATION

1. INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted at the site of the Batchawana River Bridge, located on Highway 17 approximately 5 km south of Highway 563 in the Township of Fisher, Ontario. The investigation was undertaken for the proposed rehabilitation of the bridge at this location.

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 was developed from the data obtained in the course of the investigation.

Thurber carried out the investigation as a sub-consultant to McCormick Rankin Corporation, under the Ministry of Transportation Ontario (MTO) Agreement Number 5009-E-0032.

In the preparation of this report and in addition to the boreholes drilled under the current assignment, reference has been made to information on subsurface conditions contained in a previous foundation report. The title of this report is listed as follows:

- Foundation Investigation Report for Batchawana River Bridge Detour, W.P. 910-62-09, Str. Site 38S-7, Highway 17, District 18, Sault Ste. Marie, Dated December 4, 1987. (Reference 1).

2. SITE DESCRIPTION

The Batchawana River Bridge is located north of Sault Ste Marie on Highway 17 approximately 5 km south of Highway 563 in the Township of Fisher. At present, the highway crosses the Batchawana River on a five-span structure supported on concrete filled sheet pile cells.

The Batchawana River flows south and discharges into Batchawana Bay of Lake Superior. The river channel is approximately 85 m wide at the bridge location. The surrounding area is relatively flat within the bay area.

The area to the west of the bridge is heavily treed. A few residential and commercial dwellings are located along Highway 17 on the east side of the Batchawana River bridge. A boat launch area is located on the northwest side of the bridge. Overhead transmission lines cross the river on the north side of the existing bridge.

Photographs of the site included in Appendix G show the general nature of the surrounding land:

1. General view of the Batchawana River bridge
2. Existing conditions of bridge deck
3. Bridge approach embankment

Physiographically, the site lies within the Canadian Shield, characterized by Precambrian meta-volcanic and meta-sedimentary rocks intruded by later stage diabase dykes. In some areas the Precambrian rocks are covered by sedimentary rocks of the Huronian Supergroup. The bedrock is mantled by glaciolacustrine varved clays and sand and gravel deposits.

3. SITE INVESTIGATION AND FIELD TESTING

The present site investigation and field testing for this project was carried out between October 21 and November 1, 2010 and consisted of drilling and sampling a total of eight boreholes (numbered BW-01 to BW-08) at the foundation elements. Four boreholes were drilled near the existing bridge abutments and four near the pier locations through the bridge deck.

A Dynamic Cone Penetration Test (DCPT) was performed from the bottom of each borehole to depths ranging from 24.3 m to 50.9 m below the existing highway grade. An additional DCPT was performed adjacent to Borehole BW-07 from ground surface to a depth of 20.1 m.

The borehole locations and termination depths are indicated in Table 3.1.

Table 3.1 – Borehole locations and termination depths

Foundation Unit	Borehole	Borehole termination depth/ elevation[1] (m)	DCPT termination depth/elevation[1,2] (m)
West Abutment	BW-01	12.8/173.5	24.3/162.0
	BW-02	43.3/143.1	43.8/142.6
Pier 1	BW-03	41.4/145.1	43.8/142.7
Pier 2	BW-04	41.7/144.9	44.4/142.1
Pier 3	BW-05	41.7/144.8	42.9/143.6
Pier 4	BW-06	41.6/144.9	44.9/141.6
East Abutment	BW-07	43.3/143.1	50.9/135.4
	BW-07D	-	20.1/166.2
	BW-08	12.8/173.5	25.0/161.3

(1) Depths/elevations for boreholes drilled at the pier locations were obtain from top of bridge deck. (Approx. distance from bridge deck to Batchawana River bed: 7.1 m – 7.4 m)

(1,2) DCPTs were terminated upon cone refusal

The approximate locations of the boreholes are shown on the attached Borehole Locations and Soil Strata Drawing in Appendix H. Record of Sheets of Boreholes BW-01 to BW-08 drilled during the present investigation are attached in Appendix A.

The coordinates and elevations of Boreholes BW-01 to BW-08 are given on the drawing and on the individual Record of Borehole Sheets.

Records of Boreholes 1 to 8 drilled during the previous investigation, for a proposed detour structure at the Batchawana river bridge, (Reference 1) and their respective laboratory test results are enclosed in Appendix C.

Prior to commencement of drilling, utility clearances were obtained for all borehole locations. Road occupancy permits were obtained for boreholes drilled on the existing Highway 17 platform.

The drilling was carried out from the highway grade using a CME75 truck-mounted drill rig. A combination of hollow stem auger, casing and mud rotary drilling techniques were used to advance the boreholes. Samples were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT) in the overburden soils.

Groundwater conditions in the open boreholes were observed throughout the drilling operations. Two standpipe piezometers consisting of 19 mm PVC pipe with a slotted screen were installed in Boreholes BW-02 and BW-07. The locations and completion details of the boreholes and piezometers are shown in Table 3.2.

Table 3.2 – Borehole Completion Details

Location	Borehole	Details	
		Piezometer Tip Depth/ Elevation (m)	Completion Details
West Abutment	BW-01	None installed	Backfilled with bentonite holeplug to 9.1 m, cuttings from 9.1 m to 50 mm and asphalt to surface.
	BW-02	41.1/145.2	Piezometer with 1.5 m slotted screen installed with sand filter to 39.0 m, bentonite holeplug from 39.0 m to 29.0 m, drill cuttings from 29.0 m to 1.5 m, bentonite from 1.5 m to 0.15 m, sand from 0.15 m to 75 mm, and asphalt to surface. Flushmount cover installed.
Pier 1	BW-03	None installed	Borehole caved in below river bed depth. Borehole at bridge deck backfilled with 275 mm of concrete, then 25 mm of asphalt to surface.
Pier 2	BW-04	None installed	Borehole caved in below river bed depth. Borehole at bridge deck backfilled with 275 mm of concrete, then 25 mm of asphalt to surface.
Pier 3	BW-05	None installed	Borehole caved in below river bed depth. Borehole at bridge deck backfilled with 275 mm of concrete, then 25 mm of asphalt to surface.
Pier 4	BW-06	None installed	Borehole caved in below river bed depth. Borehole at bridge deck backfilled with 275 mm of concrete, then 25 mm of asphalt to surface.
East Abutment	BW-07	42.7/143.7	Piezometer with 3.0 m slotted screen installed with sand filter to 39.2 m, bentonite holeplug from 39.2 m to 36.9 m, drill cuttings from 36.9 m to 6.1 m, bentonite from 6.1 m to 80 mm, and asphalt to surface. Flushmount cover installed.
	BW-08	None installed	Backfilled with bentonite holeplug to 40 mm then asphalt to surface.

4. LABORATORY TESTING

The recovered soil samples were subjected to Visual Identification (VI) and to natural moisture content determination. Selected samples were also subjected to grain size distribution analyses (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 are presented in this appendix and on the "Borehole Locations and Soil Strata"

drawing in Appendix H. 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.

The stratigraphy encountered in the boreholes of the east and west abutments consisted of pavement structure over sand fill, overlying extensive deposits of native sand, silt and sandy silt. At the west abutment a deposit of silty clay was encountered underneath the silt deposit.

The stratigraphy encountered below the river bed (boreholes drilled through the bridge deck at each pier location) consisted of an extensive sand deposit overlying deposits of silt and sandy silt.

5.1 Pavement structure

Pavement structure consisting of approximately 50 mm of asphalt overlying granular (sand and gravel fill) road base was encountered in Boreholes BW-01, BW-02, BW-07 and BW-08 drilled through existing Highway 17 lanes at the east and west abutments. Boreholes BW-02 and BW-07 encountered 450 mm of concrete below the asphalt. The concrete is underlain by granular fill.

Boreholes BW-03 to BW-06 drilled through the bridge deck, in close proximity to the piers, revealed 25 mm of asphalt overlying 275 mm of concrete.

5.2 Fill

Fill was contacted below the pavement structure in Boreholes BW-01, BW-02, BW-07 and BW-08 drilled at the east and west abutments. The fill generally consists of brown sand containing trace to some gravel, trace to some silt and clay and occasional cobbles and boulders.

The thickness of the fill ranged from 1.8 m to 3.0 m.

The depth to the base of the fill varied from 2.3 m to 3.0 m (Elevations 183.3 to 184.1).

During the previous investigation for the detour bridge, granular fill was contacted at the east and west approaches in Boreholes 1, 4 and 5. The thickness of the fill ranged from 1.7 m to 1.8 m.

SPT 'N' values recorded in the cohesionless fill ranged from 42 to 3 blows per 0.3 m penetration indicating a dense to very loose relative density.

The moisture content of the fill ranged from 4% to 17%.

Grain size distribution curves for samples of sand fill tested are presented on the Record of Borehole sheet and on Figure B1 of Appendix B. The results of the laboratory test are summarized as follows:

Soil Particles	(%)
Gravel	0 to 2
Sand	77 to 96
Silt and Clay	2 to 22

5.3 Sand

An extensive deposit of native sand containing trace to some gravel, trace to some silt and clay and occasional cobbles was contacted below the fill at 2.3 m to 3.0 m depth (elevations 183.3 to 184.1) in boreholes drilled at the abutments (Boreholes BW-01, BW-02, BW-07 and BW-08). The native sand was contacted from the river bed level at elevations 179.1 to 179.4 in boreholes drilled at the pier locations (Boreholes BW-03 to BW-06). The sand was generally brown becoming grey with depth.

In Boreholes 1 to 8, previously drilled, the native sand was contacted at elevations ranging from 183.5 to 183.9 at the abutments and at elevations ranging from 178.8 to 179.8 at the piers.

Layers of gravelly sand and silty sand were encountered within the sand at various depths.

The thickness of the native sand ranged from 21.0 m to 28.0 m.

Boreholes BW-01 and BW-08 drilled at the west and east abutments were terminated within the native sand layer at 12.8 m depth (Elevation173.5). The thickness of the sand is anticipated to be greater than 10.0 m at these locations.

The depth to the base of the sand was 30.5 m and 20.5 m (Elevations 155.9 and 157.9) below ground surfaces in Boreholes BW-02 and BW-07 drilled at the abutments.

The depth to the base of the sand varied from 21.1 m to 23.2 m (elevations 155.9 to 158.1) below the river bed in Boreholes BW-03 to BW-06 drilled at the piers.

SPT 'N' values recorded in the sand generally ranged from 1 to 43 blows per 0.3 m penetration indicating a very loose to dense relative density.

An SPT 'N' value of 58 blows per 0.3 m of penetration indicating a very dense relative density was measured with the gravelly sand layer near elevation 177.0 in Borehole BW-02.

The moisture content of the sand ranged from 8% to 30%. A high moisture content of 58% was measured near elevation 178.8 in Borehole BW-05.

Grain size distribution curves for samples of the sand deposit and silty sand and gravelly sand layers tested are presented on the Record of Borehole sheet and on Figure B2 to B8 of Appendix B. The results of the laboratory test are summarized as follows:

Soil Particles	Sand (%)	Silty sand (%)	Gravelly sand (%)
Gravel	0 to 18	0	23 to 37
Sand	79 to 97	34 to 76	59 to 75
Silt and Clay	1 to 21	24	2 to 4
Silt	-	29 to 61	-
Clay	-	2 to 5	-

5.4 Silt and sandy silt

Native grey silt containing trace gravel, trace to some sand and trace to some clay was contacted below the sand in Boreholes BW-02 to BW-07.

The thickness of the silt layer was 4.9 m and 6.7 m in Boreholes BW-02 and BW-03, respectively.

The depth to the base of the silt was 35.4 m and 29.8 m (elevations 151.0 and 149.4) in Boreholes BW-02 and BW-03, respectively.

Boreholes BW-04 to BW-06 were terminated within the silt layer at depths ranging from 34.2 m to 34.6 m (elevations 144.8 to 144.9), below the river bed.

In Boreholes BW-02 and BW-03, a layer of grey sandy silt containing trace clay was contacted at 41.3 m and 29.8 m depth (elevations 145.0 and 149.4), respectively. Both boreholes were terminated within the sandy silt at 43.3 m and 34.1 m depth (elevations 143.1 and 145.1), respectively.

SPT 'N' values recorded in the silt and sandy silt layers generally ranged from 19 to 78 blows for 0.3 m of penetration, indicating compact to very dense relative density. Low SPT 'N' values of 7 and 15 blows per 0.3 m of penetration were measured at elevation 157.5 in Boreholes BW-04 and BW-05.

The measured moisture contents in the silt and sandy silt range from 17% to 22%.

DCPTs were conducted below borehole termination depths and extended to cone refusal at depths presented in Table 3.1.

Grain size distribution curves for samples of silt and sandy silt tested are presented on the Record of Borehole sheets and on Figures B10 and B11 of Appendix B. The results of the laboratory test are summarized as follows:

Soil Particles	Silt (%)	Sandy silt (%)
Gravel	0 to 1	0
Sand	0 to 20	30 to 34
Silt	67 to 91	61 to 65
Clay	5 to 13	5

5.5 Silty Clay

A layer of reddish brown to grey silty clay containing trace sand was encountered underneath the silt layer at 35.4 m depth (elevation 151.0) in Borehole BW-02 drilled at the west abutment.

The thickness of the silty clay was 5.9 m.

The depth to the base of the silty clay was 41.3 m (elevation 145.0).

SPT 'N' values measured in the silty clay were 13 to 15 blows per 0.3 m of penetration, indicating a stiff consistency.

Moisture contents in the silty clay ranged from 19% to 39%.

Grain size distribution curves for two samples of silty clay tested are presented on the Record of Borehole sheet and on Figure B9. Atterberg Limits test results are presented on Figure B12 of Appendix B.

The results of the laboratory tests are summarized as follows:

Soil Particles	(%)
Gravel	0
Sand	1 to 3
Silt	20 to 24
Clay	73 to 79

Index Property	(%)
Liquid Limit	58 to 59
Plastic Limit	21 to 23

The above results show that the silty clay is typically of high plasticity with a group symbol of CH.

5.6 Water Levels

Water levels were observed in the boreholes during and upon completion of drilling. Two standpipe piezometers were installed in two boreholes to monitor water levels after

completion of drilling. The water levels measured in the piezometers are summarized in Table 5.1, along with the measurements in the boreholes upon completion of drilling.

Level Measurements

Foundation Unit	Borehole	Date	Water Level (m)		Comment
			Depth	Elevation	
West Abutment	BW-02	-	-	-	Unable to locate piezometer. It may have been destroyed after installation.
East Abutment	BW-07	November 28, 2010	3.4	183.0	In piezometer

During drilling operations, water levels measured at the Batchawana River were generally 3.2 m to 3.7 m below the bridge deck.

Reference 1 indicates that water level measured in the Batchawana River was at elevation 183.2 in June 1987. Piezometric reading indicates that water level is at elevation 183.0

The above values are short-term readings and 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

Borehole locations were selected and established in the field by Thurber Engineering Ltd. Surveyors from MMM Group Limited obtained the co-ordinates and the ground surface elevations at each borehole.

Thurber obtained utility clearances for the borehole locations prior to drilling.

Eastern Ontario Diamond Drilling of Hawkesbury, 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 Ms. Eckie Siu of Thurber.

Routine laboratory testing was carried out by Thurber Engineering Ltd.

Overall supervision of the field program was conducted by Mr. Alastair E. Gorman, P.Eng. and Mr. Lukasz Gilarski, E.I.T. Interpretation of the data and preparation of the report were carried out by Mr. Alastair E. Gorman, P.Eng., Mr. Lukasz Gilarski, E.I.T. 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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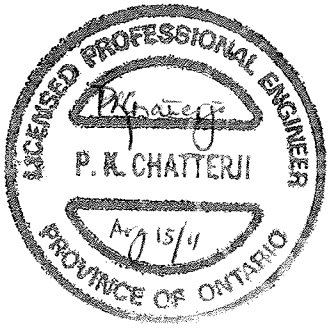

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PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

7. GENERAL

This report presents interpretation of the geotechnical data in the factual report and presents geotechnical assessment of the existing foundations for rehabilitation of the Batchawana River bridge in the Township of Fisher, Sault Ste. Marie Area.

The Batchawana River bridge was constructed in 1941 and rehabilitated in 1990 and 2001. Based on the General Arrangement (GA) drawing provided by McCormick Rankin Corporation (MRC), the existing structure consists of five continuous steel girder spans (16.3 m long end spans, 19.3 long interior spans and 20.8 m long middle span) with a reinforced concrete deck slab carrying Highway 17 over the Batchawana River. The length of the bridge is approximately 92.0 m between abutments. The bridge is supported on two abutments and four intermediate piers.

Available drawings show that originally, the piers and abutments were each supported on two sheet piles cells filled partially with concrete. The original drawings show that "soft material" was to be removed from inside the caissons. Rehabilitation drawings indicate that treated timber piles were subsequently installed to support abutment extensions.

The proposed bridge rehabilitation program will include the following:

- Staged girder, deck and diaphragm replacement
- Resurfacing of the abutment, pile caps and ballast walls
- Retrofitting bridge to semi-integral abutments

Communication from MRC states that the proposed rehabilitation will not increase loading on the existing foundation. The purpose of the present investigation is to assess the available geotechnical capacity of the existing foundations and to compare it to the required capacity.

The discussions and recommendations presented in this report are based on information provided by McCormick Rankin Corporation and on the factual data obtained in the course of this investigation.

8. EVALUATION OF STRUCTURE FOUNDATIONS

The stratigraphy encountered in the four boreholes drilled during the present investigation at the east and west abutments revealed pavement structure overlying 2.3 m to 3.0 m of sand fill underlying extensive deposits of loose to compact native sand underlain by silt and sandy silt. A layer of silty clay was contacted below the sand layer in one borehole drilled at the west abutment.

The stratigraphy at the pier locations consisted of extensive native layers of loose to compact sand underlain by silt and sandy silt. The thickness of the sand deposit ranged from 21.0 m to 28.0 m.

Piezometric reading indicates that water level is at elevation 183.0. Water level measured in the Batchawana River was at elevation 183.2 in June 1987.

8.1 Existing foundations

The foundation information on the original design drawing has been converted to SI units and is summarized as follows:

Table 8.1 – Foundation Loads

		Each Pier Caisson	Each Abutment Caisson
Description		12 pieces of steel sheet piling. Enclosing reinforced concrete.	4 pieces of steel sheet piling. Enclosing reinforced concrete.
Area of caisson		1.9 m^2	0.315m^2
Equivalent Caisson diameter		1.5 m	0.6 m
Length		12 m	12 m
Applied structural load (working stress design)	per piece of sheet pile	116 kN (13 tons)	177 kN (20 tons)
	per group of sheet pile	1390 kN (156 tons)	708 kN (80 tons)

The 1989 rehabilitation drawings show the addition of six Size 36 Jack Pine timber piles at each abutment. The piles were designed for an ultimate capacity of 300 kN. This implies a factored ULS capacity of 120 kN per pile. The approximate length of each pile was specified at 13.0 m.

8.2 Re-analysis of existing foundations

Analysis of the existing foundations for the piers and abutment was conducted to determine the geotechnical capacities of these foundations. For the purpose of geotechnical capacity analyses, the method and coefficients/parameters indicated for drilled shaft foundations (caissons) in the CFEM 4th Edition were employed. The vertical geotechnical resistances for caissons of 0.6 m and 1.5 m diameters were calculated based on contribution of end-bearing and skin friction. The anticipated tip elevations for piers and abutments are 172.0, respectively.

Results of the re-analysis of the existing piers and abutments are presented below:

Table 8.2 – Assessment of foundation capacity

	Each Pier Caisson	Each Abutment Caisson
Area of caisson	1.9 m^2	0.315m^2
Caisson diameter	1.5 m	0.6 m
Length	12 m	12 m
Geotechnical SLS resistance	2,800* kN	1,000 kN
Factored geotechnical resistance at ULS (per group of sheet piles)	3,500 kN	1,200 kN

*Based on sheet pile perimeter of 6.2 m for the pier caisson provided by MRC

At each abutment, there are also six timber piles which provide an additional, total resistance of :

720 kN ULS_f

600 kN SLS

8.2.1 Lateral capacity of existing foundations

The lateral resistance of the caissons may be calculated using a value for the coefficient of horizontal subgrade reaction (k_s) and ultimate lateral resistance (p_{ult}) as follows:

$k_s = n_h . z / D$ (kN/m^3)

$p_{ult} = 3 . \gamma . z . K_p$ (kPa)

where
- z = depth of embedment of caisson in metres
- D = caisson diameter in metres
- n_h = coefficient of horizontal subgrade reaction (Table 8.3)
- γ = effective unit weight (Table 8.3)
- K_p = passive earth pressure coefficient (Table 8.3)

The above equations and recommended parameters may be used to analyze the interaction between a caisson and the surrounding soil. The lateral pressures obtained from the analysis must not exceed the ultimate lateral resistance.

Table 8.3 – Recommended Soil Parameters

Location	Elevation	n_h (kN/m^3)	K_p	γ, Unit Weight* (kN/m^3)	Soil Conditions
Abutments and piers	Below 183.0	3,000	3.0	11	Sand, loose to compact

*Buoyant unit weight below the water table.

The spring constant, K_s, for analysis may be obtained by the expression, $K_s = k_s \times L \times D$ (kN/m), where k_s is the coefficient of horizontal subgrade reaction (kN/m^3), D is the caisson width (m) and L is the length (m) of the caisson segment or element used in the analysis. The ultimate lateral resistance, P_{ult}, may be obtained from the expression, $P_{ult} = p_{ult} \times L \times D$. This represents the ultimate passive geotechnical soil reaction.

Caisson interaction should be considered with reference to CHBDC Clause 6.8.9.2.

For lateral soil/ caisson group interaction analysis, the equation for k_s and p_{ult} quoted above may be used in conjunction with appropriate reduction factors.

Where a caisson group is oriented ***perpendicular*** to the direction of loading, group action may be considered by reducing values for k_s and p_{ult} by a reduction factor R as follows:

Caisson Spacing Perpendicular to Direction of Loading	Horizontal Subgrade Reaction Reduction Factor, R
4 D*	1.00
1 D*	0.50

* D is the diameter of the caisson, and spacing is measured centre to centre

Where a caisson group is oriented ***parallel*** to the direction of loading, group action may be considered by reducing values for k_s by a reduction factor R as follows:

Caisson Spacing Parallel To Direction of Loading	Horizontal Subgrade Reaction Reduction Factor, R
8 D	1.00
6 D	0.70
4 D	0.40
3 D	0.25

Intermediate values may be obtained by interpolation.

9. ALTERNATIVES TO INCREASE GEOTECHNICAL CAPACITY OF EXISTING FOUNDATIONS

If it is found that the loads imposed by the new design exceed the available geotechnical resistance, it is possible to install additional foundation elements to augment the total resistance at a pier or abutment. Various foundation options can be considered, each of which has its own advantages and disadvantages. These options include:

- Augered Caissons (drilled shafts)
- Driven H-piles
- Micro-piles
- Timber piles

9.1 Augered Caissons (drilled shafts)

Consideration was given to the use of caissons to improve geotechnical capacity at the abutments.

However, the use of augered caissons is not recommended at this site in view of the significant depth, greater than 40.0 m, to reach suitable end bearing material and potential installation difficulties through a deep deposit of cohesionless soil under water. The investigation did not encounter any soil that the caisson liner could be sealed into to prevent base instability.

9.2 Driven H-piles

Additional foundation resistance could be achieved by adding driven H-piles to the existing foundations, provided such piles can be installed without creating negative impacts on the existing structure. In view of the nature of the rehabilitation project and the

soil stratigraphy encountered at the site, capacities have been calculated for 20 m long piles developing resistance mainly in friction. The capacities are as shown below:

A 20- m long HP 310 X 110 pile may be designed on the basis of:

- 800 kN factored geotechnical resistance at ULS
- 600 kN geotechnical resistance at SLS

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

If driven H-piles are selected, there are a number of issues to be resolved including the practicality of installation in a suitable location to pick up structural load. The greatest disadvantage may be the risk that driving piles will create vibrations and excess porewater pressures that could induce settlement of the existing foundation elements.

In light of the above concern, driven H-piles are not recommended at this site.

9.3 Micro-piles

From a foundation feasibility point of view, additional foundation capacity could be achieved by using micropiles.

Micropiles are small diameter drilled and grouted piles. Each pile is reinforced with steel elements/solid bars that are bonded into the bearing soil or rock, generally with cement grout. The installation of micropiles is customized depending on the specification and need of the bridge rehabilitation project.

At this site, typical micropile installation techniques should be capable of penetrating the existing fill and loose to compact sands and into the dense silt deposit and to provide additional foundation support.

Overall benefits of using micropiles are:

- They can be installed through most ground conditions using highly adaptable mobile drilling equipment.
- Less susceptible to disturbance of the pile base, reducing the risk of undermining the existing foundations.
- Installation imparts less vibration, reducing the potential for damage to the existing foundations and subsoil
- Installation is typically carried out using duplex drilling techniques that protect against the danger of blow-in of the bottom of the pile.
- Can be installed in areas with little headroom and very close to existing structures.

- Can be preloaded to working load before connecting to particularly sensitive structures like in underpinning works.
- The disadvantages relate mainly to the cost and to the fact that they are generally installed by specialty contractors.

A preliminary analysis was carried out to estimate the geotechnical capacity of micropiles. This geotechnical analysis should be considered preliminary as several factors used in the final design will vary depending on the equipment and the installation methods utilized during construction. Micropiles are typically design/build elements of a structure and the final micropile design should be provided by the specialty micropile Contractor and should be compatible with the site conditions and his installation methods and equipment.

The following preliminary micropile design is based on the piles achieving capacity from adhesion between the pile concrete and the surrounding soil. End bearing was ignored.

An ultimate grout-to-ground bond stress of 150 kPa is considered a reasonable design value at the interface between the grout and the existing loose to compact sand.

Table 9.1 provides the preliminary geotechnical capacities of 200 mm and 250 mm diameter micropiles.

Table 9.1 – Micropile Preliminary Axial Geotechnical Resistance

Micropile Length (m)	Preliminary Axial Geotechnical Resistance			
	Micropile diameter 200 mm (8 in)		Micropile diameter 250 mm (10 in)	
	Factored ULS_f (kN)	SLS (kN)	Factored ULS_f (kN)	SLS (kN)
10	500	400	600	500
15	720	600	840	700
20	900	750	1,150	950

If this option has to be explored further, it will be necessary to discuss the design with a specialty contractor, who is qualified to perform micropile design and construction, in order to develop appropriate resistances to be used in design. At this site, the micropile design must ensure an adequate transfer of load from the existing foundation to the micropiles.

On the basis of preliminary evaluation, micro-piles are the preferred solution for reinforcing the existing foundations at this site.

9.4 Timber piles

Installation of timber piles could also be considered since this option has been used previously to support abutment extension. The design of timber piles must conform with the requirements of the National Building Code of Canada (2010). At this site, treated timber piles are recommended as a portion of the piles (approximately 5 m to 7 m) will be under water.

The 1989 rehabilitation drawings indicate that the design involved installation of Size 36 Jack Pine piles to 13.0 m depth. The piles were designed for an ultimate capacity of 300 kN. This implies a factored ULS capacity of 120 kN/pile and an SLS resistance of 100 kN/pile.

The tips and heads of all driven piles should be protected from damage due to driving stresses in accordance with OPSD 3003.100 and OPSD 3003.150.

It is recognized that timber piles were driven for the past rehabilitation and no adverse impacts are known. However, there is a risk of inducing settlement with any driven pile solution and this is not the preferred option for this site.

10. STRUCTURE APPROACHES

The GA drawing indicates that work on the approaches will involve construction of new approach slabs. Communication with MRC indicates that the approach grade will be raised by approximately 130 mm.

The foundation soils governing stability of the approach embankments consist of existing loose to dense sand and gravel fill overlying native loose to compact sand. The existing embankment height is about 7.0 m, including 4.0 m under water. Drawings show that existing embankment forward slope is in the order of 2H:1V.

An evaluation of the slope stability of the existing approach embankments was conducted. Global stability analyses were conducted for granular fill embankments at inclinations of 2H:1V. The computed factor of safety is shown in Table 10.1. The slope stability computation output is included in Appendix D.

Table 10.1 Computed Factors of Safety

Material/Slope	Factor of Safety	Figure (Appendix D)
North and South Approaches – 7.0 m high embankment		
Earth Fill – 2:1V	1.3	1

The factor of safety against global failure was 1.3. This factor of safety are considered to be acceptable for the existing embankment bearing on non-cohesive soil.

Any new embankment construction should be in accordance with OPSS 206, November 2010. It is recommended that earth fill should consists of granular materials in compliance with Special Provision 110S13, "Amendment to OPSS 1010 April 2004".

The embankment foundation soils are considered to provide adequate stability to new earth fills inclined at 2H:1V or flatter.

All topsoil and organic soils should be stripped from the footprint of any new fill.

In general, earth fill embankment slopes must be provided with erosion protection in accordance with OPSS 804, November 2010.

11. ROADWAY PROTECTION

During staging of the bridge rehabilitation operations, temporary excavation of the existing embankments in the abutment area will extend approximately 2.0 m to 3.0 m depth. Therefore, roadway (Highway 17) protection will be required to support the existing Highway 17 adjacent to the excavation.

An item titled "Protection System" as per OPSS 539 should be included in the contract documents. It is recommended that Performance Level 2 as per Clause 539.04.01.01 and the alignment of the shoring be specified on the contract drawings.

The design of roadway protection should be the responsibility of the contractor. The temporary shoring for roadway protection must be designed by a Professional Engineer experienced in such designs and should be retained by the Contractor.

One option for roadway protection is provision of conventional steel soldier pile and timber lagging walls. Timber lagging boards should be installed as soon as the soil face is exposed and properly prepared.

The roadway protection system selected will be installed through the 2.3 to 3.0 m thick granular fill embankment and into the underlying very loose to compact sand. The upper 1.0 m of the embankment is generally in a compact to dense state then it becomes very loose to compact. The fill contains cobbles.

For a temporary cantilevered shoring system consisting of a soldier pile and lagging wall, the lateral earth pressure diagram as shown on Figure 1 in Appendix E may be used for design in conjunction with the following parameter values:

γ	=	20 kN/m^3	(bulk unit weight)
γ_w	=	10 kN/m^3	(submerged unit weight under groundwater table)
K_a	=	0.33	(Active pressure coefficient for road embankment fill)
	=	0.33	(Active earth pressure coefficient for sand)
K_p	=	3.0	(Passive earth pressure coefficient for road embankment fill)
	=	3.0	(Passive earth pressure coefficient for sand)
h_w	=	0	(assuming that the groundwater is maintained below the base of the excavation and that there is no hydrostatic pressure build-up behind a presumably permeable wall, soldier pile and lagging)

The actual pressure distribution acting on the shoring system is a function of the construction sequence and the relative flexibility of the wall and these factors must be considered when designing the shoring system.

12. EARTH PRESSURE

Earth pressure acting on the abutment may be assumed to be triangular and to be governed by the characteristics of the abutment backfill.

For fully drained conditions, earth pressures acting on the structure should be computed in accordance with Clause 6.9 of the CHBDC but generally are given by the expression:

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

P_h = horizontal pressure on the wall at depth h (kPa)

K = earth pressure coefficient (see table 12.1)

γ = unit weight of retained soil (see table 12.1)

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 at a depth of 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 given in Table 12.1.

The coefficients in the Table 12.1 are ultimate values and require certain movements for the respective conditions to be mobilized. The values to use in design can be estimated from Figure C6.9.1 (a) in the Commentary to the CHBDC, 2006.

Table 12.1 – Earth Pressure Coefficients

Wall 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		Embankment Fill $\phi = 30°; \gamma = 20.0$ kN/m3	
	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 (Unrestrained Wall)	0.27	0.40*	0.31	0.48*	0.33	0.54
At rest (Restrained	0.43	-	0.47	-	0.50	-
Passive (Movement Towards Soil Mass)	3.70	-	3.30	-	3.0	-

* For wing walls.

13. TEMPORARY EXCAVATION

Temporary excavation will be required at the abutments in order to conduct rehabilitation operations, including retrofitting the bridge from conventional abutments to the semi-integral abutments and removal of deteriorated concrete in abutments and pile caps. The excavation is expected to extend approximately 2.0 m to 3.0 m depth into the existing fill.

All excavations must be carried out in accordance with the Occupational Health and Safety Act (OHSA) and in accordance with OPSS 902, November 2010. For the purposes of the OHSA, the native soils and the fill in the existing approach embankments at this site may be classified as Type 3 soils. Excavation below the groundwater level is not recommended without prior dewatering.

The selection of the method of excavation is the responsibility of the contractor and must be based on his equipment, experience and interpretation of the site conditions. Excavations should be inspected regularly for evidence of instability if they have been left open for extended periods of

time and following periods of heavy rain or thawing. If required, remedial actions must be taken to ensure the stability of the excavation and the safety of workers.

14. BACKFILL TO ABUTMENTS

Backfill to the abutments should consist of Granular A or Granular B Type II material meeting the requirements of Special Provision 110S13 "Amendment to OPSS 1010, April 2004". The backfill must be in accordance with OPSS 902, November 2010 and placed to the extents shown in OPSD 3101.150.

Compaction equipment to be used adjacent to retaining structures must be restricted in accordance with OPSS 501, November 2010. It is assumed that there is a functioning subdrain at the base of approach embankment.

15. GROUNDWATER AND SURFACE WATER CONTROL

A piezometer installed in Borehole BW-07, drilled at the east abutment, revealed that the groundwater level is approximately 3.4 m below ground surface, near elevation 183.0. Seepage may be experienced from perched zones in the granular fill. The level of perched water within the fill will vary between locations.

The Contractor should be prepared to pump from sumps to remove any remaining seepage water or surface water collecting in an excavation. Unwatering must remain operational and effective until the abutment is backfilled.

The design of the dewatering system that may be required is the responsibility of the Contractor and the Contract Documents must alert him to this responsibility.

16. EROSION PROTECTION

If the capacity of the foundation for Piers 1 to 4 needs to be increased, it is recommended that any selected method to achieve higher capacities be protected from erosion and undercutting by the river. The depth of scour must be determined by a river hydraulic specialist and the depth of pile embedment to achieve fixity must be measured from the predicted scour level.

No signs of major erosion were observed at the forward and side slopes at the east and west abutments. However, a specialist in river hydrology should be consulted regarding the potential for erosion and, if necessary, erosion protection must be provided at the toe of the slope.

17. IMPACT ON EXISTING FOUNDATIONS

The rehabilitation design should take into consideration the possible impact on existing foundation elements during construction.

If existing foundation elements at piers and abutments need to be rehabilitated, the risk of foundation construction inducing settlement of the existing structure must be assessed

It is recommended that the existing structure be monitored before, during and after any foundation work starts.

The structural design team should assess the magnitude of settlement or horizontal displacement that would constitute a concern for the stability or serviceability of the existing structure and these limits should be incorporated into a monitoring program in the construction contract. The monitoring program must incorporate selected points on the existing structure and continue at least for the duration the underpinning operations.

18. CONSTRUCTION CONCERNS

Potential construction concerns include, but are not necessarily limited to the issues discussed below.

Impact on Existing Structure

It is recommended that the contract documents include a monitoring program for the existing structure before, during and after construction starts. As a minimum, this program should require the contractor to establish a reference point on each pier cap and abutment of the existing structure and to monitor movement of these points relative to known fixed reference points on a regular basis.

A contingency plan should be in place to address any situation when the settlement or movement of the existing bridge becomes unacceptable from a serviceability point of view.

Potential Disturbance or Loss of Ground

The construction recommendations provided in this report are aimed at reducing the risk of the founding surface being disturbed or loss of ground occurring under the existing foundations but unforeseen circumstances may cause one of these conditions to develop. The QVE must be made aware that it is a contractual requirement that the rehabilitation process must not disturb the founding surface or create loss of ground under the existing foundations. If either of these conditions is found to be developing, he must bring it to the attention of the Contract Administrator (CA) immediately. The CA must make a decision

as to whether the Contractor needs to take steps to protect the site and whether the designer must be contacted to review the situation.

19. CLOSURE

Engineering analysis and preparation of the report were carried out by 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.

THURBER ENGINEERING LTD.

Rocío Palomeque Reyna, P.Eng.
Geotechnical Engineer

P. K. Chatterji, P.Eng.
Review Principal

Appendix A

Record of Borehole Sheets

(present investigation)

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

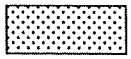
ROCK WEATHERING CLASSIFICATION

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 0.3m 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

THURBER

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No BW-01 1 OF 3 METRIC

W.P. 5198-06-00 LOCATION N 5 199 416.9 E 264 509.2 (Batchawana River Bridge) ORIGINATED BY ES
HWY 17 BOREHOLE TYPE Hollow Stem Augers/HW/HQ Mud Rotary/DCPT COMPILED BY AN
DATUM DATE 2010.10.21 - 2010.10.21 CHECKED BY 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 (O 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
186.3											
0.0	**ASPHALT:** (50mm)										
0.1	**SAND**, some gravel, some silt and clay Dense Brown Moist (FILL)		1	SS	42		186				
			2	SS	12						0 85 15 (SI+CL)
	Becoming compact to loose						185				
			3	SS	6						
	Occasional oxide staining		4	SS	7		184				
183.4											
3.0	**SAND**, trace silt and clay, occasional cobbles Loose Brown Moist		5	SS	7		183				0 97 3 (SI+CL)
	Becoming grey Wet		6	SS	4		182				
			7	SS	5						
			8	SS	5		181				
	silty sand layer at 6.1m		9	SS	4		180				0 76 24 (SI+CL)
							179				
	Becoming compact		10	SS	22						
							178				
			11	SS	28		177				No Recovery

Continued Next Page

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

(%) STRAIN AT FAILURE

ONTMT4S 1185.GPJ 2/18/11

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Ontario

RECORD OF BOREHOLE No BW-01 2 OF 3 METRIC

W.P. 5198-06-00 LOCATION N 5 199 416.9 E 264 509.2 (Batchawana River Bridge) ORIGINATED BY ES
HWY 17 BOREHOLE TYPE Hollow Stem Augers/HW/HQ Mud Rotary/DCPT COMPILED BY AN
DATUM DATE 2010.10.21 - 2010.10.21 CHECKED BY 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
	Continued From Previous Page										
	SAND, trace gravel, trace silt and clay Loose to Compact Grey Wet						176				
			12	SS	15		175		o		
							174		o		
173.5			13	SS	9						3 95 2 (SI+CL)
12.8	End of sampling at 12.8m and start DCPT						173				
							172				
							171				
							170				
							169				
							168				
							167				

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Continued Next Page

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

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

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No BW-01 3 OF 3 METRIC

W.P. 93-89-00 LOCATION N 5 199 416.9 E 264 509.2 (Batchawana River Bridge) ORIGINATED BY ES

HWY 17 BOREHOLE TYPE Hollow Stem Augers/HW/HQ Mud Rotary/DCPT COMPILED BY AN

DATUM Geodetic DATE 2010.10.21 - 2010.10.21 CHECKED BY 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 (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page						166				
							165				
							164				
							163				
162.0											
24.3	END OF BOREHOLE AT 24.3m UPON CONE REFUSAL. WATER LEVEL WAS NOT OBSERVED UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH HOLEPLUG TO 9.1m, CUTTINGS TO 0.05m AND ASPHALT TO SURFACE.										

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

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

ONTMT4S 1185.GPJ 6/15/11

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Ontario

RECORD OF BOREHOLE No BW-02 1 OF 5 METRIC

W.P. 5198-06-00 LOCATION N 5 199 410.7 E 264 511.0 (Batchawana River Bridge) ORIGINATED BY ES
HWY 17 BOREHOLE TYPE Hollow Stem Augers/HW Mud Rotary COMPILED BY AN
DATUM DATE 2010.10.24 - 2010.10.27 CHECKED BY 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 + 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
186.3											
0.0 / 0.0	**ASPHALT:** (50mm)										
185.8	**CONCRETE**						186				
0.5	**GRAVEL**, some sand, occasional cobbles Compact Brown Wet (FILL)		1	SS	12				○		
	occasional cobbles and boulders from 2.1m to 2.3m		2	SS	18		185				
184.1											
2.3	**SAND**, trace gravel, trace silt and clay Very Loose to Loose Dark Brown Moist		3	SS	2		184		○		
			4	SS	8		183		○		0 95 5 (SI+CL)
			5	SS	6				○		
							182				
	Becoming wet		6	SS	3				○		
	Becoming grey		7	SS	4		181		○		
			8	SS	6		180		○		
							179				
	Some gravel Compact		9	SS	28				○		14 83 3 (SI+CL)
							178				
	Gravelly sand layer at 9.1m Cobbles										
	Very Dense		10	SS	58		177				No Recovery

Continued Next Page

+³, ×³: Numbers refer to Sensitivity

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

ONTMT4S 1185.GPJ 2/18/11

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No BW-02 2 OF 5 METRIC

W.P. 5198-06-00 LOCATION N 5 199 410.7 E 264 511.0 (Batchawana River Bridge) ORIGINATED BY ES
HWY 17 BOREHOLE TYPE Hollow Stem Augers/HW Mud Rotary COMPILED BY AN
DATUM DATE 2010.10.24 - 2010.10.27 CHECKED BY JL

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 × 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
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	SAND, some gravel, trace silt and clay, occasional cobbles Compact Grey Wet						176				
			11	SS	22		175		o		
			12	SS	15		174		o		16 81 3 (SI+CL)
			13	SS	11		173		o		
			14	SS	16		172		o		
			15	SS	10		171		o		
			16	SS	15		170		o		
							169				
							168				
							167				

Continued Next Page

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

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

ONTMT4S 1185.GPJ 2/18/11

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Ontario

RECORD OF BOREHOLE No BW-02 3 OF 5 METRIC

W.P. 5198-06-00 LOCATION N 5 199 410.7 E 264 511.0 (Batchawana River Bridge) ORIGINATED BY ES
HWY 17 BOREHOLE TYPE Hollow Stem Augers/HW Mud Rotary COMPILED BY AN
DATUM DATE 2010.10.24 - 2010.10.27 CHECKED BY JL

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)	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			○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE			GR SA SI CL
	Continued From Previous Page										
	SAND, trace gravel, trace silt and clay Compact to Dense Grey Wet		17	SS	20		166		○		
			18	SS	26		165		○		
							164				
							163				
							162				
	Silty sand layer, trace clay at 24.4m		19	SS	31				○		0 57 39 4
							161				
							160				
			20	SS	18		159		○		
							158				
							157				

Continued Next Page

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

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

ONTMT4S 1185.GPJ 2/18/11

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THURBER

RECORD OF BOREHOLE No BW-02 4 OF 5 METRIC

W.P. 5198-06-00 LOCATION N 5 199 410.7 E 264 511.0 (Batchawana River Bridge) ORIGINATED BY ES

HWY 17 BOREHOLE TYPE Hollow Stem Augers/HW Mud Rotary COMPILED BY AN

DATUM DATE 2010.10.24 - 2010.10.27 CHECKED BY 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
	Continued From Previous Page										
155.9	**SAND**, trace gravel, silt and clay Compact Grey						156				
30.5	Wet										
	SILT, some clay, trace sand Dense Grey Moist		21	SS	38		155				No Recovery
							154				
							153				
			22	SS	40						0 5 84 11
151.0							152				
35.4	Silty **CLAY**, trace sand Stiff Reddish Brown to Grey						151				
							150				
			23	SS	15						0 3 24 73
							149				
			24	SS	15		148				
			25	SS	13		147				0 1 20 79

Continued Next Page

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

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

ONTMT4S 1185.GPJ 2/18/11

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RECORD OF BOREHOLE No BW-02 5 OF 5 METRIC

W.P. 5198-06-00 LOCATION N 5 199 410.7 E 264 511.0 (Batchawana River Bridge) ORIGINATED BY ES
HWY 17 BOREHOLE TYPE Hollow Stem Augers/HW Mud Rotary COMPILED BY AN
DATUM DATE 2010.10.24 - 2010.10.27 CHECKED BY JL

SOIL PROFILE ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ 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
	Continued From Previous Page										
	Silty **CLAY**, trace sand Stiff Grey						146				
145.0											
41.3	Sandy **SILT**, trace clay Very Dense Grey Wet		26	SS	50		145		○		
							144				
143.1			27	SS	55				○		0 30 65 5
43.3	End of sampling at 43.3m and start DCPT						143				
142.6											
43.8	END OF BOREHOLE AT 43.8m UPON CONE REFUSAL. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) Piezometer was destroyed and it was not possible to locate.										

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

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

ONTMT4S 1185.GPJ 2/18/11

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RECORD OF BOREHOLE No BW-03 1 OF 5 METRIC

W.P. 5198-06-00 LOCATION N 5 199 411.7 E 264 534.2 (Batchawana River Bridge) ORIGINATED BY ES
HWY 17 BOREHOLE TYPE HQ/HW Mud Rotary COMPILED BY AN
DATUM DATE 2010.10.29 - 2010.10.31 CHECKED BY 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
186.5											
0.0 / 186.2	**BRIDGE DECK** 25mm of asphalt over 275mm of concrete						186				
0.3							185				
							184				
183.3	**RIVER SURFACE**										
3.2	**WATER**						183				
							182				
							181				
							180				
179.3	**RIVER BED**										
7.3	**SAND**, some silt, trace clay, gravelly layer Very Loose to Compact Brown Wet		1	SS	2		179				
			2	SS	14		178				
			3	SS	23						0 87 13 (SI+CL)
			4	SS	21		177				

Continued Next Page

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

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

ONTMT4S 1185.GPJ 2/18/11

Ministry of Transportation
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RECORD OF BOREHOLE No BW-03 2 OF 5 METRIC

W.P. 5198-06-00 LOCATION N 5 199 411.7 E 264 534.2 (Batchawana River Bridge) ORIGINATED BY ES
HWY 17 BOREHOLE TYPE HQ/HW Mud Rotary COMPILED BY AN
DATUM DATE 2010.10.29 - 2010.10.31 CHECKED BY JL

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, × 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
	Continued From Previous Page										
	SAND, trace to some silt and clay Loose to Compact Grey Wet Cobble at 10.5m		5	SS	13		176				
			6	SS	18		175				
			7	SS	7		174				
			8	SS	16						0 88 12 (SI+CL)
			9	SS	10		173				
							172				
			10	SS	10						
							171				
	Gravelly sand layer at 16.4m		11	SS	11		170				23 75 2 (SI+CL)
							169				
			12	SS	13		168				
							167				
			13	SS	12						

Continued Next Page

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

15 20 10 5 (%) STRAIN AT FAILURE

ONTMT4S 1185.GPJ 2/18/11

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No BW-03 3 OF 5 METRIC

W.P. 5198-06-00 LOCATION N 5 199 411.7 E 264 534.2 (Batchawana River Bridge) ORIGINATED BY ES
HWY 17 BOREHOLE TYPE HQ/HW Mud Rotary COMPILED BY AN
DATUM DATE 2010.10.29 - 2010.10.31 CHECKED BY 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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	SAND, trace silt and clay Compact to Dense Grey Moist						166				
			14	SS	15		165		o		0 91 9 (SI+CL)
			15	SS	31		164		o		
			16	SS	30		163		o		
			17	SS	24		162		o		
	Silty sand layer, trace clay at 27.1m		18	SS	21		161		o		0 66 29 5
			19	SS	21		160		o		
							159				
							158		o		
							157				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

20
15 ⊕ 5 (%) STRAIN AT FAILURE
10

ONTMT4S 1185.GPJ 2/18/11

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BW-03 4 OF 5 METRIC

W.P. 5198-06-00 LOCATION N 5 199 411.7 E 264 534.2 (Batchawana River Bridge) ORIGINATED BY ES

HWY 17 BOREHOLE TYPE HQ/HW Mud Rotary COMPILED BY AN

DATUM DATE 2010.10.29 - 2010.10.31 CHECKED BY JL

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, × 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
	Continued From Previous Page										
156.1 30.4	**SAND**, trace silt and clay Compact to Dense Grey Moist						156				
	SILT, some sand, some clay, trace gravel Very Dense Grey Wet		20	SS	53		155		o		1 14 74 11
							154				
			21	SS	68		153				
							152		o		
							151				
149.4 37.1	Sandy **SILT**, trace clay Very Dense to Dense Grey Wet		22	SS	68		150				
							149		o		0 34 61 5
							148				
							147				

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

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

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RECORD OF BOREHOLE No BW-03 5 OF 5 METRIC

W.P. 93-89-00 LOCATION N 5 199 411.7 E 264 534.2 (Batchawana River Bridge) ORIGINATED BY ES
HWY 17 BOREHOLE TYPE HQ/HW Mud Rotary COMPILED BY AN
DATUM Geodetic DATE 2010.10.29 - 2010.10.31 CHECKED BY JL

SOIL PROFILE ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa O UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
145.1	Sandy **SILT**, trace clay Dense Grey Wet		23	SS	40		146				
41.4	End of sampling at 41.4m and start DCPT						145				
142.7							144				
43.8	END OF BOREHOLE AT 43.8m ON CONE REFUSAL. WATER LEVEL WAS NOT OBSERVED UPON COMPLETION OF DRILLING. BOREHOLE CAVED TO 7.3m WHILE PULLING CASING, BOREHOLE BACKFILLED WITH 275mm OF CONCRETE AND 25mm OF ASPHALT AT BRIDGE DECK.						143				

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

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

ONTMT4S 1185.GPJ 6/15/11

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BW-04 1 OF 5 METRIC

W.P. 5198-06-00 LOCATION N 5 199 402.5 E 264 550.5 (Batchawana River Bridge) ORIGINATED BY ES

HWY 17 BOREHOLE TYPE HQ/HW Mud Rotary COMPILED BY AN

DATUM DATE 2010.10.31 - 2010.11.01 CHECKED BY 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
186.6											
0.0 / 186.3	**BRIDGE DECK** 25mm of asphalt over 275mm of concrete						186				
0.3							185				
							184				
183.0	**RIVER SURFACE**						183				
3.6	**WATER**						182				
							181				
							180				
179.3	**RIVER BED**						179				
7.3	**SAND**, trace to some gravel, trace silt and clay Loose to Compact Brown to Grey Wet		1	SS	4				○		17 81 2 (SI+CL)
			2	SS	11		178		○		
			3	SS	16		177		○		

Continued Next Page

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

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

ONTMT4S 1185.GPJ 2/18/11

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RECORD OF BOREHOLE No BW-04 2 OF 5 METRIC

W.P. 5198-06-00 LOCATION N 5 199 402.5 E 264 550.5 (Batchawana River Bridge) ORIGINATED BY ES
HWY 17 BOREHOLE TYPE HQ/HW Mud Rotary COMPILED BY AN
DATUM DATE 2010.10.31 - 2010.11.01 CHECKED BY 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						
	Continued From Previous Page										
	SAND, trace silt and clay Loose to Compact Grey Wet		4	SS	24		176		○		
			5	SS	10		175		○		
			6	S	8		174		○		
			7	SS	9		173		○		
			8	SS	9		172		○		
			9	SS	10		171		○		0 97 3 (SI+CL)
			10	SS	27		170		○		
	cobbles		11	SS	11		169		○		
			12	SS	14		168		○		0 90 10 (SI+CL)
							167				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 1185.GPJ 2/18/11

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No BW-04 3 OF 5 METRIC

W.P. 5198-06-00 LOCATION N 5 199 402.5 E 264 550.5 (Batchawana River Bridge) ORIGINATED BY ES
HWY 17 BOREHOLE TYPE HQ/HW Mud Rotary COMPILED BY AN
DATUM DATE 2010.10.31 - 2010.11.01 CHECKED BY JL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / 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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
	SAND, trace silt and clay Compact Grey Wet		13	SS	18		166				
			14	SS	19		165				
			15	SS	24		164				
			16	SS	28		163				
			17	SS	39		162				0 88 12 (SI+CL)
	Dense		18	SS	24		161				
158.1							160				
28.4	**SILT**, trace to some sand, trace clay Compact Grey Wet		19	SS	15		159				
							158				0 14 81 5
							157				

ONTMT4S 1185.GPJ 2/18/11

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

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

Ministry of Transportation
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THURBER

RECORD OF BOREHOLE No BW-04 4 OF 5 METRIC

W.P. 5198-06-00 LOCATION N 5 199 402.5 E 264 550.5 (Batchawana River Bridge) ORIGINATED BY ES

HWY 17 BOREHOLE TYPE HQ/HW Mud Rotary COMPILED BY AN

DATUM DATE 2010.10.31 - 2010.11.01 CHECKED BY 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
	Continued From Previous Page										
	SILT, trace sand, trace clay Compact to Very Dense Grey Wet						156 155 154 153 152 151 150 149 148 147				
			20	SS	61				o		
			21	SS	49				o		0 7 87 6
			22	SS	56				o		

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

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

ONTMT4S 1185.GPJ 2/18/11

Ministry of Transportation
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RECORD OF BOREHOLE No BW-04 5 OF 5 METRIC

W.P. 93-89-00 LOCATION N 5 199 402.5 E 264 550.5 (Batchawana River Bridge) ORIGINATED BY ES

HWY 17 BOREHOLE TYPE HQ/HW Mud Rotary COMPILED BY AN

DATUM Geodetic DATE 2010.10.31 - 2010.11.01 CHECKED BY 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						
	Continued From Previous Page										
144.9	**SILT**, trace sand, trace clay Very Dense Grey Wet		23	SS	59		146 145		○		
142.1	End of sampling at 41.7m and start DCPT						144 143				
44.4	END OF BOREHOLE AT 44.4m ON CONE REFUSAL. WATER LEVEL WAS NOT OBSERVED UPON COMPLETION OF DRILLING. BOREHOLE CAVED TO 7.6m WHILE PULLING CASING, BOREHOLE BACKFILLED WITH 275mm OF CONCRETE AND 25mm OF ASPHALT AT BRIDGE DECK.										

+ ³, × ³: Numbers refer to Sensitivity

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

ONTMT4S 1185.GPJ 6/15/11

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No BW-05 1 OF 5 METRIC

W.P. 5198-06-00 LOCATION N 5 199 404.4 E 264 571.1 (Batchawana River Bridge) ORIGINATED BY ES
HWY 17 BOREHOLE TYPE HQ/HW Mud Rotary COMPILED BY AN
DATUM DATE 2010.10.28 - 2010.10.29 CHECKED BY JL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
186.5								20 40 60 80 100	20 40 60		
0.0 / 186.2	**BRIDGE DECK** 25mm of asphalt over 275mm of concrete						186				
0.3											
							185				
							184				
183.0	**RIVER SURFACE**										
3.5	**WATER**						183				
							182				
							181				
							180				
179.4	**RIVER BED**										
7.1	**SAND**, trace to some gravel, trace silt and clay Very Loose to Compact Brown Wet		1	SS	1		179		○		
			2	SS	18		178		○		
			3	SS	23				○		
	Gravelly sand layer from 9.4m to 10.0m		4	SS	21		177				37 61 2 (SI+CL)

Continued Next Page

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

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

ONTMT4S 1185.GPJ 2/18/11

Ministry of Transportation
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THURBER

RECORD OF BOREHOLE No BW-05 2 OF 5 METRIC

W.P. 5198-06-00 LOCATION N 5 199 404.4 E 264 571.1 (Batchawana River Bridge) ORIGINATED BY ES

HWY 17 BOREHOLE TYPE HQ/HW Mud Rotary COMPILED BY AN

DATUM DATE 2010.10.28 - 2010.10.29 CHECKED BY JL

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, × 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
	Continued From Previous Page										
	SAND, trace gravel, trace silt and clay Loose to Compact Grey Wet		5	SS	8		176				
			6	SS	17		175				
			7	SS	15		174				
			8	SS	14		173				
			9	SS	8		172				
			10	SS	12		171				
			11	SS	17		170				
			12	SS	21		169				
			13	SS	18		168				18 81 1 (SI+CL)
							167				

Continued Next Page

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

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

ONTMT4S 1185.GPJ 2/18/11

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RECORD OF BOREHOLE No BW-05 3 OF 5 METRIC

W.P. 5198-06-00 LOCATION N 5 199 404.4 E 264 571.1 (Batchawana River Bridge) ORIGINATED BY ES
HWY 17 BOREHOLE TYPE HQ/HW Mud Rotary COMPILED BY AN
DATUM DATE 2010.10.28 - 2010.10.29 CHECKED BY 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
	Continued From Previous Page										
	SAND, trace gravel, trace to some silt and clay Compact Grey Wet						166				
			14	SS	19						
							165				
			15	SS	25		164				
											1 88 11 (SI+CL)
			16	SS	29		163				
							162				
			17	SS	26		161				
							160				
			18	SS	24		159				
158.1											
28.4	**SILT**, some sand, some clay Loose Grey Wet		19	SS	7		158				0 20 67 13
							157				

Continued Next Page

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

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

ONTMT4S 1185.GPJ 2/18/11

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No BW-05 4 OF 5 METRIC

W.P. 5198-06-00 LOCATION N 5 199 404.4 E 264 571.1 (Batchawana River Bridge) ORIGINATED BY ES
HWY 17 BOREHOLE TYPE HQ/HW Mud Rotary COMPILED BY AN
DATUM DATE 2010.10.28 - 2010.10.29 CHECKED BY 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
	Continued From Previous Page										
	SILT, trace to some sand, trace clay Dense to Very Dense Grey Wet						156 155 154 153 152 151 150 149 148 147				
			20	SS	43						
			21	SS	61						0 7 88 5
			22	SS	47						

Continued Next Page

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

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

ONTMT4S 1185.GPJ 2/18/11

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BW-05 5 OF 5 METRIC

W.P. 93-89-00 LOCATION N 5 199 404.4 E 264 571.1 (Batchawana River Bridge) ORIGINATED BY ES

HWY 17 BOREHOLE TYPE HQ/HW Mud Rotary COMPILED BY AN

DATUM Geodetic DATE 2010.10.28 - 2010.10.29 CHECKED BY 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 (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	SILT, trace to some sand, trace clay Very Dense Grey Moist						146				
			23	SS	50						
144.8							145				
41.7	End of sampling at 41.7m and start DCPT										
143.6							144				
42.9	END OF BOREHOLE AT 42.9m ON CONE REFUSAL. WATER LEVEL WAS NOT OBSERVED UPON COMPLETION OF DRILLING. BOREHOLE CAVED TO 7.6m WHILE PULLING CASING, BOREHOLE BACKFILLED WITH 275mm OF CONCRETE AND 25mm OF ASPHALT AT BRIDGE DECK.										

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

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

ONTMT4S 1185.GPJ 6/15/11

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RECORD OF BOREHOLE No BW-06 1 OF 5 METRIC

W.P. 5198-06-00 LOCATION N 5 199 395.2 E 264 587.3 (Batchawana River Bridge) ORIGINATED BY ES
HWY 17 BOREHOLE TYPE HQ/HW Mud Rotary COMPILED BY AN
DATUM DATE 2010.11.01 - 2010.11.01 CHECKED BY 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: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
186.5											
0.0 / 186.2	**BRIDGE DECK** 25mm of asphalt over 275mm of concrete						186				
0.3							185				
							184				
	RIVER SURFACE						183				
182.9											
3.6	**WATER**						182				
							181				
							180				
179.1	**RIVER BED**						179				
7.4	**SAND**, some gravel, trace silt and clay Very Loose to Compact Brown Wet		1	SS	3						
	Gravelly sand layer at 7.9m		2	SS	10		178				37 59 4 (SI+CL)
			3	SS	10		177				

Continued Next Page

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

(%) STRAIN AT FAILURE

ONTMT4S 1185.GPJ 2/18/11

Ministry of Transportation
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THURBER

RECORD OF BOREHOLE No BW-06 2 OF 5 METRIC

W.P. 5198-06-00 LOCATION N 5 199 395.2 E 264 587.3 (Batchawana River Bridge) ORIGINATED BY ES

HWY 17 BOREHOLE TYPE HQ/HW Mud Rotary COMPILED BY AN

DATUM DATE 2010.11.01 - 2010.11.01 CHECKED BY 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: O 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										
	SAND, trace to some gravel, trace silt and clay Loose to Compact Brown Wet		4	SS	13						
			5	SS	8		176				17 82 1 (SI+CL)
			6	SS	8		175				
			7	SS	10						
			8	SS	11		174				
			9	SS	11		173				7 91 2 (SI+CL)
							172				
	Becoming grey		10	SS	12						
							171				
	Gravelly sand layer at 16.5m		11	SS	13		170				26 71 3 (SI+CL)
							169				
			12	SS	14		168				
			13	SS	18		167				

Continued Next Page

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

(%) STRAIN AT FAILURE

ONTMT4S 1185.GPJ 2/18/11

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RECORD OF BOREHOLE No BW-06 3 OF 5 METRIC

W.P. 5198-06-00 LOCATION N 5 199 395.2 E 264 587.3 (Batchawana River Bridge) ORIGINATED BY ES
HWY 17 BOREHOLE TYPE HQ/HW Mud Rotary COMPILED BY AN
DATUM DATE 2010.11.01 - 2010.11.01 CHECKED BY JL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page										
	SAND, trace to some silt and clay Compact Grey Moist						166				
			14	SS	25		165				0 86 14 (SI+CL)
			15	SS	18		164				
			16	SS	31		163				
			17	SS	20		162				
			18	SS	26		161				
	Silty sand, trace clay layer at 27.2m						160				0 55 43 2
			19	SS	15		159				
							158				
							157				

Continued Next Page

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

(%) STRAIN AT FAILURE

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RECORD OF BOREHOLE No BW-06 4 OF 5 METRIC

W.P. 5198-06-00 LOCATION N 5 199 395.2 E 264 587.3 (Batchawana River Bridge) ORIGINATED BY ES
HWY 17 BOREHOLE TYPE HQ/HW Mud Rotary COMPILED BY AN
DATUM DATE 2010.11.01 - 2010.11.01 CHECKED BY JL

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 × 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
	Continued From Previous Page										
155.9	**SAND**, trace to some silt, trace clay Compact Grey Moist						156				
30.6	**SILT**, trace sand, trace clay Very Dense to Dense Grey Wet						155				
			20	SS	46		154				0 4 89 7
			21	SS	33		153				
							152				
			22	SS	53		151				
							150				
							149				
							148				
							147				

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Continued Next Page

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

20
15 ⊕ 5
10
(%) STRAIN AT FAILURE

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BW-06 5 OF 5 METRIC

W.P. 93-89-00 LOCATION N 5 199 395.2 E 264 587.3 (Batchawana River Bridge) ORIGINATED BY ES

HWY 17 BOREHOLE TYPE HQ/HW Mud Rotary COMPILED BY AN

DATUM Geodetic DATE 2010.11.01 - 2010.11.01 CHECKED BY 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 (O 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										
144.9	**SILT**, trace clay Very Dense Grey Wet		23	SS	55		146 145		o		0 0 91 9
141.6	End of sampling at 41.5m and start DCPT						144 143 142				
44.9	END OF BOREHOLE AT 44.8m ON CONE REFUSAL. WATER LEVEL WAS NOT OBSERVED UPON COMPLETION OF DRILLING. BOREHOLE CAVED TO 7.4m WHILE PULLING CASING, BOREHOLE BACKFILLED WITH 275mm OF CONCRETE AND 25mm OF ASPHALT TO BRIDGE DECK.										

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

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

ONTMT4S 1185.GPJ 6/15/11

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THURBER

RECORD OF BOREHOLE No BW-07 1 OF 6 METRIC

W.P. 5198-06-00 LOCATION N 5 199 396.0 E 264 610.3 (Batchawana River Bridge) ORIGINATED BY ES

HWY 17 BOREHOLE TYPE Hollow Stem Augers and HQ/HW Mud Rotary COMPILED BY AN

DATUM DATE 2010.10.22 - 2010.10.23 CHECKED BY JL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ 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
186.4											
0.0	**ASPHALT:** (50mm)										
0.0	**CONCRETE:** (150mm)										
185.8							186				
0.5	**SAND**, trace gravel, some silt and clay, occasional cobbles Compact Brown Moist (FILL)		1	SS	26				○		
			2	SS	21		185		○		
			3	SS	11		184		○		1 77 22 (SI+CL)
183.3											
3.0	**SAND**, coarse grained, trace gravel, trace silt and clay Loose to Compact Brown Moist		4	SS	18		183 ▼		○		
			5	SS	9				○		
			6	SS	4		182		○		7 92 1 (SI+CL)
			7	SS	9		181		○		
	Silty sand layer at 6.0m Becoming grey Wet		8	SS	4		180		○		0 69 29 2
			9	SS	9		179		○		
			10	SS	8		178		○		
							177		○		

Continued Next Page

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

20
15 ⊕ 5 (%) STRAIN AT FAILURE
10

ONTMT4S 1185.GPJ 2/18/11

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BW-07 2 OF 6 METRIC

W.P. 5198-06-00 LOCATION N 5 199 396.0 E 264 610.3 (Batchawana River Bridge) ORIGINATED BY ES

HWY 17 BOREHOLE TYPE Hollow Stem Augers and HQ/HW Mud Rotary COMPILED BY AN

DATUM DATE 2010.10.22 - 2010.10.23 CHECKED BY 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
	Continued From Previous Page										
	SAND, trace gravel, trace silt and clay, occasional cobbles Compact Grey Wet						176				
			11	SS	25		175				
			12	SS	15		174				
			13	SS	15		173				
			14	SS	19		172				3 95 2 (SI+CL)
			15	SS	23		171				
			16	SS	24		170				
							169				
							168				
							167				

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Continued Next Page

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

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

Ministry of Transportation
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RECORD OF BOREHOLE No BW-07 3 OF 6 METRIC

W.P. 5198-06-00 LOCATION N 5 199 396.0 E 264 610.3 (Batchawana River Bridge) ORIGINATED BY ES
HWY 17 BOREHOLE TYPE Hollow Stem Augers and HQ/HW Mud Rotary COMPILED BY AN
DATUM DATE 2010.10.22 - 2010.10.23 CHECKED BY JL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, ● 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										
	SAND, some silt and clay Compact to Dense Grey Wet		17	SS	25		166		o		
							165				
			18	SS	43				o		0 88 12 (SI+CL)
							164				
			19	SS	33				o		
							163				
			20	SS	25		162		o		
							161				
			21	SS	29				o		
							160				
							159				
			22	SS	28				o		0 79 21 (SI+CL)
157.9							158				
28.5	**SILT**, some sand, trace clay Compact Grey Moist										
			23	SS	26		157		o		

Continued Next Page

+ ³, × ³ : Numbers refer to Sensitivity

20
15 ⊕ 5
10 (%) STRAIN AT FAILURE

ONTMT4S 1185.GPJ 2/18/11

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RECORD OF BOREHOLE No BW-07 4 OF 6 METRIC

W.P. 5198-06-00 LOCATION N 5 199 396.0 E 264 610.3 (Batchawana River Bridge) ORIGINATED BY ES
HWY 17 BOREHOLE TYPE Hollow Stem Augers and HQ/HW Mud Rotary COMPILED BY AN
DATUM DATE 2010.10.22 - 2010.10.23 CHECKED BY JL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60		GR SA SI CL
	Continued From Previous Page										
	SILT, some sand, trace clay Compact to Very Dense Grey Wet										
			24	SS	57		156				
							155				
			25	SS	78		154				
							153				
			26	SS	47		152				
			27	SS	28		151				0 10 85 5
							150				
			28	SS	51		149				
							148				
							147				
			29	SS	41						0 1 88 11

Continued Next Page

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

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

ONTMT4S 1185.GPJ 2/18/11

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BW-07 5 OF 6 METRIC

W.P. 5198-06-00 LOCATION N 5 199 396.0 E 264 610.3 (Batchawana River Bridge) ORIGINATED BY ES

HWY 17 BOREHOLE TYPE Hollow Stem Augers and HQ/HW Mud Rotary COMPILED BY AN

DATUM DATE 2010.10.22 - 2010.10.23 CHECKED BY 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 (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	Continued From Previous Page										
	SILT, some sand, trace clay Compact Grey Wet						146 145 144				
143.1			30	SS	19				o		
43.3	End of sampling at 43.3m and start DCPT						143 142 141 140 139 138 137				

Continued Next Page

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

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

ONTMT4S 1185.GPJ 2/18/11

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BW-07 6 OF 6 METRIC

W.P. 5198-06-00 LOCATION N 5 199 396.0 E 264 610.3 (Batchawana River Bridge) ORIGINATED BY ES

HWY 17 BOREHOLE TYPE Hollow Stem Augers and HQ/HW Mud Rotary COMPILED BY AN

DATUM — DATE 2010.10.22 - 2010.10.23 CHECKED BY JL

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 × 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						
	Continued From Previous Page										
							136				
135.4											
50.9	END OF BOREHOLE AT 50.9m ON CONE REFUSAL. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 1.52m slotted screen. WATER LEVEL READINGS: DATE DEPTH (m) ELEV. (m) 2010.11.28 3.4 183.0										

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

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

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Ontario

RECORD OF BOREHOLE No BW-07D 1 OF 3 METRIC

W.P. 5198-06-00 LOCATION N 5 199 396.0 E 264 610.3 (Batchawana River Bridge) ORIGINATED BY ES

HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY AN

DATUM DATE 2010.10.24 - 2010.10.24 CHECKED BY JL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
186.4								20 40 60 80 100	20 40 60	kN/m³	GR SA SI CL
0.0	DCPT conducted 0.4m South of Borehole BW-07						186				
	Start DCPT at 1.5 m						185				
							184				
							183				
							182				
							181				
							180				
							179				
							178				
							177				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

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

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RECORD OF BOREHOLE No BW-07D 2 OF 3 METRIC

W.P. 5198-06-00 LOCATION N 5 199 396.0 E 264 610.3 (Batchawana River Bridge) ORIGINATED BY ES

HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY AN

DATUM DATE 2010.10.24 - 2010.10.24 CHECKED BY JL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	w_P w w_L	γ	
	Continued From Previous Page							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	WATER CONTENT (%) 20 40 60	kN/m^3	GR SA SI CL

176
175
174
173
172
171
170
169
168
167

Continued Next Page

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

20
15 ⊕ 5 (%) STRAIN AT FAILURE
10

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RECORD OF BOREHOLE No BW-07D 3 OF 3 METRIC

W.P. 5198-06-00 LOCATION N 5 199 396.0 E 264 610.3 (Batchawana River Bridge) ORIGINATED BY ES

HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY AN

DATUM DATE 2010.10.24 - 2010.10.24 CHECKED BY JL

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 × 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
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
166.2	Continued From Previous Page										
20.1	END OF DCPT AT 20.1m UPON CONE REFUSAL. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.1m THEN ASPHALT TO SURFACE.						166				

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

(%) STRAIN AT FAILURE

ONTMT4S 1185.GPJ 2/18/11

Ministry of Transportation
Ontario

THURBER

RECORD OF BOREHOLE No BW-08 1 OF 3 METRIC

W.P. 5198-06-00 LOCATION N 5 199 389.9 E 264 612.4 (Batchawana River Bridge) ORIGINATED BY ES

HWY 17 BOREHOLE TYPE Hollow Stem Augers and HQ/HW Mud Rotary COMPILED BY AN

DATUM _____ DATE 2010.10.21 - 2010.10.21 CHECKED BY 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 (20 40 60 80 100) o 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
186.3											
0.0	**ASPHALT:** (50mm)										
	SAND, trace to some gravel, trace silt and clay Very Loose to Dense Brown Moist (FILL)		1	SS	36		186				
			2	SS	11						
							185				
			3	SS	4						2 96 2 (SI+CL)
							184				
			4	SS	3						
183.3											
3.0	**SAND**, trace to some gravel, trace to some silt and clay Very Loose to Compact Brown Wet		5	SS	14		183				
			6	SS	7						16 83 1 (SI+CL)
							182				
			7	SS	5						
							181				
			8	SS	3						
	Becoming grey		9	SS	3		180				
							179				
			10	SS	8						0 89 11 (SI+CL)
							178				
	Silty sand layer at 9.1m		11	SS	2		177				0 34 61 5

Continued Next Page

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

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

ONTMT4S 1185.GPJ 2/18/11

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No BW-08 2 OF 3 METRIC

W.P. 5198-06-00 LOCATION N 5 199 389.9 E 264 612.4 (Batchawana River Bridge) ORIGINATED BY ES
HWY 17 BOREHOLE TYPE Hollow Stem Augers and HQ/HW Mud Rotary COMPILED BY AN
DATUM DATE 2010.10.21 - 2010.10.21 CHECKED BY JL

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Continued From Previous Page									
	SAND, trace to some gravel, trace silt and clay, occasional cobbles Compact Grey Wet									
			12	SS	20					
173.5			13	SS	14					
12.8	End of sampling at 12.8m and start DCPT									

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
ELEVATION SCALE: 176 175 174 173 172 171 170 169 168 167

Continued Next Page

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

ONTMT4S 1185.GPJ 2/18/11

Ministry of Transportation
Ontario

RECORD OF BOREHOLE No BW-08 3 OF 3 METRIC

W.P. 93-89-00 LOCATION N 5 199 389.9 E 264 612.4 (Batchawana River Bridge) ORIGINATED BY ES

HWY 17 BOREHOLE TYPE Hollow Stem Augers and HQ/HW Mud Rotary COMPILED BY AN

DATUM Geodetic DATE 2010.10.21 - 2010.10.21 CHECKED BY JL

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (O UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × LAB VANE)	WATER CONTENT (%) (PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	Continued From Previous Page										
							166				
							165				
							164				
							163				
							162				
161.3											
25.0	END OF BOREHOLE AT 25.0m UPON CONE REFUSAL. WATER LEVEL WAS NOT OBSERVED UPON COMPLETION OF DRILLING. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.04m, THEN ASPHALT TO SURFACE.										

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

(%) STRAIN AT FAILURE

ONTMT4S 1185.GPJ 6/15/11

Appendix B

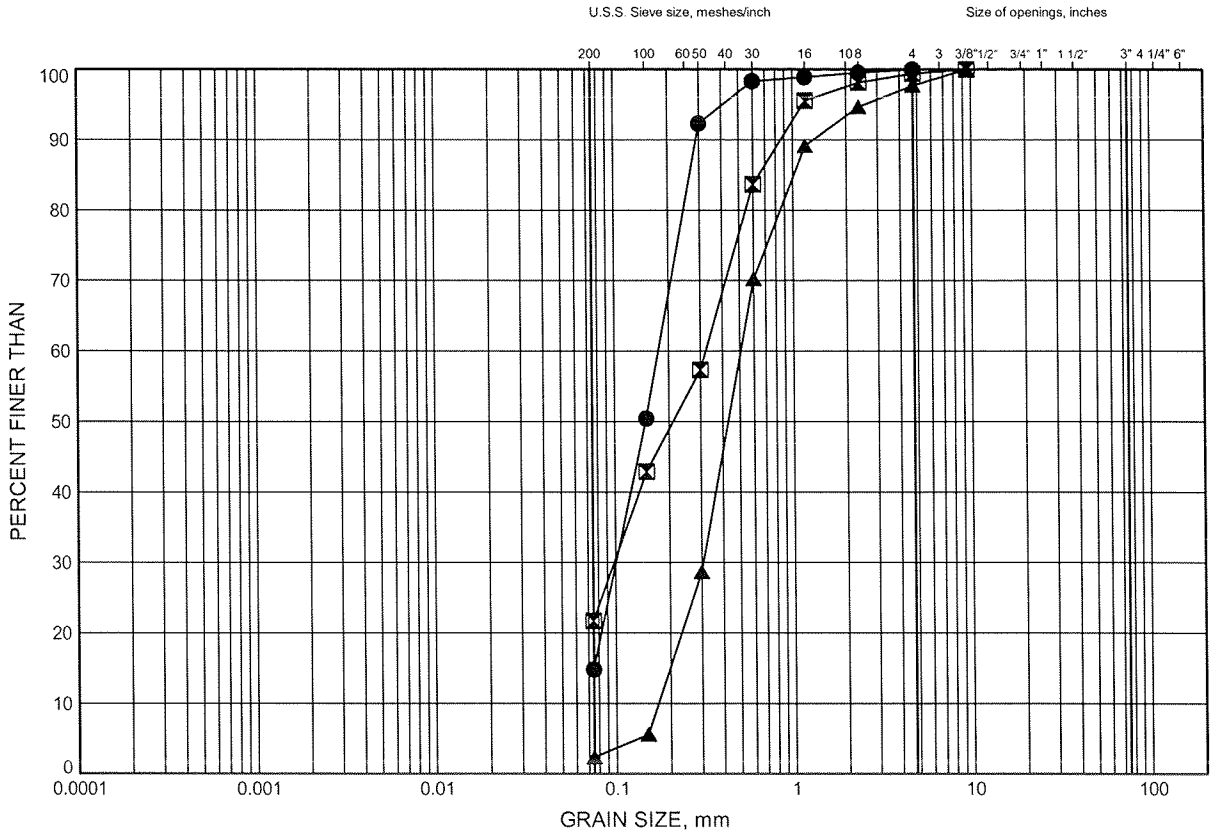
Laboratory Test Results
(present investigation)

Ten Bridge Rehabilitations and Two Bridge Replacements

GRAIN SIZE DISTRIBUTION

FIGURE B1

SAND FILL



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BW-01	1.07	185.27
⊠	BW-07	2.59	183.76
▲	BW-08	1.83	184.50

W.P.# 5198-06-00
Prepared By AN
Checked By RPR

THURBER

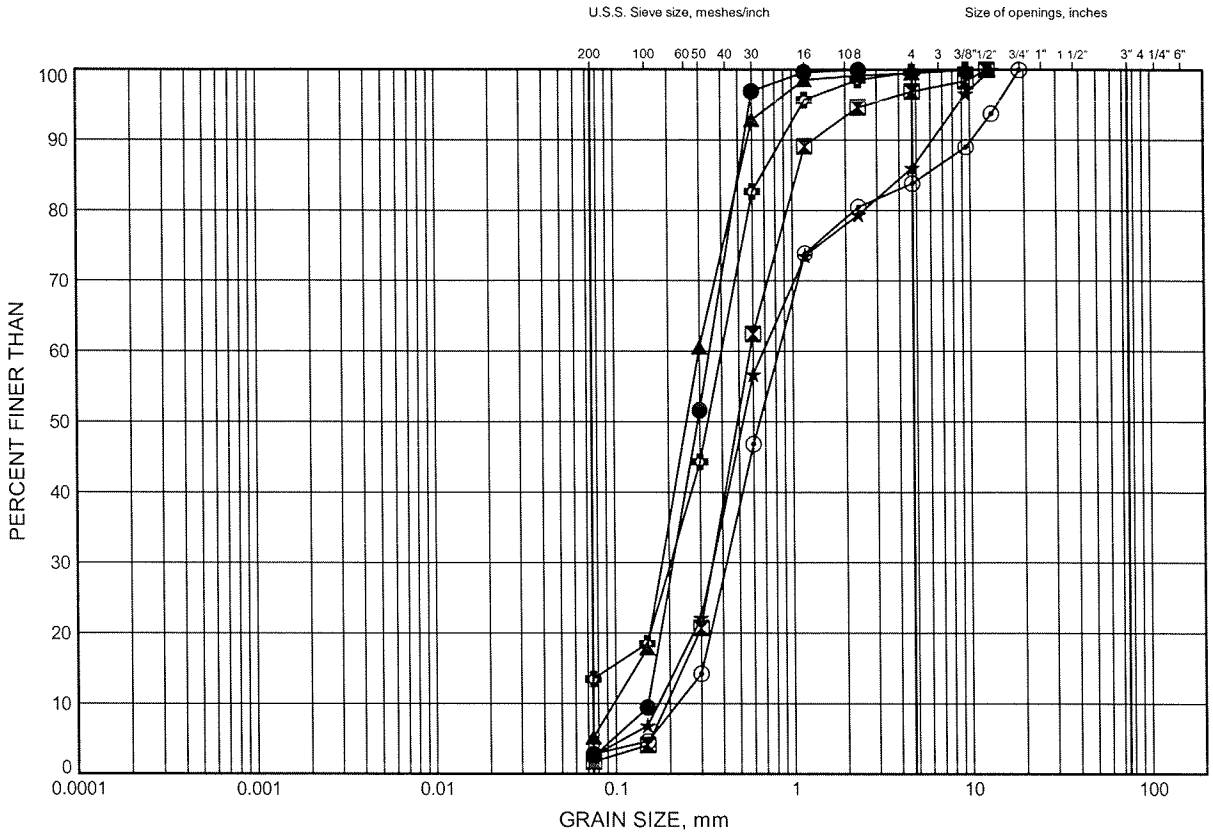
GRAIN SIZE DISTRIBUTION - THURBER 1185.GPJ 1/26/11

Ten Bridge Rehabilitations and Two Bridge Replacements

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)
●	BW-01	3.35	182.98
⊠	BW-01	12.50	173.84
▲	BW-02	3.35	182.99
★	BW-02	7.92	178.42
⊙	BW-02	12.50	173.85
✿	BW-03	9.09	177.42

W.P.# 5198-06-00
Prepared By AN
Checked By RPR

THURBER

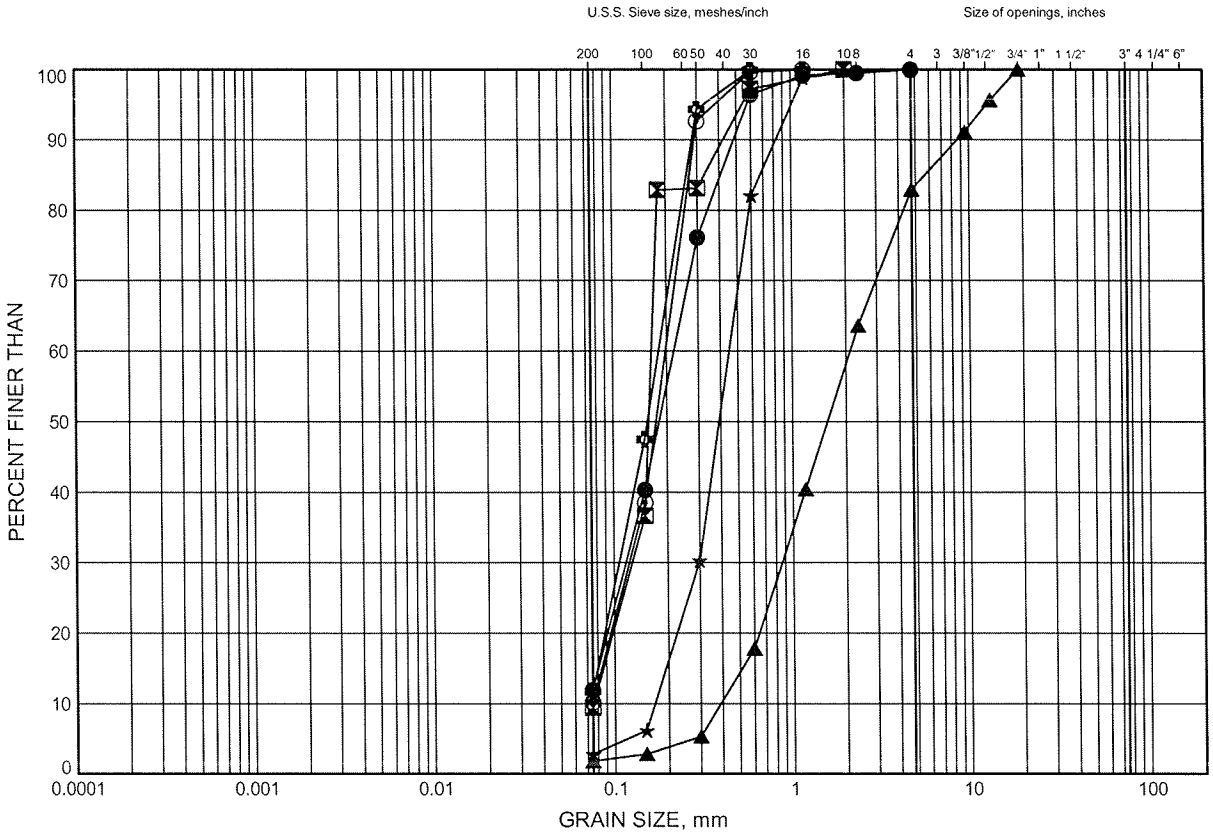
GRAIN SIZE DISTRIBUTION - THURBER 1185.GPJ 1/26/11

Ten Bridge Rehabilitations and Two Bridge Replacements

GRAIN SIZE DISTRIBUTION

FIGURE B3

SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BW-03	12.90	173.61
⊠	BW-03	21.28	165.23
▲	BW-04	7.87	178.70
★	BW-04	13.97	172.61
⊙	BW-04	18.54	168.03
✿	BW-04	26.16	160.41

W.P.# 5198-06-00
Prepared By AN
Checked By RPR

THURBER

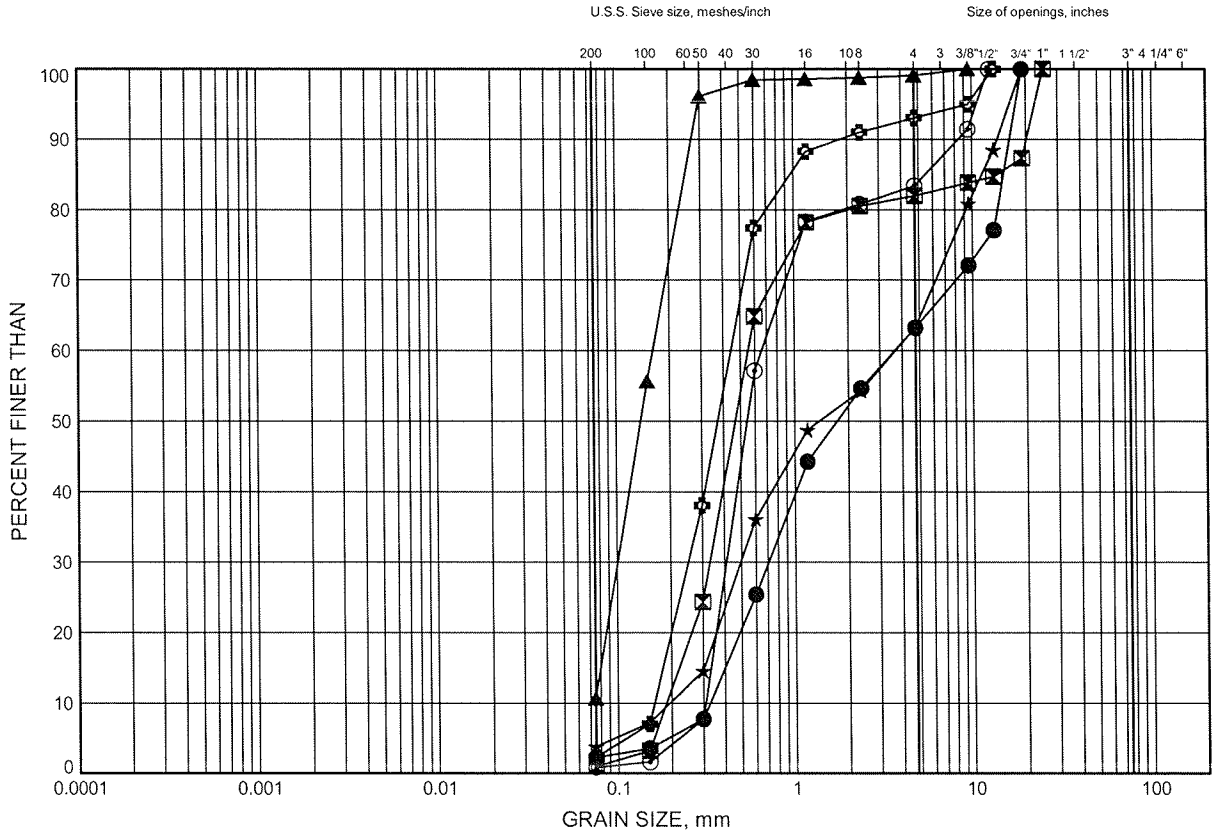
GRAIN SIZE DISTRIBUTION - THURBER 1185.GPJ 1/26/11

Ten Bridge Rehabilitations and Two Bridge Replacements

GRAIN SIZE DISTRIBUTION

FIGURE B4

SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BW-05	9.70	176.84
⊠	BW-05	18.54	168.00
▲	BW-05	23.11	163.43
★	BW-06	8.48	178.00
⊙	BW-06	10.77	175.71
✿	BW-06	13.82	172.66

W.P.# 5198-06-00
Prepared By AN
Checked By RPR

THURBER

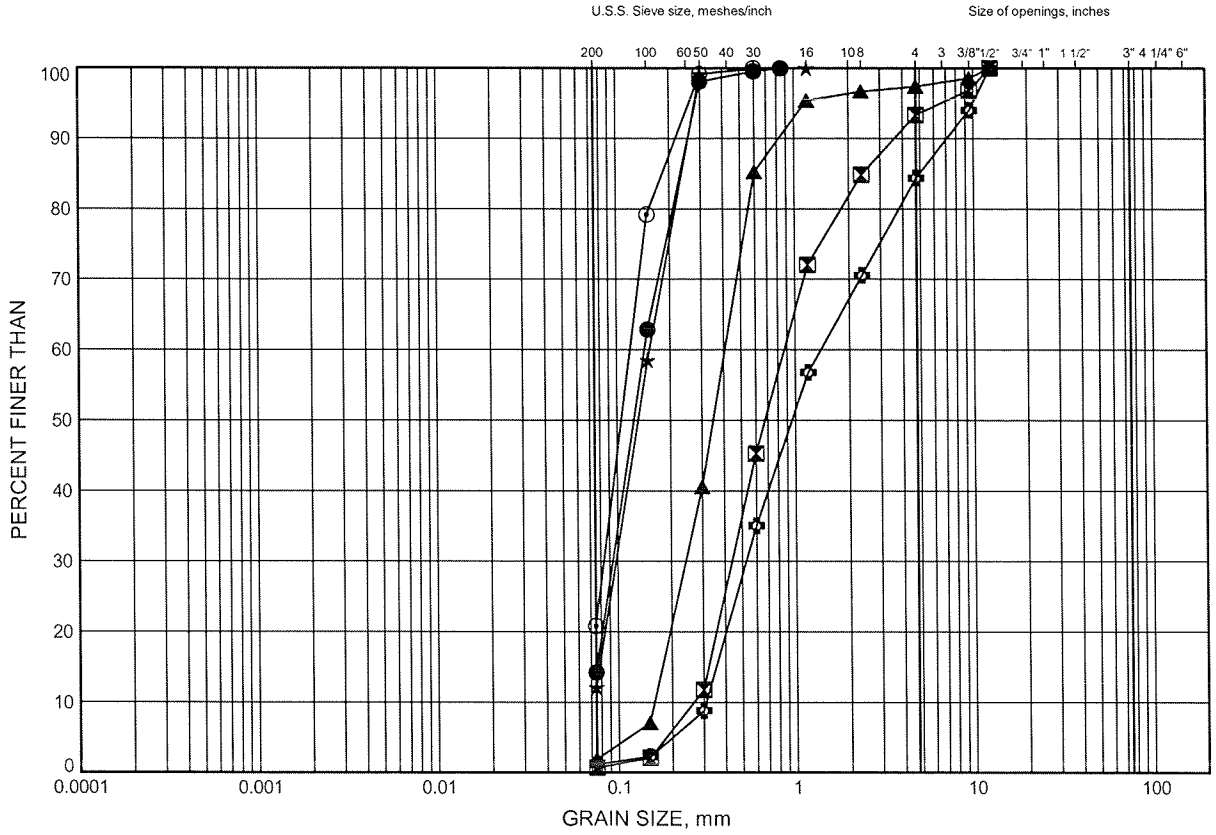
GRAIN SIZE DISTRIBUTION - THURBER 1185.GPJ 1/26/11

Ten Bridge Rehabilitations and Two Bridge Replacements

GRAIN SIZE DISTRIBUTION

FIGURE B5

SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BW-06	21.44	165.04
⊠	BW-07	4.88	181.47
▲	BW-07	15.54	170.81
★	BW-07	21.64	164.71
⊙	BW-07	27.74	158.61
✿	BW-08	4.11	182.21

W.P.# 5198-06-00
Prepared By AN
Checked By RPR

THURBER

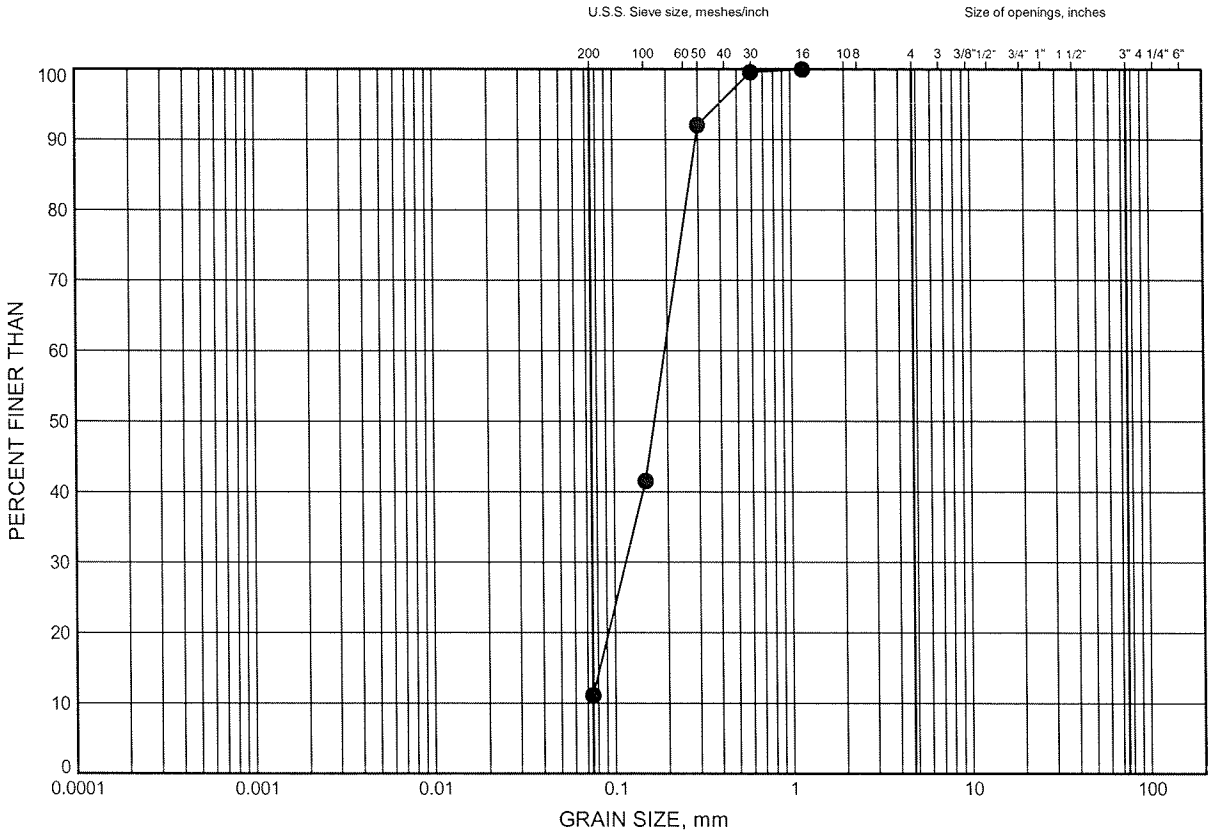
GRAIN SIZE DISTRIBUTION - THURBER 1185.GPJ 1/26/11

Ten Bridge Rehabilitations and Two Bridge Replacements

GRAIN SIZE DISTRIBUTION

FIGURE B6

SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BW-08	7.92	178.40

W.P.# 5198-06-00
Prepared By AN
Checked By RPR

THURBER

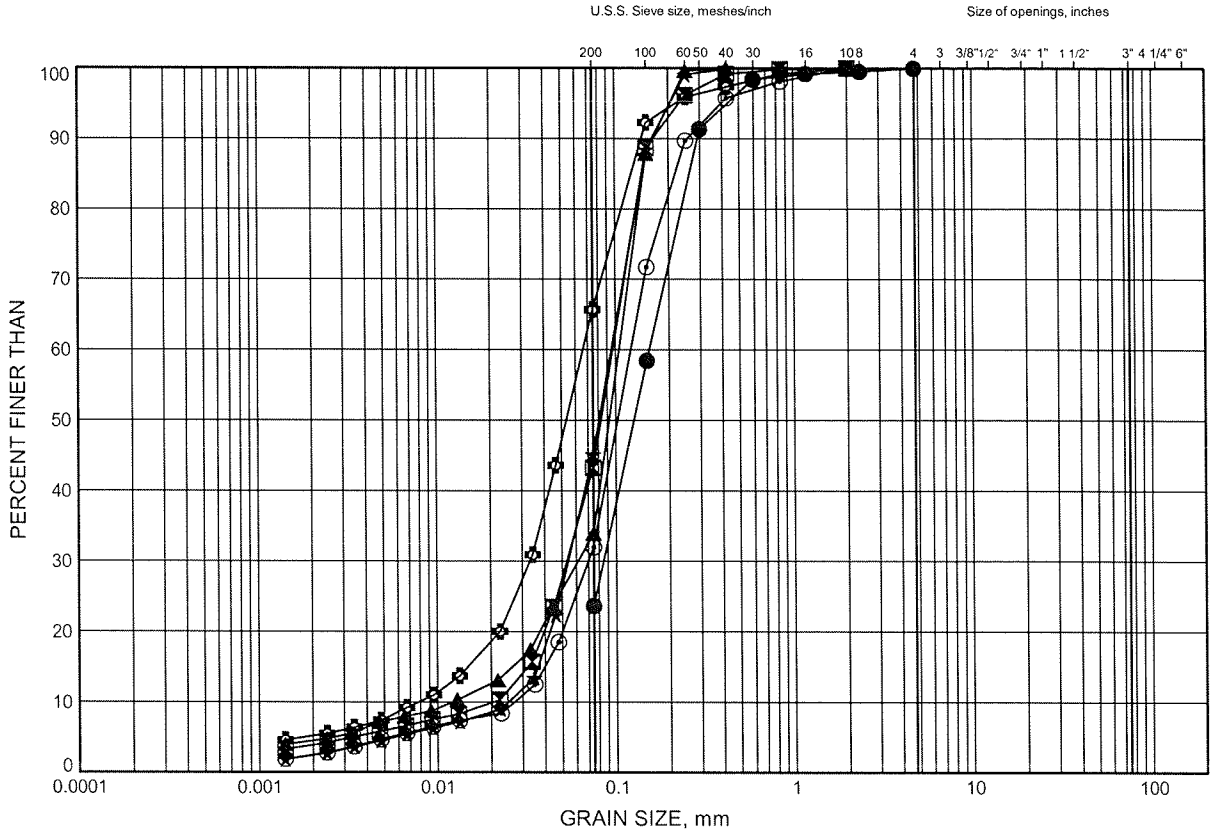
GRAIN SIZE DISTRIBUTION - THURBER 1185.GPJ 1/26/11

Ten Bridge Rehabilitations and Two Bridge Replacements

GRAIN SIZE DISTRIBUTION

FIGURE B7

SILTY SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BW-01	6.40	179.94
⊠	BW-02	24.69	161.66
▲	BW-03	27.38	159.14
★	BW-06	27.53	158.95
⊙	BW-07	6.40	179.95
✿	BW-08	9.45	176.88

W.P.# 5198-06-00
Prepared By AN
Checked By RPR

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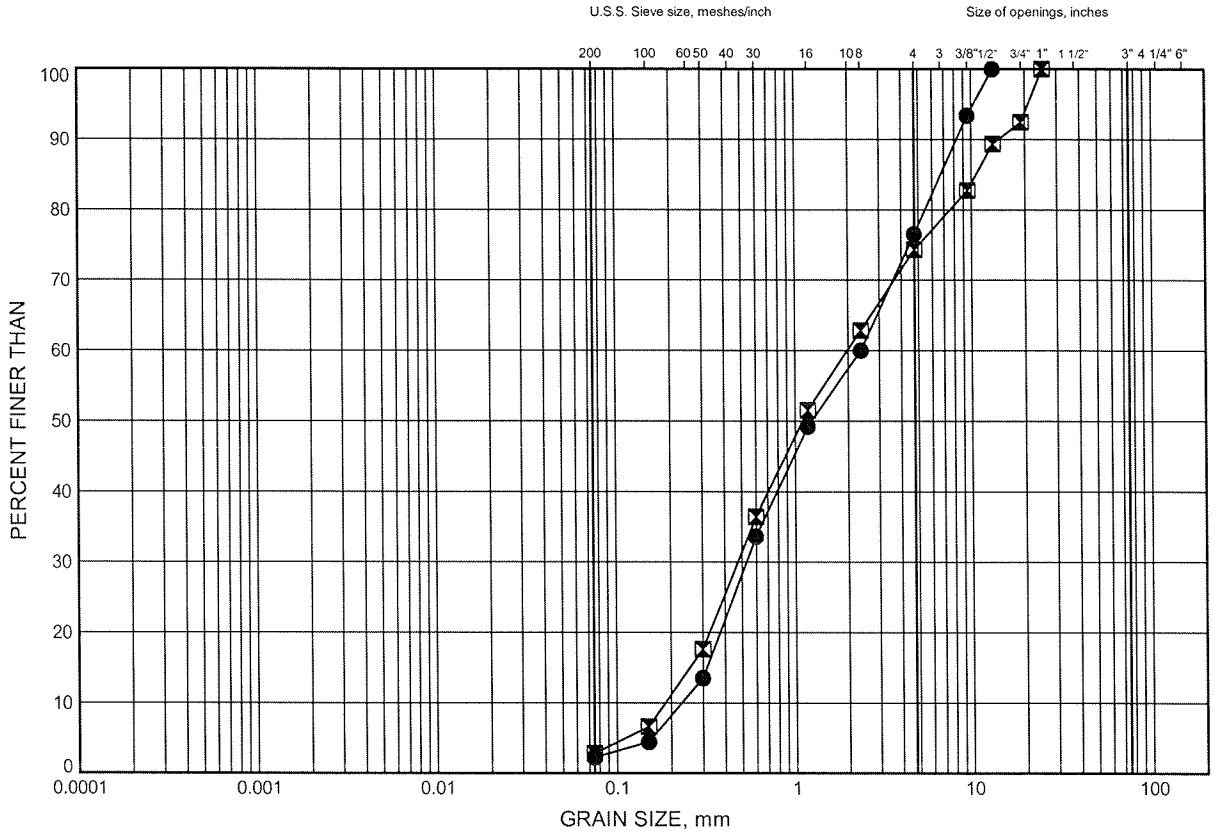
GRAIN SIZE DISTRIBUTION - THURBER 1185.GPJ 1/26/11

Ten Bridge Rehabilitations and Two Bridge Replacements

GRAIN SIZE DISTRIBUTION

FIGURE B8

GRAVELLY SAND



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BW-03	16.71	169.80
⊠	BW-06	16.86	169.62

W.P.# 5198-06-00
Prepared By AN
Checked By RPR

THURBER

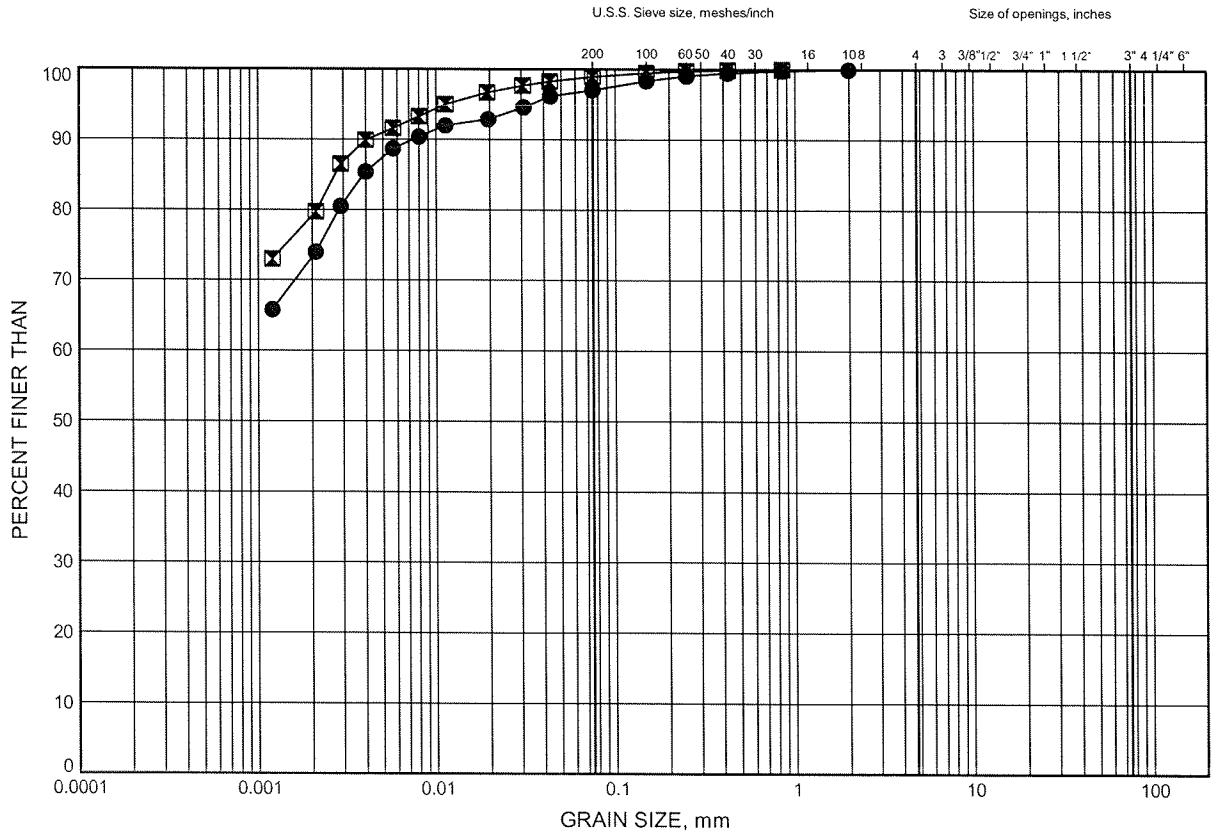
GRAIN SIZE DISTRIBUTION - THURBER 1185.GPJ 1/26/11

Ten Bridge Rehabilitations and Two Bridge Replacements

GRAIN SIZE DISTRIBUTION

FIGURE B9

SILTY CLAY



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BW-02	36.88	149.47
⊠	BW-02	39.93	146.42

W.P.# 5198-06-00
Prepared By AN
Checked By RPR

THURBER

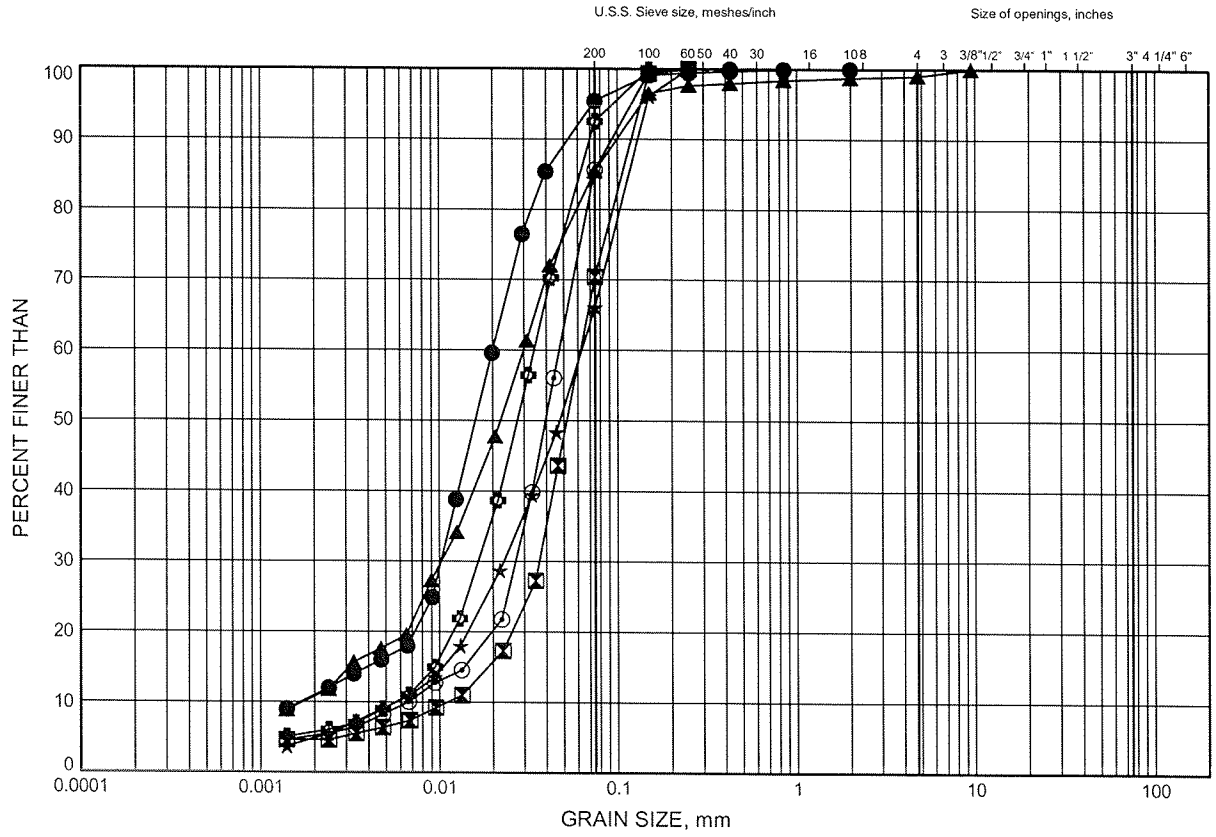
GRAIN SIZE DISTRIBUTION - THURBER 1185.GPJ 1/26/11

Ten Bridge Rehabilitations and Two Bridge Replacements

GRAIN SIZE DISTRIBUTION

FIGURE B10

SILT/SANDY SILT



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BW-02	33.83	152.51
⊠	BW-02	42.98	143.37
▲	BW-03	31.95	154.56
★	BW-03	38.05	148.47
⊙	BW-04	29.21	157.37
✿	BW-04	35.30	151.27

W.P.# 5198-06-00
Prepared By AN
Checked By RPR

THURBER

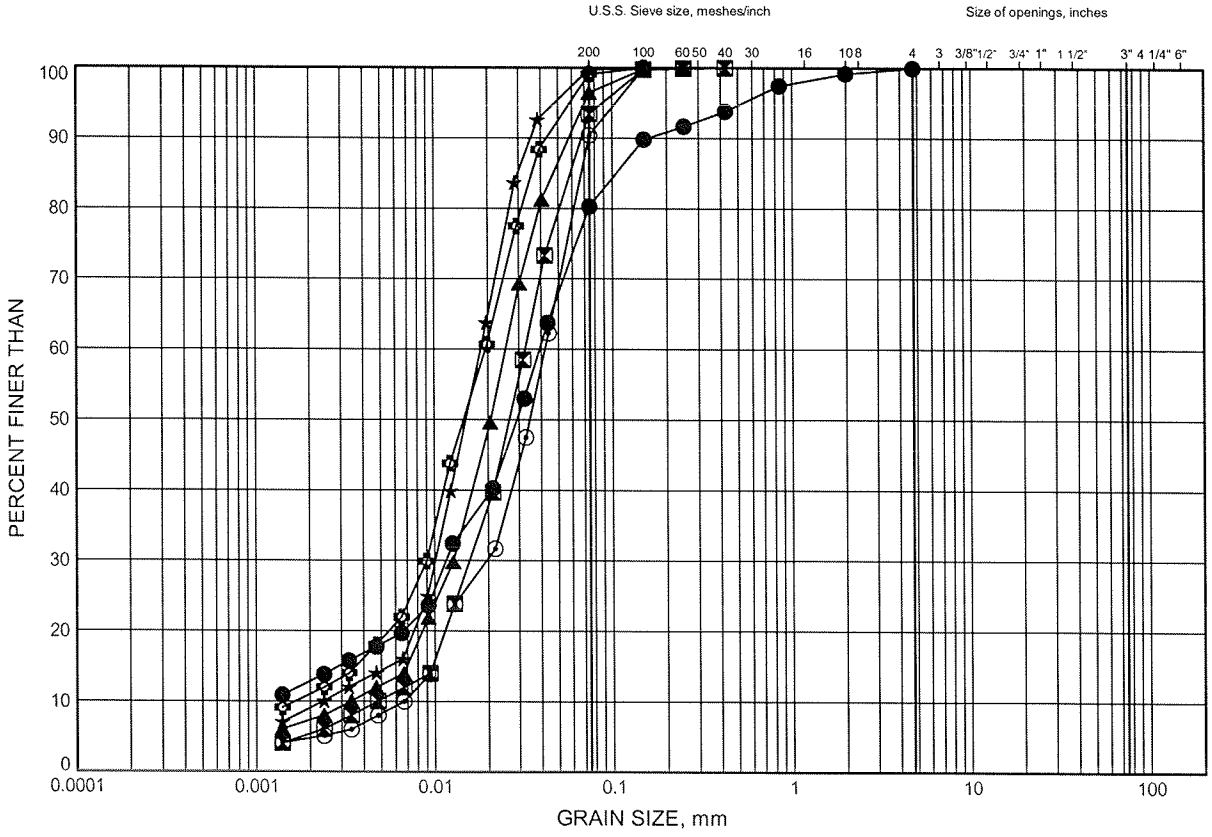
GRAIN SIZE DISTRIBUTION - THURBER 1185.GPJ 1/26/11

Ten Bridge Rehabilitations and Two Bridge Replacements

GRAIN SIZE DISTRIBUTION

FIGURE B11

SILT/SANDY SILT



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

LEGEND

SYMBOL	BOREHOLE	DEPTH (m)	ELEV. (m)
●	BW-05	29.21	157.33
⊠	BW-05	35.30	151.24
▲	BW-06	32.10	154.38
★	BW-06	41.25	145.23
⊙	BW-07	35.36	150.99
✿	BW-07	39.93	146.42

W.P.# 5198-06-00
Prepared By AN
Checked By RPR

THURBER

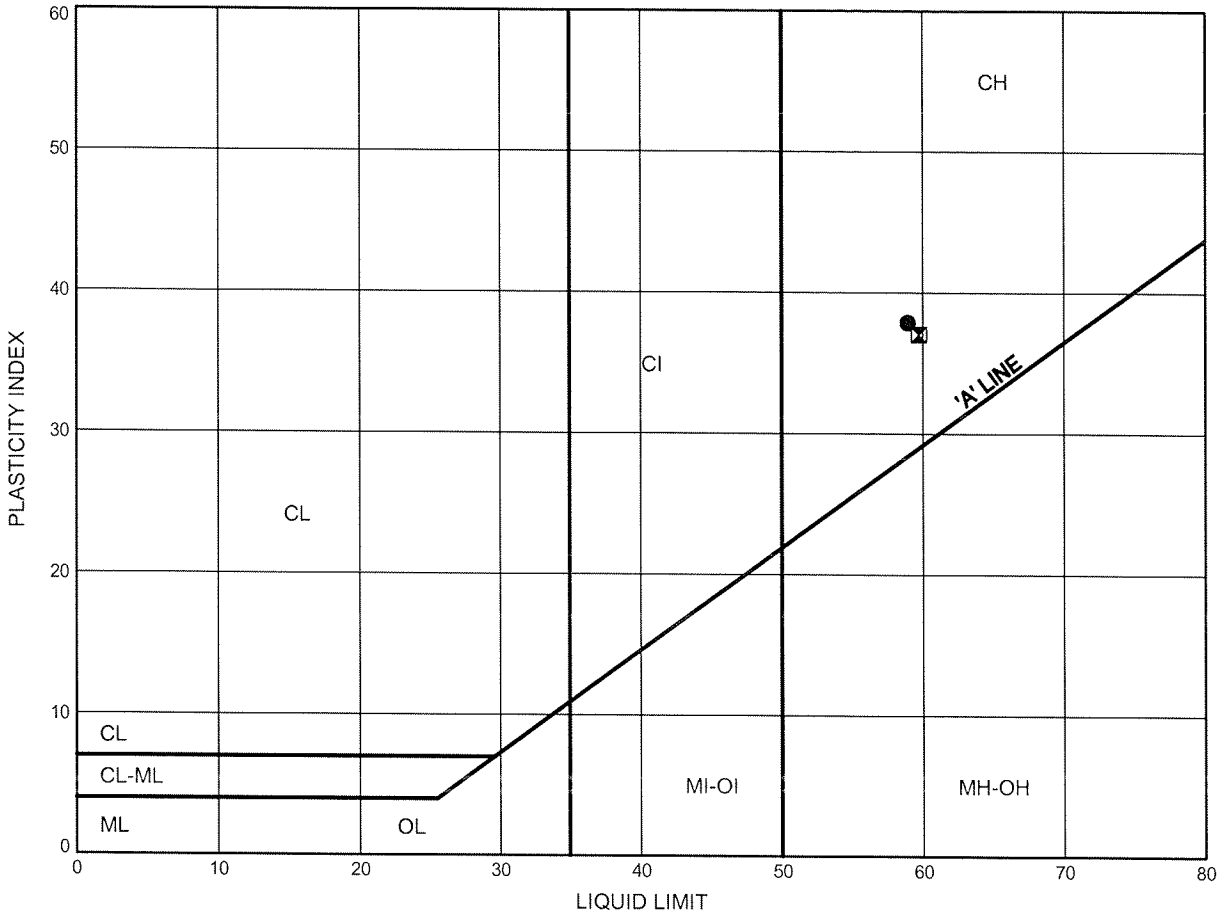
GRAIN SIZE DISTRIBUTION - THURBER 1185.GPJ 1/26/11

Ten Bridge Rehabilitations and Two Bridge Replacements

ATTERBERG LIMITS TEST RESULTS

FIGURE B12

SILTY CLAY



SYMBOL	BH	DEPTH (m)	ELEV. (m)
●	BW-02	36.88	149.47
⊠	BW-02	39.93	146.42

Date January 2011

Project 5198-06-00

THURBER

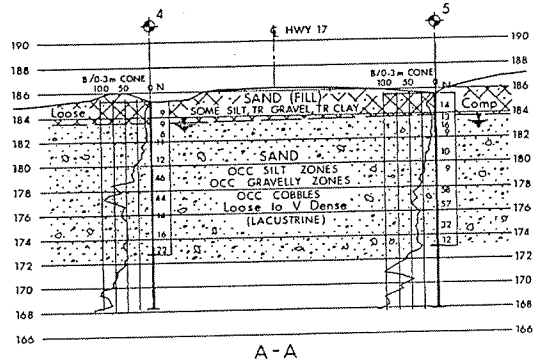
Prep'd AN

Chkd. RPR

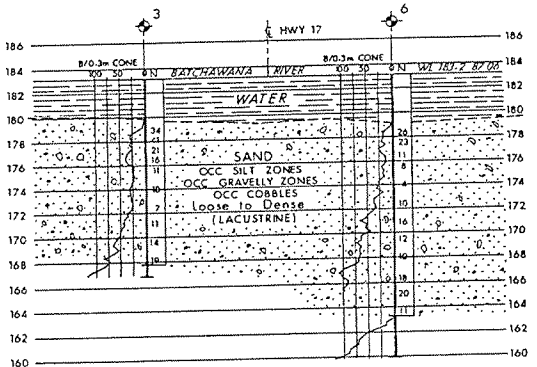
THURBALT 1185.GPJ 1/26/11

Appendix C

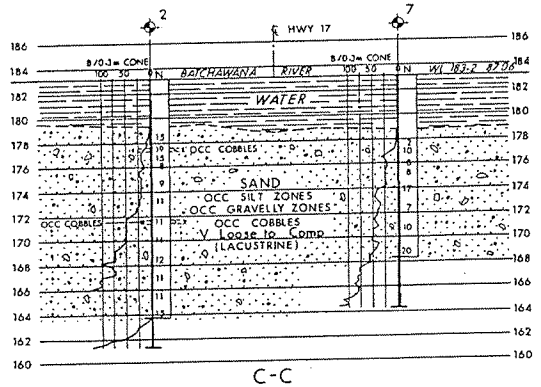
Record of Borehole Sheets and Laboratory Results
(previous investigation)



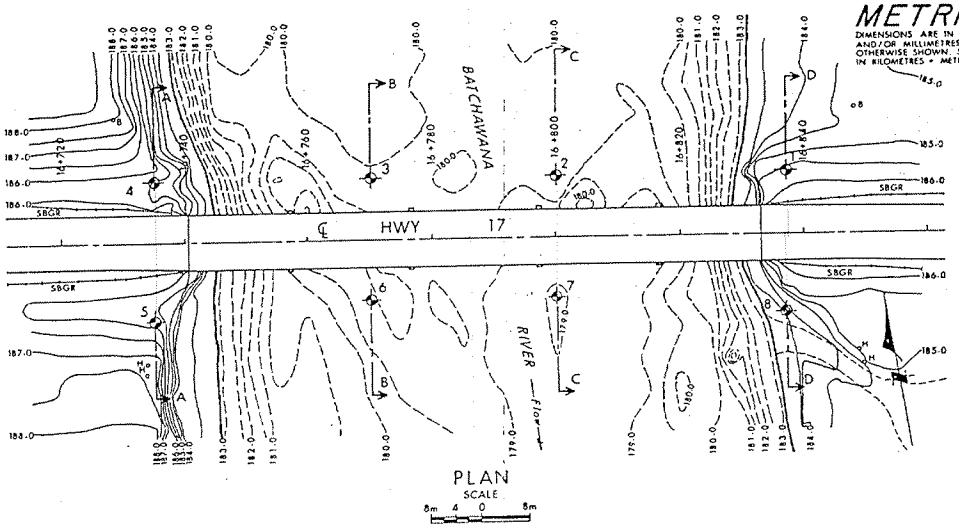
A-A



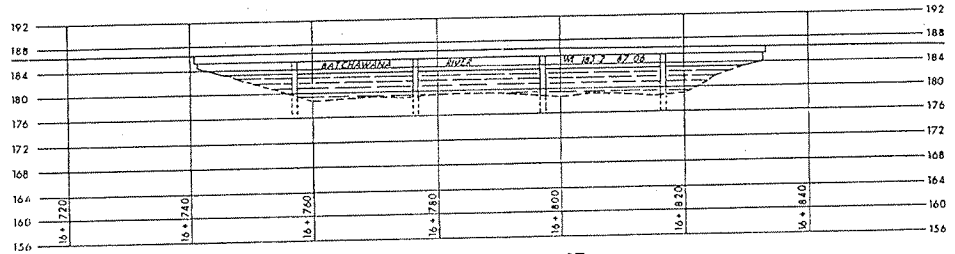
B-B



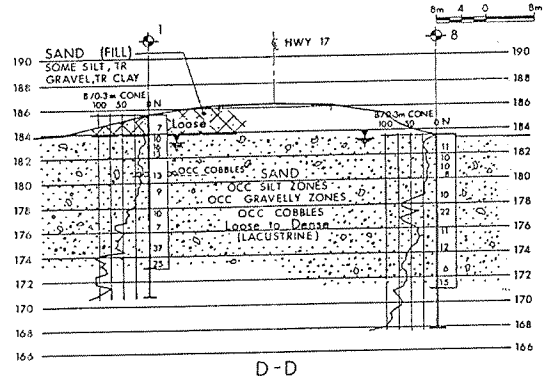
C-C



PLAN
SCALE
8m 4 0 8m



℄ PROFILE HWY 17
SCALE
8m 4 0 8m



D-D

SECTIONS
SCALE
4m 2 0 4m

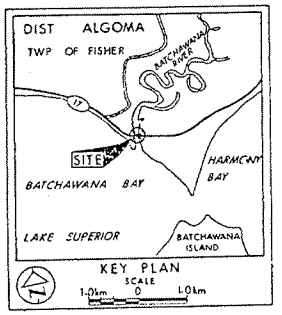
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No
WP No 910-62-09

BATCHAWANA RIVER

BORE HOLE LOCATIONS & SOIL STRATA

SHEET



KEY PLAN
SCALE
1.0km 0 1.0km

LEGEND

- Bore Hole
- Dynamic Cone Penetration Test (Cone)
- Bore Hole & Cone
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- CONE Blows/0.3m (60° Cone, 475 J/blow)
- WL at time of investigation 87 06

No	ELEVATION	STATION	OFFSET
1	185.6	16+837.0	10.4 m Lt
2	183.2	16+800.0	10.0 m Lt
3	183.2	16+770.0	10.0 m Lt
4	185.3	16+735.0	10.0 m Lt
5	185.6	16+735.0	13.0 m Rt
6	183.2	16+770.0	10.0 m Rt
7	183.2	16+800.0	10.0 m Rt
8	183.6	16+837.0	13.0 m Rt

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

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

REV.	DATE	BY	DESCRIPTION

Geocres No 41K-45

HWY No 17			DIST 18
SUBMD DD	CHECKED	DATE 87 12 02	SITE 385-7
DRAWN DT	CHECKED JF	***ISSUED	DWG 9106209-A

REF No E-8082-1, 87 07

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 1

METRIC

W P 910-62-09 LOCATION Sta. 16 + 837.0; 10.4 m Lt. of Hwy. 17 ℄ ORIGINATED BY MLP

DIST 18 HWY 17 BOREHOLE TYPE Cone Test, N-Casing COMPILED BY MLP

DATUM Geodetic DATE 87 06 18 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						GR SA SI CL
185.6	Ground Surface										
0.0	Sand Some Silt trace gravel, trace clay Loose (Fill)		1	SS	7				○		4 83 11 2
183.9			2	SS	10		184				
1.7			3	SS	16	87 6 19			○		11 79 (10)
			4	SS	13		182				
	Occ. Cobbles		5	SS	13				○		72 28 (0)
	Sand Occasional Silt Zones Occasional Gravelly Zones Occasional Cobbles		6	SS	9		180				
			7	SS	10		178		○		1 90 8 1
	Loose to Dense (Lacustrine)		8	SS	7		176		○		23 32 43 2
			9	SS	37		174				
173.0			10	SS	25						
12.6	End of Borehole						172				
170.7											
14.9	End of Cone Test										

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

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

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 2 METRIC

W P 910-62-09 LOCATION Sta. 16 + 800.0; 10.0 m Lt. of Hwy.17 ℄ ORIGINATED BY MLP
DIST 18 HWY 17 BOREHOLE TYPE Cone Test, N-Casing COMPILED BY MLP
DATUM Geodetic DATE 87 06 15 CHECKED BY DD

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
183.2	River Surface						
0.0	Water						182
179.4	River Bed						180
3.8	Occ. Cobbles		1	SS	15		178
			2	SS	19		
			3	SS	15		
	Sand Occ. Silt Zones Occ. Gravelly Zones Occ. Cobbles Loose to Compact (Lacustrine)		4	SS	8		176
			5	SS	9		174
			6	SS	11		
	Occ. Cobbles		7	SS	11		172
			8	SS	11		170
			9	SS	12		168
			10	SS	11		
			11	SS	11		166
163.7			12	SS	15		164
19.5	End of Borehole						
161.2							162
22.0	End of Cone Test						

DYNAMIC CONE PENETRATION RESISTANCE PLOT — 20 40 60 80 100

SHEAR STRENGTH
o UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE

PLASTIC LIMIT Wp | NATURAL MOISTURE CONTENT W | LIQUID LIMIT Wl
WATER CONTENT (%)

UNIT WEIGHT γ

REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

Cone Test Below Casing

OFFICE REPORT ON SOIL EXPLORATION

+3, ×5 : Numbers refer to Sensitivity

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 3 METRIC

W P 910-62-09 LOCATION Sta. 16 + 770.0; 10.0 m Lt. of Hwy. 17 ℄ ORIGINATED BY MLP
DIST 18 HWY 17 BOREHOLE TYPE Cone Test, N-Casing COMPILED BY MLP
DATUM Geodetic DATE 87 06 13 CHECKED BY DD

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 (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT W_P / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
183.2	River Surface										
0.0	Water						182				
179.8	River Bed						180				
3.4	Sand Occ. Silty Zones Occ. Gravelly Zones Occ. Cobbles Loose to Dense (Lacustrine)		1	SS	34		178		○		79 19 (2)
			2	SS	41				○		56 44 (0)
			3	SS	21				○		15 84 (1)
			4	SS	16		176				
			5	SS	11						
			6	SS	10		174				
			7	SS	7				○		6 93 (1)
			8	SS	11		172				
			9	SS	14		170				
167.8			10	SS	19		168		○		9 88 (3)
15.4 / 166.8	End of Borehole										
16.4	End of Cone Test										

OFFICE REPORT ON SOIL EXPLORATION

$+^3$, $\times^5$: Numbers refer to Sensitivity

15 20 10 5 (%) STRAIN AT FAILURE

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 4 METRIC

W P 910-62-09 LOCATION Sta. 16 + 735.0; 10.0 m Lt. of Hwy. 17 ℄ ORIGINATED BY MLP
DIST 18 HWY 17 BOREHOLE TYPE Cone Test, N-Casing COMPILED BY MLP
DATUM Geodetic DATE 87 06 22-23 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES			SHEAR STRENGTH: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	WATER CONTENT (%)	γ	GR SA SI CL
185.3	Ground Surface										
0.0	Sand Some Silt trace gravel, trace clay Loose (Fill)		1	SS	9						
183.5			2	SS	9						
1.8			3	SS	6	87 6 23					
			4	SS	11						
	Sand Occ. Silt Zones Occ. Gravelly Zones Occ. Cobbles Loose to Dense (Lacustrine)		5	SS	12						
			6	SS	46						
			7	SS	44						
			8	SS	14						
			9	SS	16						
172.7			10	SS	22						
12.6	End of Borehole										
168.2											
17.1	End of Cone Test										

ELEVATION SCALE: 184, 182, 180, 178, 176, 174, 172, 170

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

$+^3$, $\times^5$: Numbers refer to Sensitivity

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

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

OFFICE REPORT ON SOIL EXPLORATION

RECORD OF BOREHOLE No 5 METRIC

W P 910-62-09 LOCATION Sta. 16 + 735.0; 13.0 m Rt. of Hwy. 17 ℄ ORIGINATED BY MLP
DIST 18 HWY 17 BOREHOLE TYPE Cone Test, N-Casing COMPILED BY MLP
DATUM Geodetic DATE 87 06 23 CHECKED BY DD

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 (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE)	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT Wl — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
185.6	Ground Surface										
0.0	Sand Some Silt trace gravel, trace clay Compact (Fill)		1	SS	14						1 83 15 1
183.8			2	SS	13		184				0 81 19 0
1.8			3	SS	16	▼					11 75 13 1
			4	SS	9		182				
			5	SS	10						1 46 52 1
	Sand Occ. Silt Zones Occ. Gravelly Zones Occ. Cobbles		6	SS	9		180				
			7	SS	58		178				
	Loose to Very Dense (Lacustrine)		8	SS	57						24 76 (0)
			9	SS	32		176				
173.0			10	SS	12		174				
12.6	End of Borehole						172				
167.9							170				
17.7	End of Cone Test						168				

+3, ×5 : Numbers refer to Sensitivity

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

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 6

METRIC

W P 910-62-09 LOCATION Sta. 16 + 770.0; 10.0 m Rt. of Hwy. 17 ℄ ORIGINATED BY MLP

DIST 18 HWY 17 BOREHOLE TYPE Cone Test, N-Casing COMPILED BY MLP

DATUM Geodetic DATE 87 06 10 - 13 CHECKED BY DD

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
183.2	River Surface						
0.0							182
	Water						180
179.2	River Bed						
4.0			1	SS	26		178
			2	SS	23		
			3	SS	11		176
			4	SS	8		
			5	SS	4		174
	Sand						
	Occ. Silt Zones		6	SS	10		172
	Occ. Gravelly Zones						
	Occ. Cobbles		7	SS	16		170
	Loose to Compact (Lacustrine)		8	SS	12		
			9	SS	10		168
			10	SS	18		166
			11	SS	20		
163.2			12	SS	11		164
20.0	End of Borehole						162
159.9							160
23.3	End of Cone Test						

DYNAMIC CONE PENETRATION RESISTANCE PLOT — 20 40 60 80 100

SHEAR STRENGTH
o UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE

PLASTIC LIMIT W_P — NATURAL MOISTURE CONTENT W — LIQUID LIMIT W_L

WATER CONTENT (%)

UNIT WEIGHT γ

REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

Cone Test Below Casing

$+^3$, $\times^5$: Numbers refer to Sensitivity

$15 \overset{20}{\underset{10}{\diamond}} 5$ (%) STRAIN AT FAILURE

OFFICE REPORT ON SOIL EXPLORATION

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 7

METRIC

W P 910-62-09 LOCATION Sta. 16 + 800.0; 10.0 m Rt. of Hwy. 17 ℄ ORIGINATED BY MLP

DIST 18 HWY 17 BOREHOLE TYPE Cone Test, N-Casing COMPILED BY MLP

DATUM Geodetic DATE 87 06 09 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × LAB VANE	PLASTIC LIMIT W_P / NATURAL MOISTURE CONTENT W / LIQUID LIMIT W_L WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
183.2	River Surface										
0.0	Water						182				
							180				
178.8	River Bed										
4.4	Sand		1	SS	2		178				
			2	SS	10				○		60 40 (0)
	Occ. Silt Zones		3	SS	8		176		○		32 67 (1)
	Occ. Gravelly Zones		4B	SS	8						
	Occ. Cobbles										
	Very Loose to Compact		5B	SS	17		174		○		0 73 26 1
	(Lacustrine)		6	SS	7		172		○		0 99 (1)
			7	SS	10						
							170				
168.3			8	SS	20						
14.9	End of Borehole						168				
							166				
164.2											
19.0	End of Cone Test										

OFFICE REPORT ON SOIL EXPLORATION

$+^3$, $\times^5$: Numbers refer to Sensitivity

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

Ministry of Transportation and Communications
Ontario

RECORD OF BOREHOLE No 8

METRIC

W P 910-62-09 LOCATION Sta. 16 + 837.0; 13.0 m Rt. of Hwy. 17 ℄ ORIGINATED BY MLP

DIST 18 HWY 17 BOREHOLE TYPE Cone Test, N-Casing COMPILED BY MLP

DATUM Geodetic DATE 87 06 19 CHECKED BY DD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH: O UNCONFINED, + FIELD VANE, ● QUICK TRIAXIAL, × LAB VANE	PLASTIC LIMIT Wp / NATURAL MOISTURE CONTENT W / LIQUID LIMIT WL — WATER CONTENT (%)	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	'N' VALUES						
183.6	Ground Surface										
0.0	Sand Occ. Silt Zones Occ. Gravelly Zones Occ. Cobbles Loose to Compact (Lacustrine)		1	SS	11	▼	182				
			2	SS	10						
			3	SS	10		180				
			4	SS	8						
			5	SS	10		178				
			6	SS	22						
			7	SS	11		176				
			8	SS	12		174				
			9	SS	6		172				
171.0			10	SS	15						
12.6	End of Borehole						170				
167.8							168				
15.8	End of Cone Test										

$+^3$, $\times^5$: Numbers refer to Sensitivity

20
15 ⊹ 5 (%) STRAIN AT FAILURE
10

OFFICE REPORT ON SOIL EXPLORATION

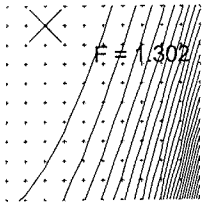
Appendix D

Slope Stability Output

	Gamma kN/m3	C kPa	Phi deg	Min c/p	Piezo Surf.
Water	9.81	0	0	0	1
Earth Fill	20	0	30	0	1
Sand	20	0	30	0	1

Thurber Engineering Ltd. - Toronto
19-1351-185
Batchawana River Bridge Rehabilitation
Hwy 17

February 4, 2011



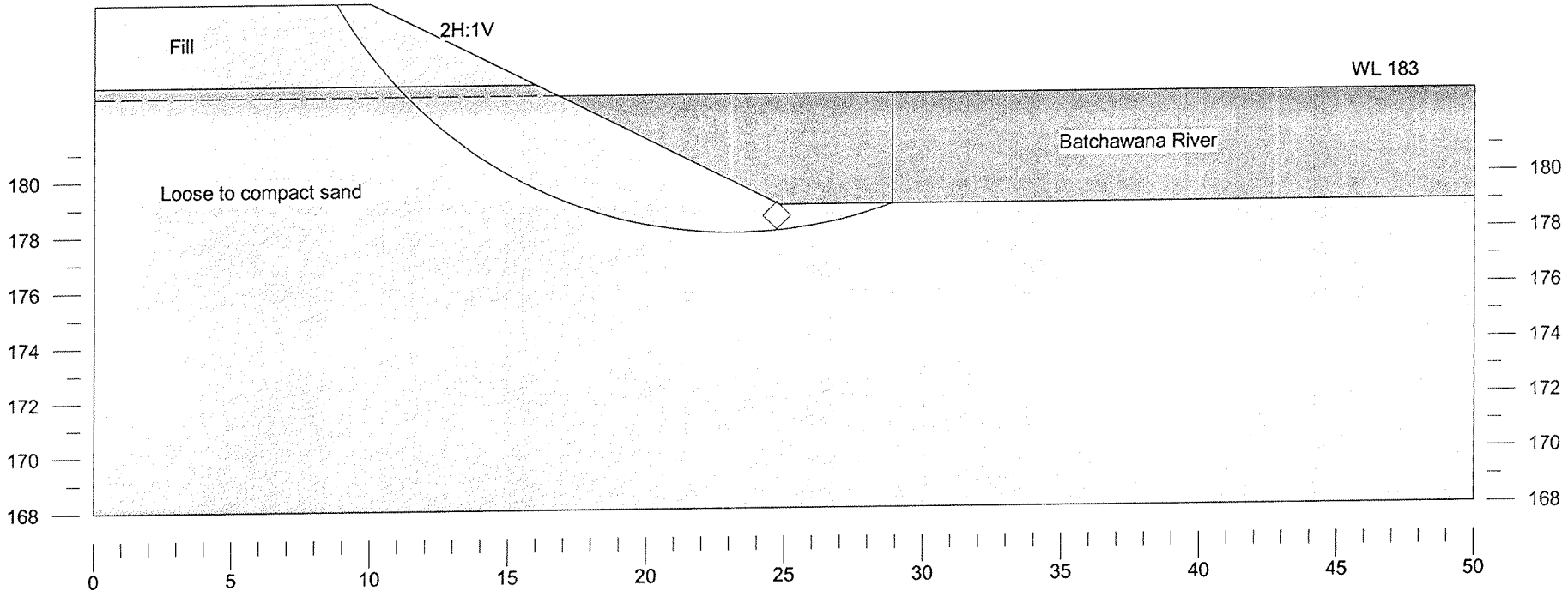
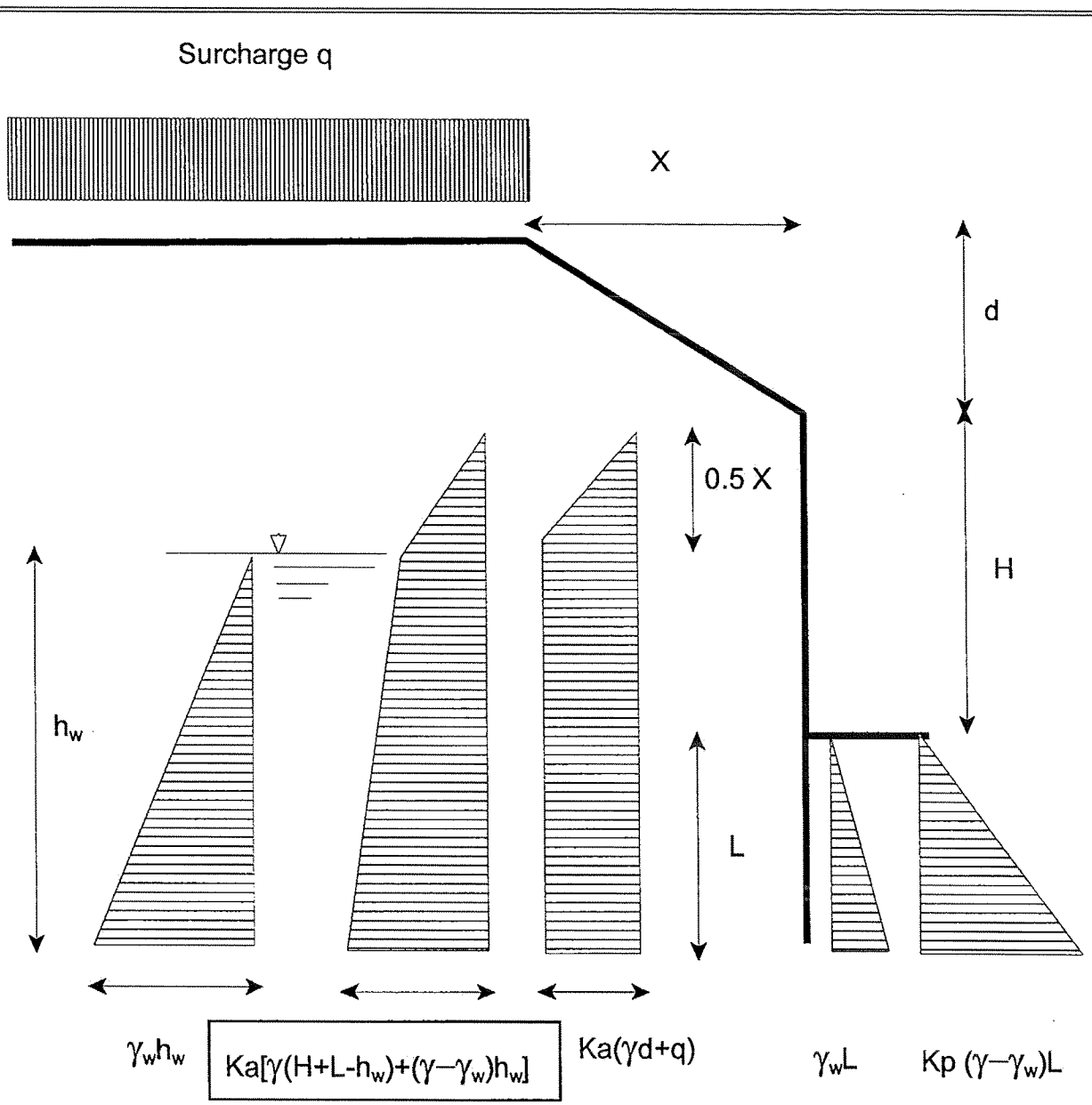


FIGURE 1

2/15/2011 5:55:44 PM H:\19\1351\185BRI~1\REPORT~1\04BATC~1\ANALYSIS\SLO2A.GSL Thurber Engineering Ltd. - Toronto F = 1.302

Appendix E

Figure 1



γ = unit weight of soil

γ_w = unit weight of water

Ka = active earth pressure coefficient

Kp = passive earth pressure coefficient

THURBER

LATERAL EARTH PRESSURES

CANTILEVERED SHORING

FIGURE 1

Appendix F

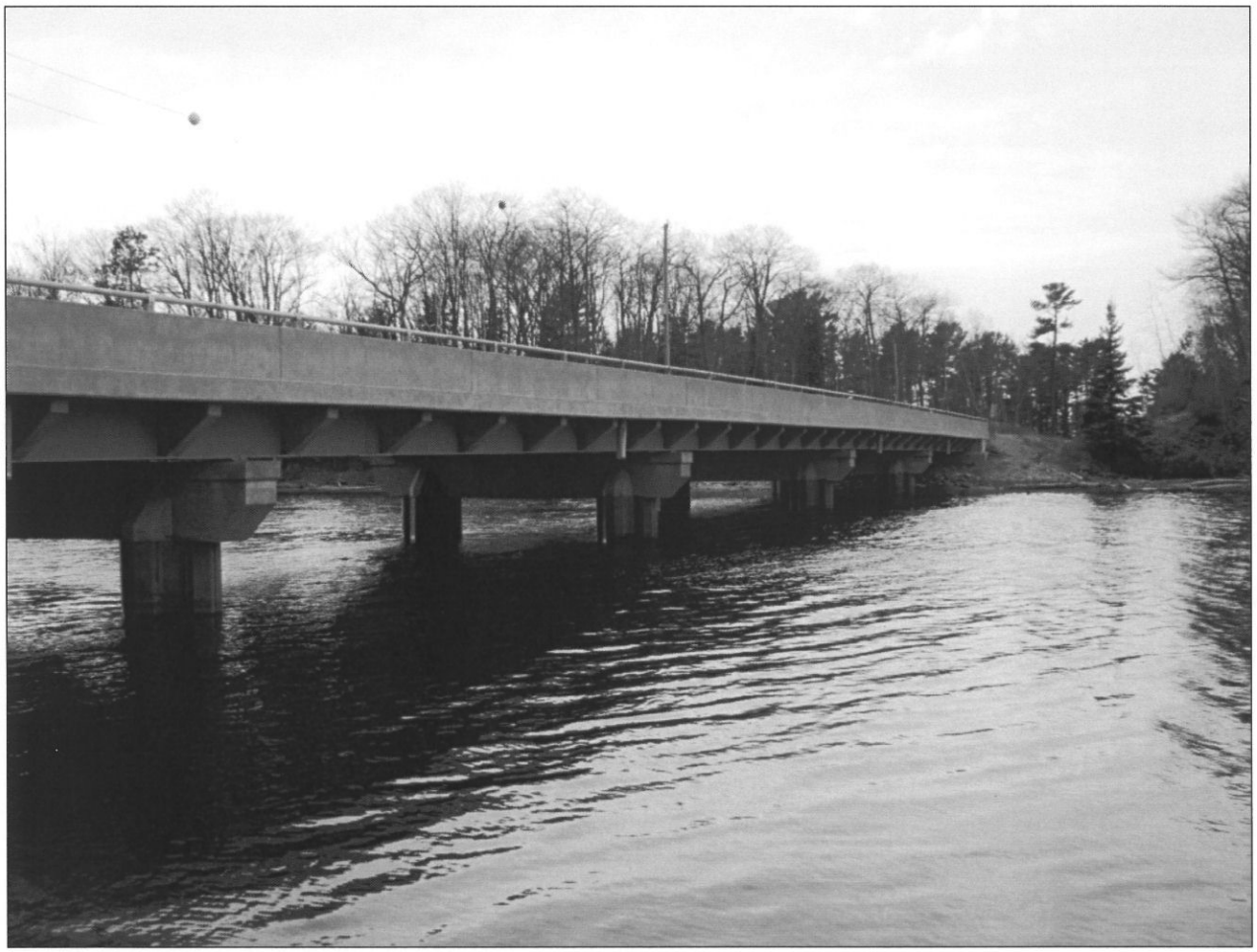
List of SPs and OPSS

The following Special Provisions documents are referenced in this report:

- OPSS 539
- OPSS 902, November 2010.
- Special Provision 110S13 "Amendment to OPSS 1010, April 2004
- OPSD 3101.150
- SP105S10
- OPSS 804, November 2010

Appendix G

Site Photographs



Photograph 1 – General view of the Batchawana River bridge

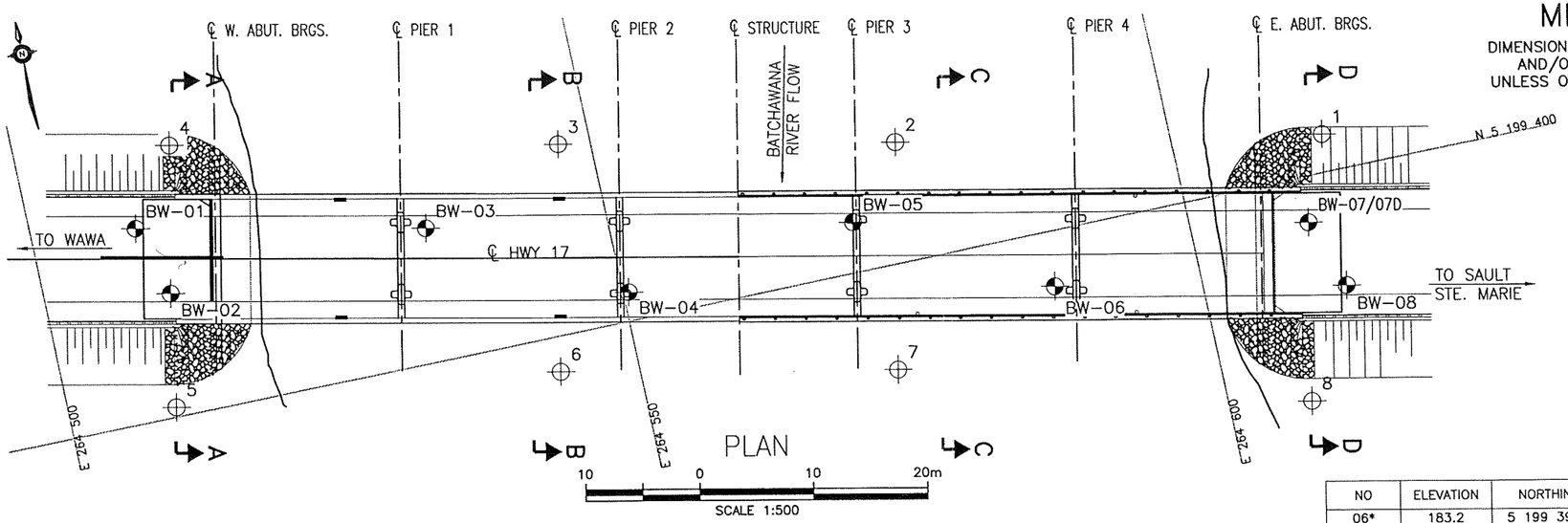
Photograph 2 – Existing conditions of bridge deck

Photograph 3 – Bridge embankment

Appendix H

Drawing titled "Borehole Locations and Soil Strata"

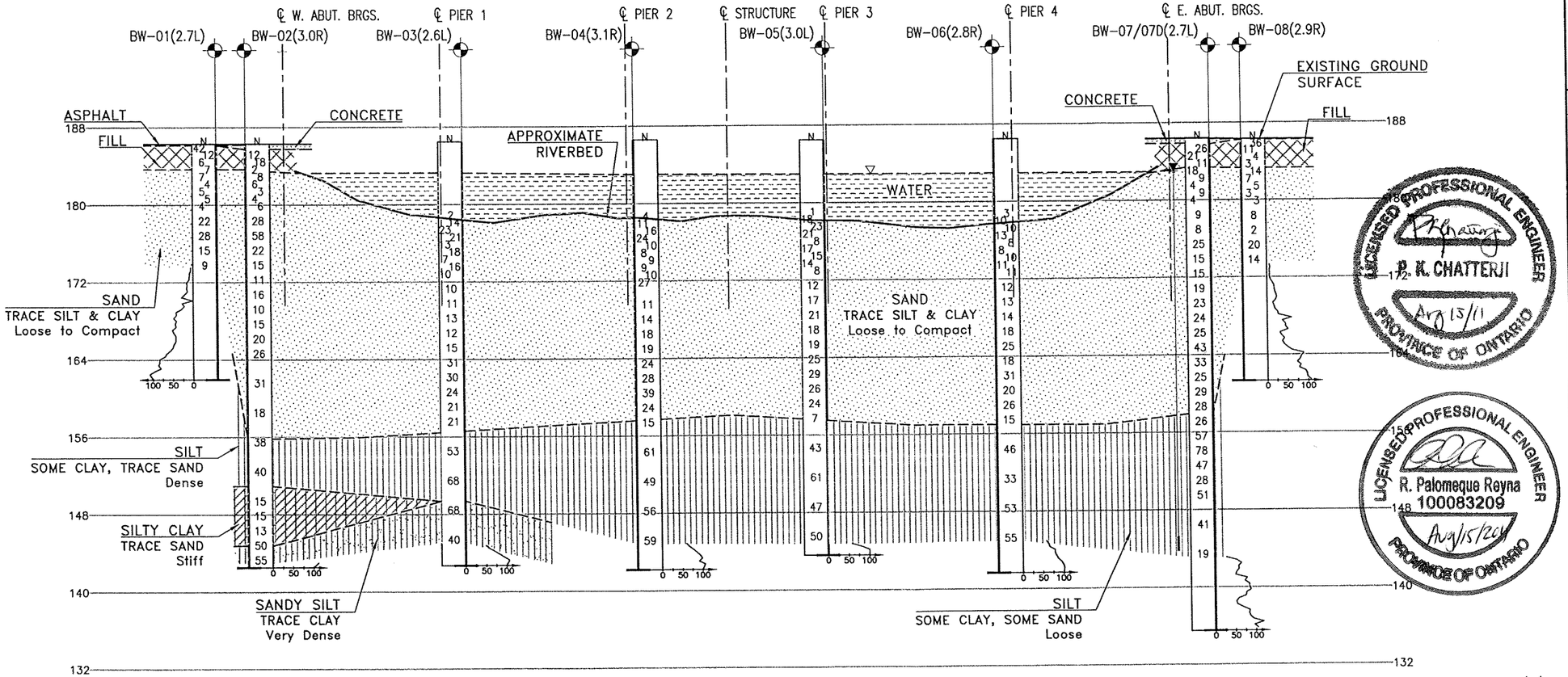
MINISTRY OF TRANSPORTATION, ONTARIO



METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

NO	ELEVATION	NORTHING	EASTING
06*	183.2	5 199 396.9	264 543.2
07*	183.2	5 199 390.9	264 572.2
08*	183.6	5 199 380.6	264 607.2



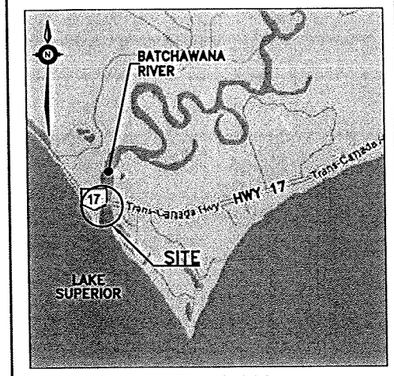
CONT No
WP No 5112-05-00

SHEET

HIGHWAY 17
BATCHAWANA RIVER
BRIDGE REHABILITATION
BOREHOLE LOCATIONS AND SOIL STRATA

McCORMICK RANKIN CORPORATION

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

⊕	Borehole and Cone (Current Investigation)
⊕	Borehole (Previous Investigation)
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
BW-01	186.3	5 199 416.9	264 509.2
BW-02	186.3	5 199 410.7	264 511.0
BW-03	186.5	5 199 411.7	264 534.2
BW-04	186.6	5 199 402.5	264 550.5
BW-05	186.5	5 199 404.4	264 571.1
BW-06	186.5	5 199 395.2	264 587.3
BW-07/07D	186.4	5 199 396.0	264 610.3
BW-08	186.3	5 199 389.9	264 612.4
01*	185.6	5 199 403.3	264 613.1
02*	183.2	5 199 410.5	264 576.2
03*	183.2	5 199 416.5	264 547.2
04*	185.3	5 199 423.4	264 513.6
05*	185.6	5 199 400.8	264 509.4

* APPROX. BOREHOLE LOCATION

-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.

GEOCRES No. 41K-88

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Aug 15/11
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
R. Palomeque Reyna
100083209
Aug/15/2011
PROVINCE OF ONTARIO

REVISIONS			
DATE	BY	DESCRIPTION	
DESIGN RPR	CHK	CODE	LOAD — DATE JUN. 2011
DRAWN AN	CHK RPR	SITE	STRUCT — DWG 1

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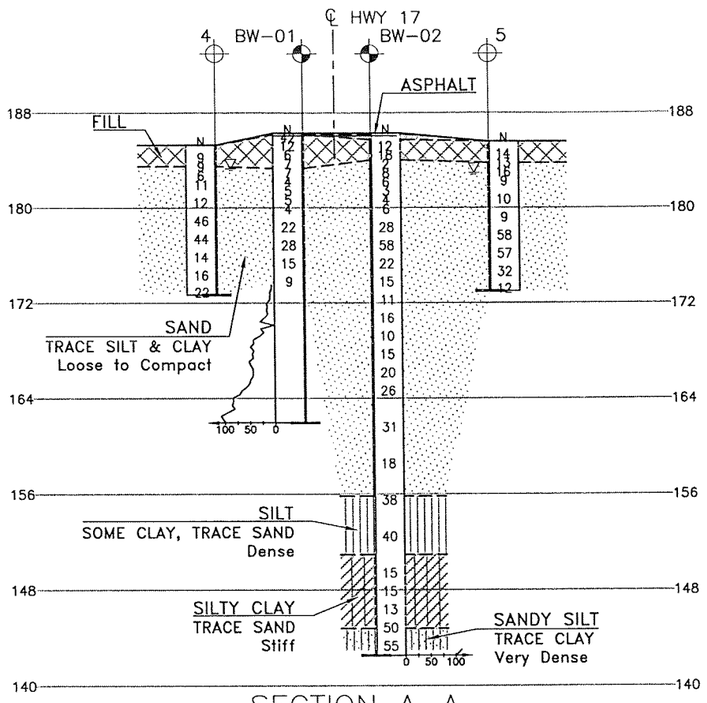
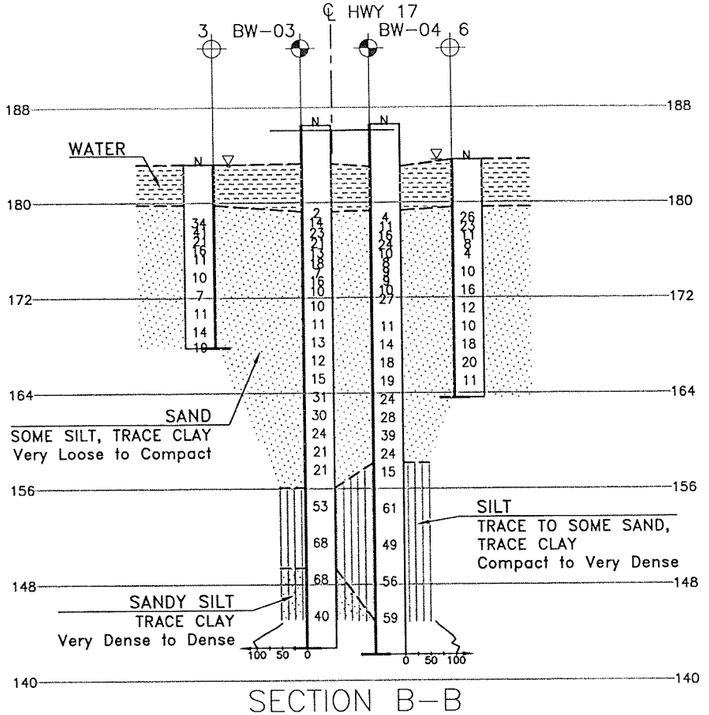
PLOTDATE: 6/20/2011 10:56 AM

MINISTRY OF TRANSPORTATION, ONTARIO



SECTION A–A



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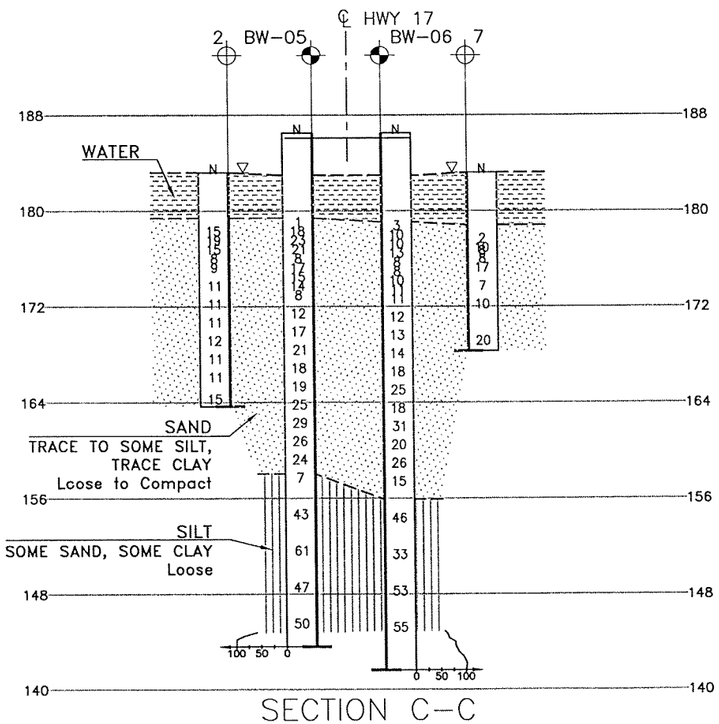
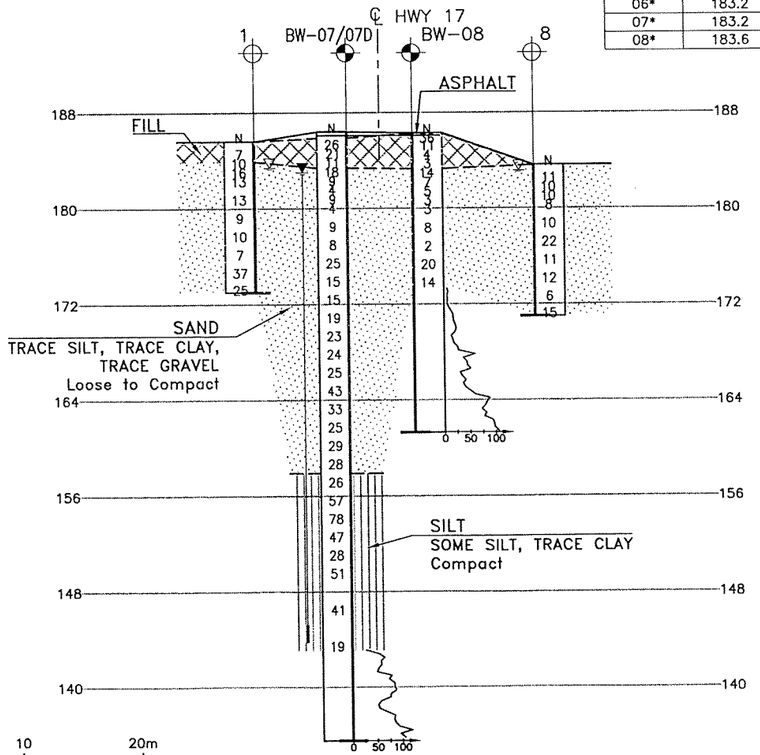


SECTION C–C



SECTION D–D

NO	ELEVATION	NORTHING	EASTING
06*	183.2	5 199 396.9	264 543.2
07*	183.2	5 199 390.9	264 572.2
08*	183.6	5 199 380.6	264 607.2

10 0 10 20m

SCALE 1:500

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

LICENSED PROFESSIONAL ENGINEER
P. K. CHATTERJI
Aug 15/11
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
R. Palomeque Reyna
100083209
Aug/15/11
PROVINCE OF ONTARIO

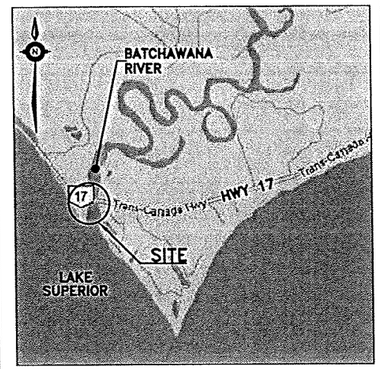
CONT No
WP No 5112-05-00

HIGHWAY 17
BATCHAWANA RIVER
BRIDGE REHABILITATION
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

MRC McCORMICK RANKIN CORPORATION

THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

	Borehole (Previous Investigation)
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
BW-01	186.3	5 199 416.9	264 509.2
BW-02	186.3	5 199 410.7	264 511.0
BW-03	186.5	5 199 411.7	264 534.2
BW-04	186.6	5 199 402.5	264 550.5
BW-05	186.5	5 199 404.4	264 571.1
BW-06	186.5	5 199 395.2	264 587.3
BW-07/7D	186.4	5 199 396.0	264 610.3
BW-08	186.3	5 199 389.9	264 612.4
01*	185.6	5 199 403.3	264 613.1
02*	183.2	5 199 410.5	264 576.2
03*	183.2	5 199 416.5	264 547.2
04*	185.3	5 199 423.4	264 513.6
05*	185.6	5 199 400.8	264 509.4

* APPROX. BOREHOLE LOCATION

-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.

GEOCRES No. 41K-88

REVISIONS			
DATE	BY	DESCRIPTION	
DESIGN RPR	CHK	CODE	LOAD
DRAWN AN	CHK RPR	SITE	STRUCT
		DATE JUN. 2011	DWG 2

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