



Terraprobe

*Consulting Geotechnical & Environmental Engineering
Construction Materials Inspection & Testing*

**FOUNDATION INVESTIGATION REPORT
HIGH FILLS AT PORT ROBINSON ROAD
HIGHWAY 406 TWINNING
PORT ROBINSON ROAD TO EAST MAIN STREET
AGREEMENT No. 2008-E-0016, W.P. 280-99-00
GEOCRES NO. 30M3-264**

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PART 1: FACTUAL INFORMATION

1 INTRODUCTION

This report presents the factual findings obtained from foundation investigations conducted at high fill areas along the proposed alignment of Port Robinson Road in the City of Thorold, Regional Municipality of Niagara, Ontario.

The purpose of this investigation was to explore the subsurface conditions at this site and based on the data obtained, to provide borehole location plans, records of boreholes, stratigraphic profiles, laboratory test results and a description of the subsurface conditions. A model of the subsurface conditions was developed from the data obtained.

Terraprobe conducted the investigation as a sub-consultant to Giffels Associates Ltd./IBI Group, under the Ministry of Transportation Ontario (MTO) Agreement Number 2008-E-0016.

2 SITE DESCRIPTION & PHYSIOGRAPHY

The alignment is located approximately 25 m south of the existing at grade intersection of Highway 406 and Port Robinson Road. It merges with the existing Port Robinson Road approximately 300 m east and west of the intersection. At this location Highway 406 is a two-lane highway with gravel shoulders carrying both north and south bound traffic.

The topography is flat consisting of farmland and open fields. Vegetation consists primarily of deciduous trees and wild bush and areas of groomed grass can be found at some locations along the existing roadways.

The site is located between the Niagara Escarpment and Lake Erie in the physiographic region of Southern Ontario referred to as the Haldimand Clay Plain. The Haldimand Clay Plain is best described as falling into a series of parallel belts with the highest ground adjacent to the Escarpment. Generally this region is flat and poorly drained although it includes several distinctive landforms such as dunes, cobble, clay and sand beaches, limestone pavements and back-shore wetland basins¹.

¹ Chapman and Putnam, "The Physiography of South Ontario", 3rd Edition, 1984.



The Niagara Region is underlain by a sequence of very gently south-dipping dolostones, limestones, shales and sandstones overlying Precambrian basement rock. The key elements in the bedrock geology of the region are the multiple layers of softer sedimentary limestones, shale, sandstone and dolostone.

The bedrock unit at this site is the Guelph Formation of Upper Silurian Age². This unit consists essentially of unweathered, grey, laminated argillaceous dolostone.

3 SITE INVESTIGATION AND FIELD TESTING

The site investigation and field testing for this project were carried out between December 21, 2009 and July 13, 2010 and consisted of drilling and sampling ten boreholes to depths ranging from 18.8 m to 38.0 m. The boreholes were numbered PR1 to PR10 and their approximate locations are shown on the attached Borehole Locations and Soil Strata Drawings in Appendix C.

The borehole locations were marked in the field by surveyors from Callon Dietz Inc. who also provided Terraprobe with their coordinates and geodetic elevations. Access to Borehole PR3 was difficult due to locally steep slopes and this borehole was relocated to be as close as feasible to the staked out location while allowing safe operation of the drill rig. Terraprobe obtained utility clearances and permits prior to drilling.

Samples of the overburden soils were obtained at selected intervals using a split spoon sampler in conjunction with Standard Penetration Testing (SPT), as specified in ASTM Method D1586. In the cohesive (clayey) deposits the undrained shear strength of the soil was measured in-situ by means of field vane tests using an MTO type field vane. Relatively undisturbed soil samples were also collected with thin-walled Shelby Tube samplers. Boreholes drilled for the proposed bridge were also advanced into bedrock by NQ size diamond coring techniques.

Ground water conditions in the open boreholes were observed throughout the drilling operations and standpipe piezometers consisting of 19 mm diameter PVC pipe with a slotted screen enclosed in sand were installed in selected boreholes to permit longer term ground water level monitoring. The remaining boreholes were abandoned in accordance with MOE Regulation 903 by sealing/grouting with a clay slurry mixture after drilling was complete.

² Ontario Division of Mines, "Quaternary Geology Of The Welland Area", Preliminary Map P.796, 1972.



The locations and completion details of the piezometers are shown in Table 3.1.

Table 3.1 – Piezometer Installation Details

Piezometer Location	Piezometer Details	
	Tip Depth/ Elevation (m)	Completion Details
PR1	32.0/149.7	Piezometer with 1.5 m slotted screen installed with filter sand to 29.9 m, bentonite seal from 29.9 m to 29.0 m, silty clay cuttings from 29.0 m to 1.5 m and bentonite seal from 1.5 m to ground surface.
PR3	32.0/149.3	Hole sealed to 32.0 m with bentonite, piezometer with 1.5 m slotted screen installed with filter sand to 29.9 m and bentonite seal from 29.9 m to ground surface.
PR4	14.6/167.6	Hole sealed to 14.8 m with bentonite, piezometer with 1.5 m slotted screen installed with filter sand to 12.8 m and bentonite seal from 12.8 m to ground surface.
PR5	30.5/150.7	Piezometer with 1.5 m slotted screen installed with filter sand to 28.3 m, bentonite seal from 28.3 m to 27.1 m, silty clay cuttings from 27.1 m to 0.6 m and bentonite seal from 0.6 m to ground surface.
PR6	10.7/168.3	Hole sealed to 10.7 m with bentonite, piezometer with 1.5 m slotted screen installed with filter sand to 8.5 m, bentonite seal from 8.5 m to 7.9 m, silty clay cuttings from 7.9 m to 0.6 m and a flush mounted casing installation from 0.6 m to ground surface.
PR8	16.8/163.8	Piezometer with 1.5 m slotted screen installed with filter sand to 14.6 m, bentonite seal from 14.6 m to 14.0 m, silty clay cuttings from 14.0 m to 0.6 m and bentonite seal from 0.6 m to ground surface.
PR9	16.8/164.8	Piezometer with 1.5 m slotted screen installed with filter sand to 14.6 m, bentonite seal from 14.6 m to 14.0 m, silty clay cuttings from 14.0 m to 1.5 m and bentonite seal from 1.5 m to ground surface.
PR10	13.7/167.8	Piezometer with 1.5 m slotted screen installed with filter sand to 11.9 m, bentonite seal from 11.9 m to 11.3 m, silty clay cuttings from 11.3 m to 0.6 m and bentonite seal from 0.6 m to ground surface.

The drilling, sampling and in-situ testing operations were observed on a full time basis by members of Terraprobe's technical staff who logged the boreholes and processed the recovered soil and rock samples for transport to Terraprobe's Brampton laboratory for further examination and testing.

4 LABORATORY TESTING

The recovered soil samples were subjected to Visual Identification (VI) and natural moisture content determination. Select samples were also subjected to a laboratory testing programme consisting of gradation analysis, Atterberg Limits tests, consolidation tests, unit weight and undrained shear strength testing with a laboratory vane. The results of this testing program are shown on the Record of Borehole sheets in Appendix A and the figures 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” drawings in Appendix C. An overall description of the stratigraphy is given in the following paragraphs. However, the factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions.

In general, the site is underlain by topsoil, asphalt, fill material (gravelly sand to sandy gravel, silty sand and silty clay) and native overburden deposits of silty clay, silt, silty clay to clayey silt, and clayey silt till. These soils are underlain by bedrock consisting primarily of dolostone of the Guelph formation.

5.1 Topsoil

Topsoil ranging from 50 mm to 300 mm in thickness was encountered at this site. Topsoil thickness may vary between and beyond the boreholes.

5.2 Asphalt

Borehole PR6 was drilled through the existing pavement on Port Robinson Road. This borehole encountered an approximately 130 mm thick layer of asphalt.

5.3 Fill – Gravelly Sand to Sandy Gravel

Boreholes PR4 and PR6 encountered layers of gravelly sand and sandy gravel fill extending to depths of 0.7 m (Elev. 181.5 m) and 1.4 m (Elev. 177.6 m) respectively.

A sample of the gravelly sand fill was subjected to a grain size analysis and the results are presented in Figure B1. These results show a grain size distribution consisting of 22% gravel, 50% sand, 20% silt and 8% clay size particles.

Standard Penetration tests in the gravelly sand to sandy gravel fill gave ‘N’ values ranging from 12 to 53 blows for 0.3 m penetration. Based on these results the fill is considered to have a compact to very dense relative density. The moisture content of samples of this fill ranged from 4% to 8% by weight.

5.4 Fill – Silty Sand

An approximately 1.1 m thick layer of silty sand fill was encountered in Borehole PR3 extending to a depth of 1.4 m (Elev. 179.9 m) below ground surface. Based on visual and tactile examinations of the retrieved samples, the fill is essentially a cohesionless material with frequent cohesive silty clay inclusions.

A sample of this fill material was subjected to a grain size analysis and the results are presented in Figure B2. These results show a grain size distribution consisting of 0% gravel, 48% sand, 34% silt and 18% clay size particles.



Standard Penetration tests in the fill gave 'N' values that ranged from 4 to 8 blows for 0.3 m penetration. Based on these results the fill is considered to have a loose relative density. The moisture content of samples of this fill ranged from 15% to 20% by weight.

5.5 Fill – Silty Clay

Silty clay fill material was encountered at this site extending to depths ranging from 0.7 m (Elev. 180.9 m) to 2.9 m (Elev. 176.1 m) below ground surface.

Samples of this fill were subjected to grain size analysis and the results are illustrated in Figure B3. These results show a grain size distribution consisting of 0% gravel, 8-32% sand, 35-45% silt and 30-57% clay size particles.

The fill material was also subjected to Atterberg Limits tests and the results are plotted on the plasticity chart, Figure B4. The index values from these tests are summarized below:

Liquid Limit:	35-40%
Plastic Limit:	19-20%
Plasticity Index:	16-20%
Natural Moisture Content:	18-36%

These values are characteristic of clayey soils of intermediate plasticity.

Standard Penetration tests in the silty clay fill gave 'N' values that ranged from 4 to 22 blows for 0.3 m penetration but generally the recorded 'N' values ranged from 4 to 11 blows for 0.3 m penetration. Based on these results the fill is considered to have a generally firm to stiff consistency with occasional very stiff zones. The moisture content of samples of this fill ranged from 13% to 36% by weight.

5.6 Silty Clay

A silty clay deposit was encountered across the site. This stratum was fully penetrated in all of the boreholes where it was found to extend to depths ranging from 13.9 m to 15.7 m below ground surface or to elevations ranging from 167.7 m to 165.1 m.

The grain size distribution plots of tested samples of the silty clay are presented in Figures B5 to B12 inclusive. These results show a grain size distribution consisting of 0-7% gravel, 0-4% sand, 16-77% silt and 23-83% clay size particles.

Samples of the silty clay were also subjected to Atterberg Limits tests and the results are illustrated on the plasticity charts, Figures B13 to B20 inclusive. The index values from these tests are summarized below:

Liquid Limit:	25-61%
Plastic Limit:	16-27%
Plasticity Index:	8-35%
Natural Moisture Content:	19-47%



These values indicate that the silty clay has a low to high plasticity.

Standard Penetration tests in this stratum gave 'N' values ranging from 0 to 44 blows for 0.3 m penetration. Field vane tests gave in-situ undrained shear strengths ranging from 24 kPa to in excess of 100 kPa and laboratory vane tests on relatively undisturbed Shelby tube samples gave undrained shear strengths ranging from 38 kPa to 108 kPa. These values indicate that the consistency of the silty clay is generally firm to very stiff with infrequent soft zones. The moisture contents of samples of the silty clay range from 18% to 47% by weight and the unit weight of selected samples ranged from 17.4 to 20.3 kN/m³.

The variation of undrained shear strength with elevation is depicted in Figure B29 (Elev. ± 181.0 m to Elev. ± 166.0 m). This "lower bound" plot generally illustrates a trend of decreasing shear strength with depth. The upper portion of this deposit up to about Elev. 177.5 m is estimated to have a relatively high undrained shear strength i.e. in excess of 100 kPa. Below Elev. 177.5 m the undrained shear strength decreases with depth and is about 30 kPa at about Elev. 170.0 m. Below Elev. 170.0 m the trend indicates increasing undrained shear strength with depth.

The Atterberg Limits tests results are also plotted against elevation, Figure B30 (Elev. ± 181.0 m to Elev. ± 166.0 m). These results illustrate that the natural moisture contents of this deposit are generally at or below the plastic limit above Elev. 178.0 m. Below Elev. 178.0 m the natural moisture content increases and is between the plastic and liquid limits.

Consolidation tests were also performed on Shelby tube samples retrieved from Boreholes PR1 and PR5 and the results are presented in Figures B31 to B36 inclusive. Preconsolidation pressures were estimated from the e-log p curves. Due to the rounded nature of the curves the preconsolidation pressures were also assessed based on the 'Work' – method proposed by Becker et al. (1987). The details of the test results are summarized below.

Borehole/Sample No.	Sample Depth/Elevation (m)	P _c (kPa)	C _c	C _r	e _o
PR1 TW8	6.1/175.6	270 – 360	0.321	0.060	0.79
PR5 TW9	7.6/173.6	200 – 350	0.337	0.049	0.75

Where: P_c = Preconsolidation pressure
C_c = Compression index
C_r = Recompression index
e_o = Initial void ratio

5.7 Silt

A native silt deposit was encountered at this site in all of the boreholes. The stratum is approximately 2.1 m to 5.0 m thick and extends to depths ranging from 16.8 m to 18.9 m below ground surface or to elevations ranging from 164.6 m to 160.1 m. Based on visual and tactile examinations of the retrieved samples, the unit is essentially a cohesionless silt with frequent cohesive silty clay seams and partings.



The grain size distribution plots of tested samples of this silt deposit are presented in Figures B21 and B22. These results show a grain size distribution consisting of 0-1% gravel, 0-6% sand, 75-96% silt and 3-24% clay size particles.

The deposit is considered to have a very loose to compact relative density based on SPT 'N' values that ranged from 0 to 26 blows for 0.3 m penetration. SPT 'N' values of 0 are likely attributed to sample disturbance. The moisture content of samples from this deposit ranged from 16% to 29% by weight.

5.8 Silty Clay to Clayey Silt

A deposit of silty clay to clayey silt was encountered across this site. This stratum was fully penetrated in Boreholes PR1 to PR5 where it extends to depths ranging from 26.9 m (Elev. 154.8 m) to 29.9 m (Elev. 152.3 m) below ground surface. The remaining boreholes were terminated in this deposit at depths ranging from 18.8 m to 21.8 m below ground surface or to elevations ranging from 161.8 m to 158.7 m.

The grain size distribution plots of tested samples from this stratum are depicted in Figures B23 and B24. These results show a grain size distribution consisting of 0-7% gravel, 0-14% sand, 59-81% silt and 16-37% clay size particles.

Samples were also subjected to Atterberg Limits tests and the results are plotted on the plasticity charts, Figures B25 and B26. The index values from these tests are summarized below:

Liquid Limit:	22-39%
Plastic Limit:	14-20%
Plasticity Index:	4-19%
Natural Moisture Content:	16-31%

These values indicate that the silty clay to clayey silt is generally of low plasticity with occasional zones of intermediate plasticity.

Standard Penetration tests in this deposit yielded 'N' values ranging from 6 to 43 blows for 0.3 m penetration. Field vane tests were also performed in this deposit and the results indicate undrained shear strengths ranging from 80 kPa to in excess of 100 kPa. Based on these results the silty clay to clayey silt is considered to have a stiff to hard consistency with occasional firm zones. The moisture content of samples from these deposits varies from 9% to 34% by weight.

The variation of undrained shear strength with elevation is depicted in Figure B29 (Elev. ± 163.5 m to Elev. ± 153.0 m). This "lower bound" plot illustrates a slight decrease in shear strength with depth. The undrained shear strength decreases from about 95 kPa at Elev. 163.5 m to about 75 kPa at Elev. 157.0 m. Below Elev. 157.0 m the trend indicates increasing undrained shear strength with depth.

The Atterberg Limits tests results are also plotted against elevation, Figure B30 (Elev. ± 163.5 m to Elev. ± 153.0 m). These results illustrate that the natural moisture content of the upper portion of this deposit is generally at or below the plastic limit above Elev. 158.0 m. Between Elev. 158.0 m



and Elev. 154.0 m the natural moisture content increases and is generally between the plastic and liquid limits. Below Elev. 154.0 m the natural moisture content is below the plastic limit.

5.9 Clayey Silt Till

Clayey silt till was encountered across the site extending to depths ranging from 33.5 m to 34.3 m below ground surface or to elevations ranging from 148.2 m to 147.7 m. Boreholes PR1 and PR5 were terminated in this deposit at depths of 32.0 m (Elev. 149.7 m) and 30.5 m (Elev. 150.7 m) respectively. The lower 1.5 m to 1.8 m of this stratum overlying bedrock contains frequent cobbles and in Borehole PR3 a boulder was encountered above the bedrock.

The grain size distribution plot of a tested sample from this till deposit is depicted in Figure B27. These results show a grain size distribution consisting of 3% gravel, 18% sand, 64% silt and 15% clay size particles.

A sample was also subjected to an Atterberg Limits test and the results are plotted on the plasticity chart, Figure B28. The index values from these tests are summarized below:

Liquid Limit:	20%
Plastic Limit:	14%
Plasticity Index:	6%
Natural Moisture Content:	11%

This data is typical of a low plasticity clayey silt soil.

Standard Penetration tests in this stratum yielded 'N' values ranging from 16 to more than 100 blows per 0.3 m penetration but generally the recorded 'N' values ranged from 30 to more than 100 blows for 0.3 m penetration. Based on these results the clayey silt till is considered to have a hard consistency with occasional very stiff zones. The moisture content of samples from this deposit varies from 3% to 23% by weight.

5.10 Bedrock (Guelph Formation)

The overburden soils described above are underlain by the Guelph Formation. Bedrock was proved by coring at the abutment and pier locations of the proposed bridge structure. Table 5.1 summarizes the bedrock depth and the elevations to the top of bedrock.

Table 5.1 – Depth to Bedrock

Location	BH Number	Depth to Bedrock (m)	Top of Bedrock Elevation (m)
West Abutment	PR2	33.5	148.2
Pier	PR3	33.6	147.7
East Abutment	PR4	34.3	147.9

The bedrock is described as unweathered dolostone and its colour is light to medium brownish grey. Total core recovery in the bedrock generally ranged from 52% to 100%. The RQD values ranged widely from 0% to 76%, but generally most of the RQD values were between 24% and



69%. The core data also reveals that there is no trend of improving rock quality with depth. Based on these results the rock quality is considered to be very poor to fair with infrequent zones of good quality rock.

5.11 Water Levels

A standpipe piezometer was installed in selected boreholes. The water level readings measured on separate visits made after the completion of drilling are presented in Table 5.2.

Table 5.2 – Water Level Measurements

Borehole	Date	Water Levels	
		Depth (m)	Elevation (m)
PR1	January 11, 2010	7.0	174.7
	January 19, 2010	7.2	174.5
	January 27, 2010	7.1	174.6
	February 08, 2010	7.2	174.5
	February 19, 2010	7.1	174.6
PR3	January 19, 2010	8.2	173.1
	January 27, 2010	6.6	174.7
	February 08, 2010	0.6	180.7
	February 19, 2010	0.5	180.8
PR4	February 08, 2010	5.0	177.2
	February 19, 2010	4.5	177.7
	April 16, 2010	4.3	177.9
PR5	January 19, 2010	6.4	174.8
	January 27, 2010	6.2	175.0
	February 08, 2010	6.3	174.9
	February 19, 2010	6.2	175.0
PR6	July 21, 2010	1.9	177.1
	July 26, 2010	1.9	177.1
PR8	July 19, 2010	2.9	177.7
	July 26, 2010	2.8	177.8
PR9	July 19, 2010	3.5	178.1
	July 26, 2010	3.3	178.3
PR10	July 19, 2010	2.8	178.7
	July 26, 2010	2.1	179.4

The ground water table was estimated based on the recorded water levels in the standpipe piezometers and our review of the moisture contents of the retrieved samples. Based on these observations and interpretations, the local ground water level is estimated to be about Elev. ± 177.0 m in the vicinity of Sta. 9+750 increasing gradually to about Elev. ± 179.5 m at the Port Robinson Road/Highway 406 intersection. The ground water elevation east of the Port Robinson Road/Highway 406 intersection varies between Elev. ± 179.0 m and Elev. ± 178.5 m. At Borehole PR3, perched water exists in the silty sand fill at Elev. ± 180.8 m.

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



5.12 Miscellaneous

The drilling, sampling and in-situ testing operations were conducted with track and truck mounted drill rigs owned and operated by DBW Drilling Limited of Ajax, Ontario and Determination Drilling & Soil Investigations of Hamilton, Ontario. The boreholes were extended using both hollow stem and solid stem auger drilling techniques. NQ size rock cores of the bedrock were obtained using diamond drilling techniques.

Messrs. Alexander Winkelmann, E.I.T., Phil Khoo, B.A.T. and Brady Lin, P.Eng. carried out the field work. The laboratory testing was performed at Terraprobe's Brampton laboratory and the Mississauga laboratory of Golder Associates. The report was written by Rehman Abdul, P.Eng. and reviewed by Michael Tanos, P.Eng.

Rehman Abdul

Prepared by:
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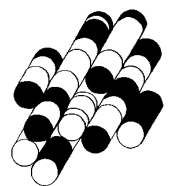
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APPENDICES

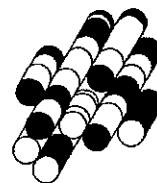
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APPENDIX A

Record of Borehole Sheets

Terraprobe Inc.



LIMITATIONS AND RISK

Procedures

The soil conditions were confirmed at the borehole and test pit locations only and conditions may vary between and beyond the boreholes. The boundaries between the various strata as shown on the logs are based on non-continuous sampling. These boundaries represent an inferred transition between the various strata, rather than a precise plane of stratigraphic change.

This investigation has been carried out using investigation techniques and engineering analysis methods consistent with those ordinarily exercised by Terraprobe and other engineering practitioners, working under similar conditions and subject to the time, financial and physical constraints applicable to this project. The discussions and recommendations that have been presented are based on the factual data obtained.

It must be recognized that there are special risks whenever engineering or related disciplines are applied to identify subsurface conditions. Even a comprehensive sampling and testing programme implemented in accordance with the most stringent level of care may fail to detect certain conditions. Terraprobe has assumed for the purposes of providing design parameters and advice, that the conditions that exist between sampling points are similar to those found at the sample locations. The conditions that Terraprobe has interpreted to exist between sampling points can differ from those that actually exist.

It may not be possible to drill a sufficient number of boreholes or sample and report them in a way that would provide all the subsurface information that could affect construction costs, techniques, equipment and scheduling. Contractors bidding on or undertaking work on the project should be directed to draw their own conclusions as to how the subsurface conditions may affect them, based on their own investigations and their own interpretations of the factual investigation results, cognizant of the risks implicit in the subsurface investigation activities.

Changes In Site And Scope

It must be recognized that the passage of time, natural occurrences, and direct or indirect human intervention at or near the site have the potential to alter subsurface conditions. Groundwater levels are particularly susceptible to seasonal fluctuations.

The design advice is based on the factual data obtained from this investigation made at the site by Terraprobe and are intended for use by the owner and its retained designers in the design phase of the project. If there are changes to the project scope and development features, or there is any additional information relevant to the interpretations made of the subsurface information, the geotechnical design parameters and comments relating to constructibility issues and quality control may not be relevant or complete for the revised project. Terraprobe should be retained to review the implications of such changes with respect to the contents of this report

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EXPLANATION OF TERMS USED IN REPORT

N VALUE: THE STANDARD PENETRATION TEST (SPT) N VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D. SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg. FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N VALUE IS DENOTED THUS \bar{N} .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

c_u (kPa)	0 - 12	12 - 25	25 - 50	50 - 100	100 - 200	>200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 - 5	5 - 10	10 - 30	30 - 50	>50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND/OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY IS:

RQD (%)	0 - 25	25 - 50	50 - 75	75 - 90	90 - 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINTING AND BEDDING:

SPACING	50mm	50 - 300mm	0.3m - 1m	1m - 3m	>3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

SS	SPLIT SPOON	TP	THINWALL PISTON
WS	WASH SAMPLE	OS	OSTERBERG SAMPLE
ST	SLOTTED TUBE SAMPLE	RC	ROCK CORE
BS	BLOCK SAMPLE	PH	TW ADVANCED HYDRAULICALLY
CS	CHUNK SAMPLE	PM	TW ADVANCED MANUALLY
TW	THINWALL OPEN	FS	FOIL SAMPLE

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa ⁻¹	COEFFICIENT OF VOLUME CHANGE
C_c	1	COMPRESSION INDEX
C_s	1	SWELLING INDEX
C_α	1	RATE OF SECONDARY CONSOLIDATION
C_v	m ² /s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	- °	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	- °	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_r	1	SENSITIVITY = c_u / τ_r

PHYSICAL PROPERTIES OF SOIL

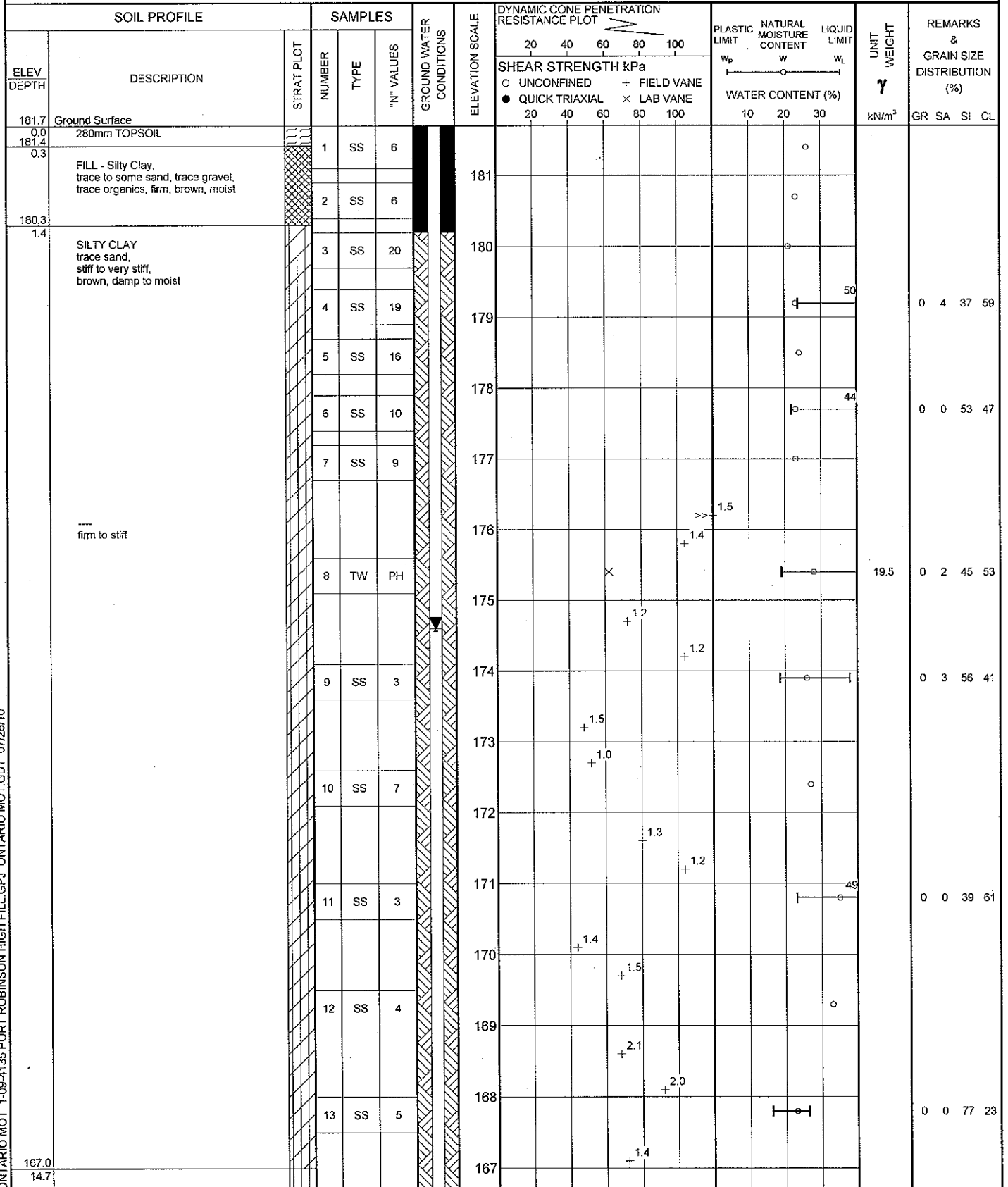
ρ_s	kg/m ³	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{mh}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m ³	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{max} - e}{e_{max} - e_{mh}}$
ρ_w	kg/m ³	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m ³	UNIT WEIGHT OF WATER	S_r	%	DEGREE OF SATURATION	D_n	mm	n PERCENT - DIAMETER
ρ	kg/m ³	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ	kN/m ³	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
ρ_d	kg/m ³	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m ² /s	RATE OF DISCHARGE
γ_d	kN/m ³	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $(w_L - w_p)$	v	m/s	DISCHARGE VELOCITY
ρ_{sat}	kg/m ³	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $(w - w_p) / I_p$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m ³	UNIT WEIGHT OF SATURATED SOIL	I_c	1	CONSISTENCY INDEX = $(w_L - w) / I_p$	k	m/s	HYDRAULIC CONDUCTIVITY
ρ'	kg/m ³	DENSITY OF SUBMERGED SOIL	e_{max}	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m ³	SEEPAGE FORCE
γ'	kN/m ³	UNIT WEIGHT OF SUBMERGED SOIL						

RECORD OF BOREHOLE No PR1

1 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4766747.4 E:326297.5 ORIGINATED BY PK
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers COMPILED BY DB
DATUM Geodetic DATE 01.04.10 - 01.06.10 CHECKED BY RA







Continued Next Page

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

ONTARIO MOT 1-09-4135 PORT ROBINSON HIGH FILL GPJ ONTARIO MOT.GDT 07/25/10

2 OF 3

METRIC

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT 	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI
			NUMBER	TYPE						
							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 	WATER CONTENT (%) 		

Station	Depth (m)	Soil Type	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Moisture (%)	Notes
163.9	17.8	SILT						trace sand, frequent silty clay seams and partings, loose, brown, wet
		14	SS	4				
		15	SS	6				
154.3	27.4	SILTY CLAY TO CLAYEY SILT						trace sand, stiff to hard, brown / reddish brown, damp to moist
		16	SS	15				
		17	SS	12				
		18	SS	29				
		19	SS	32				
		20	SS	15				
		21	SS	10				
		22	SS	18				
154.3	27.4	CLAYEY SILT						trace to some sand, trace gravel, very stiff to hard, brown, moist (GLACIAL TILL)
		23	SS	34				

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

○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No PR2

1 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4766747.3 E:326311.5 ORIGINATED BY PK
 DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / NQ Rock Coring COMPILED BY DB
 DATUM Geodetic DATE 12.29.09 - 12.30.09 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE						
181.7	Ground Surface							20 40 60 80 100							
0.0 181.4	300mm TOPSOIL		1	SS	5										
0.3	FILL - Silty Clay, trace sand, firm to stiff, brown, moist		2	SS	11										
180.3			3	SS	27										
1.4	SILTY CLAY trace sand, occasional gravel inclusions, stiff to very stiff, brown, damp to moist		4	SS	20										
			5	SS	14										
			6	SS	10										
			7	SS	7										
			8	SS	8										

Continued Next Page

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

ONTARIO MOT. 1-09-4135 PORT ROBINSON HIGH FILL GPJ ONTARIO MOT.GDT. 07/26/10

RECORD OF BOREHOLE No PR2

2 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4766747.3 E:326311.5 ORIGINATED BY PK
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / NQ Rock Coring COMPILED BY DB
DATUM Geodetic DATE 12.29.09 - 12.30.09 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
								20 40 60 80 100						
								20 40 60 80 100						
166.0 15.7	SILT trace clay, trace sand, very loose, brown, wet		14	SS	3		166	+3.2						
			15	SS	0		165							0 1 95 4
							164							
163.9 17.8	SILTY CLAY TO CLAYEY SILT trace sand, stiff to hard, brown / reddish brown, damp to moist		16	SS	15		163							
			17	SS	12		162	+1.2 1.2						0 5 79 16
			18	SS	23		161							
			19	SS	43		160							0 0 80 20
			20	SS	17		159							
			21	SS	16		158							
			22	SS	16		157							0 1 79 20
			23	SS	41		156							
154.8 26.9	CLAYEY SILT trace to some sand, trace gravel, very stiff to hard, brown, moist (GLACIAL TILL)						155							Dec.29 Dec.30

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

ONTARIO MOT 1-09-4135 PORT ROBINSON HIGH FILL.GPJ - ONTARIO MOT.GDT 07/26/10

METRIC

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

RECORD OF BOREHOLE No PR3

1 OF 3

METRIC

W.P. 280-89-00 LOCATION Coords: N:4766747.0 E:326343.5 ORIGINATED BY PK
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / NQ Rock Coring COMPILED BY DB
DATUM Geodetic DATE 01.07.10 - 01.08.10 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE						
								● QUICK TRIAXIAL	× LAB VANE						
181.3	Ground Surface						20 40 60 80 100	10 20 30							
0.0	280mm TOPSOIL						20 40 60 80 100								
0.3															
	FILL - Silty Sand, frequent clayey inclusions, loose, grey, wet		1	SS	8								0 48 34 18		
			2	SS	4										
179.9			3	SS	6										
1.4	SILTY CLAY trace sand, occasional gravel inclusions, firm to stiff, grey / brown, moist														
			4	SS	12								0 1 39 60		
			5	SS	14										
			6	SS	9								1 1 65 33		
	soft		7	SS	4										
			8	SS	4								0 4 55 41		
			9	SS	7								0 3 54 43		
			10	SS	4								0 1 57 42		
			11	TW	PH							18.3			
			12	SS	1								0 0 65 35		
			13	SS	3										
166.6															
14.7															

ONTARIO MOT 1-09-4135 PORT ROBINSON HIGH FILL GPJ ONTARIO MOT.GDT 07/26/10

Continued Next Page

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

RECORD OF BOREHOLE No PR3

2 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4766747.0 E:326343.5 ORIGINATED BY PK
 DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / NQ Rock Coring COMPILED BY DB
 DATUM Geodetic DATE 01.07.10 - 01.08.10 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)				
								20	40	60	80	100	10	20	30	GR	SA	SI	CL	
164.5	SILT trace clay, trace sand, very loose, brown, wet		14	SS	0		166													
16.8	SILTY CLAY TO CLAYEY SILT trace sand, trace gravel, stiff to very stiff, brown / reddish brown, damp to moist		15	SS	15		165													
			16	SS	17		164													
															</					

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

ONTARIO MOT 1-09-4135 PORT ROBINSON HIGH FILL GPJ ONTARIO MOT.GDT 07/26/10

METRIC

CON. PROFILE	SAMPLE NO.		DYNAMIC CONE PENETRATION			
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ONTARIO MOT 1-09-4135 PORT ROBINSON HIGH FILL.GPJ ONTARIO MOT GDT 07/26/10

RECORD OF BOREHOLE No PR4

1 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4766752.2 E:326382.2 ORIGINATED BY PK
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / NQ Rock Coring COMPILED BY DB
DATUM Geodetic DATE 01.28.10 - 02.03.10 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)	
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × LAB VANE							
182.2	Ground Surface							20 40 60 80 100		10 20 30				GR SA SI CL		
182.0	180mm TOPSOIL															
0.2	FILL - Sand, gravelly, some silt, trace clay, trace organics, compact, brown, moist		1	SS	12					○				22 50 20 8		
181.5																
0.7	FILL - Silty Clay, some sand, trace gravel, stiff to very stiff, brown, moist		2	SS	10					○						
			3	SS	22					○				0 12 44 44		
180.1																
2.1	SILTY CLAY trace sand, firm to very stiff, brown, damp to moist		4	SS	12					○			56	0 1 35 64		
			5	SS	12					○						
			6	SS	13					○			44	0 0 47 53		
			7	SS	4					○						
			8	TW	PH									20.3		
			9	SS	7									0 2 59 39		
			10	SS	8											
			11	SS	1									0 1 16 83		
			12	SS	4											
			13	SS	3											
167.5																
14.7																

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

ONTARIO MOT 1-09-4135 PORT ROBINSON HIGH FILL.GPJ ONTARIO MOT.GDT 07/26/10

METRIC

[illegible]

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

ONTARIO MOT 1-094135 PORT ROBINSON HIGH FILL.GPJ ONTARIO MOT.GDT 07/26/10

RECORD OF BOREHOLE No PR4

3 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4766752.2 E:326382.2 ORIGINATED BY PK
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers / NQ Rock Coring COMPILED BY DB
DATUM Geodetic DATE 01.28.10 - 02.03.10 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH KPa								WATER CONTENT (%)
								20 40 60 80 100								
								○ UNCONFINED + FIELD VANE								
								● QUICK TRIAXIAL × LAB VANE								
								20 40 60 80 100								
29.9	CLAYEY SILT trace to some sand, trace gravel, hard, brown, moist (GLACIAL TILL)		24	SS	46		152									
							151									
			25	SS	145		150									
	---- frequent cobbles		1	RUN	NQ		149									RUN#1 TCR=23% SCR=18% RQD=0%
147.9			2	RUN	NQ		148									RUN#2 TCR=54% SCR=40% RQD=0%
34.3	BEDROCK - DOLOSTONE Unweathered, thinly laminated, light to medium brownish grey, medium strength, argillaceous.		3	RUN	NQ		147									RUN#3 TCR=100% SCR=100% RQD=41%
		4	RUN	NQ		146								RUN#4 TCR=56% SCR=34% RQD=0%		
		5	RUN	NQ		145								RUN#5 TCR=100% SCR=100% RQD=62%		
		6	RUN	NQ										RUN#6 TCR=100% SCR=100% RQD=14%		
144.2	End of Borehole															
38.0	Sampler wet at 10.7m. Unable to push vane beyond 27.9m. Borehole filled with drill water on completion. Piezometer installation consists of a 19mm diameter, Schedule 40 PVC pipe with a 1.52m slotted screen. Water Level Readings: Date Depth(m) Elevation(m) Feb.08.10 5.0 177.2 Feb.19.10 4.5 177.7 Apr.16.10 4.3 177.9															

ONTARIO MOT 1-06-4135 PORT ROBINSON HIGH FILL GPJ ONTARIO MOT.GDT 07/26/10

RECORD OF BOREHOLE No PR5

1 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4766743.3 E:326398.5 ORIGINATED BY PK
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers COMPILED BY DB
DATUM Geodetic DATE 12.21.09 - 12.22.09 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
181.2	Ground Surface							20 40 60 80 100						
181.0	300mm TOPSOIL							20 40 60 80 100						
0.2	FILL - Silty Clay, some sand, trace organics, firm, brown, moist		1	SS	4		181							
180.5														
0.7	SILTY CLAY trace sand, occasional gravel inclusions, stiff to very stiff, brown, moist		2	SS	8		180							
			3	SS	16									
			4	SS	14		179						49	0 1 45 54
			5	SS	11		178							
			6	SS	12		177							0 1 68 31
	firm to stiff		7	SS	3									
							176							
			8	SS	2		175							0 3 52 45
							174							
			9	TW	PH		173						19.7	0 3 57 40
							172							7 4 38 51
			10	SS	0		171							
							170							
			11	SS	4		169							0 0 60 40
							168							
			12	SS	3		167							0 0 64 36
			13	SS	5									
166.5														
14.7														

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

ONTARIO MOT 1-09-4135 PORT ROBINSON HIGH FILL GPJ ONTARIO MOT.GDT 07/26/10

METRIC

CHECKED BY _____ RA _____



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

RECORD OF BOREHOLE No PR5

3 OF 3

METRIC

W.P. 280-99-00 LOCATION Coords: N:4766743.3 E:326398.5 ORIGINATED BY PK
DIST HWY 406 BOREHOLE TYPE Hollow Stem Augers COMPILED BY DB
DATUM Geodetic DATE 12.21.09 - 12.22.09 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								20	40	60	80	100					
								20	40	60	80	100					
150.7			24	SS	92		151										
30.5	End of Borehole																
	Unable to push vane beyond 19.2m.																
	Resistance to augering at 28.9m.																
	No sample recovery at SS5 and SS23. Sampler redriven and disturbed sample collected.																
	Consolidation test performed on TW 9.																
	Sampler wet at 6.1m.																
	Borehole was dry (not stabilized) and hole open to full depth on completion.																
	Piezometer installation consists of a 19mm diameter, Schedule 40 PVC pipe with a 1.52m slotted screen.																
	Water Level Readings:																
	Date Depth(m) Elevation(m)																
	Jan.19.10 6.4 174.8																
	Jan.27.10 6.2 175.0																
	Feb.08.10 6.3 174.9																
	Feb.19.10 6.2 175.0																

RECORD OF BOREHOLE No PR6

1 OF 2

METRIC

W.P. 280-99-00 LOCATION Coords: N:4766772.3 E:326098.9 ORIGINATED BY BL
 DIST HWY 406 BOREHOLE TYPE Solid Stem Augers COMPILED BY DB
 DATUM Geodetic DATE 07.12.10 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
179.0	Ground Surface							20 40 60 80 100						GR SA SI CL
178.9 0.1	130mm ASPHALT													
	FILL - Sandy Gravel, dense to very dense, brown, damp		1	SS	46									
			2	SS	53									
177.6 1.4	FILL - Silty Clay, sandy, stiff, brown, damp to moist		3	SS	9									
			4	SS	11									0 25 45 30
176.1 2.9	SILTY CLAY trace sand, stiff to very stiff, brown, damp to moist		5	SS	16									
			6	SS	26									0 4 51 45
			7	SS	9									
	firm to stiff		8	SS	3									
								3.0						
								1.3						
			9	SS	WOH									0 0 48 52
								2.0						
								2.7						
			10	SS	1									0 0 61 39
								1.8						
165.1 13.9														

Continued Next Page

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

ONTARIO MOT 1-09-4135 PORT ROBINSON HIGH FILL.GPJ ONTARIO MOT.GDT 07/28/10

RECORD OF BOREHOLE No PR6

2 OF 2

METRIC

W.P. 280-99-00 LOCATION Coords: N:4766772.3 E:326098.9 ORIGINATED BY BL
DIST HWY 406 BOREHOLE TYPE Solid Stern Augers COMPILED BY DB
DATUM Geodetic DATE 07.12.10 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								20	40	60	80	100					
								○ UNCONFINED	+	FIELD VANE							
								● QUICK TRIAXIAL	x	LAB VANE							
								20	40	60	80	100					
													10	20	30		

RECORD OF BOREHOLE No PR7

1 OF 2

METRIC

W.P. 280-99-00 LOCATION Coords: N:4766756.9 E:326163.1 ORIGINATED BY PK
DIST HWY 406 BOREHOLE TYPE Solid Stem Augers COMPILED BY DB
DATUM Geodetic DATE 07.12.10 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			WATER CONTENT (%)				
180.1	Ground Surface							20 40 60 80 100							GR SA SI CL
180.0 0.1	50mm TOPSOIL FILL - Silty Clay, trace sand, trace organics, stiff, brown, damp to moist		1	SS	11		180								
179.4 0.7	SILTY CLAY trace sand, stiff to hard, brown, moist		2	SS	28		179								
			3	SS	30		178								
			4	SS	21		177								0 1 60 39
			5	SS	16		176								
			6	SS	12		175								
			7	SS	13		174								0 2 55 43
							173								
			8	TW	PH		172								
							171								
			9	SS	8		170								
							169								
							168								
							167								
							166								
166.2 13.9			10	SS	9		171								0 3 29 68
							170								
							169								
							168								
							167								
							166								
			11	SS	7		167								
							166								

Continued Next Page

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

ONTARIO MOT 1-08-4135 PORT ROBINSON HIGH FILL GPJ ONTARIO MOT GDT 07/26/10

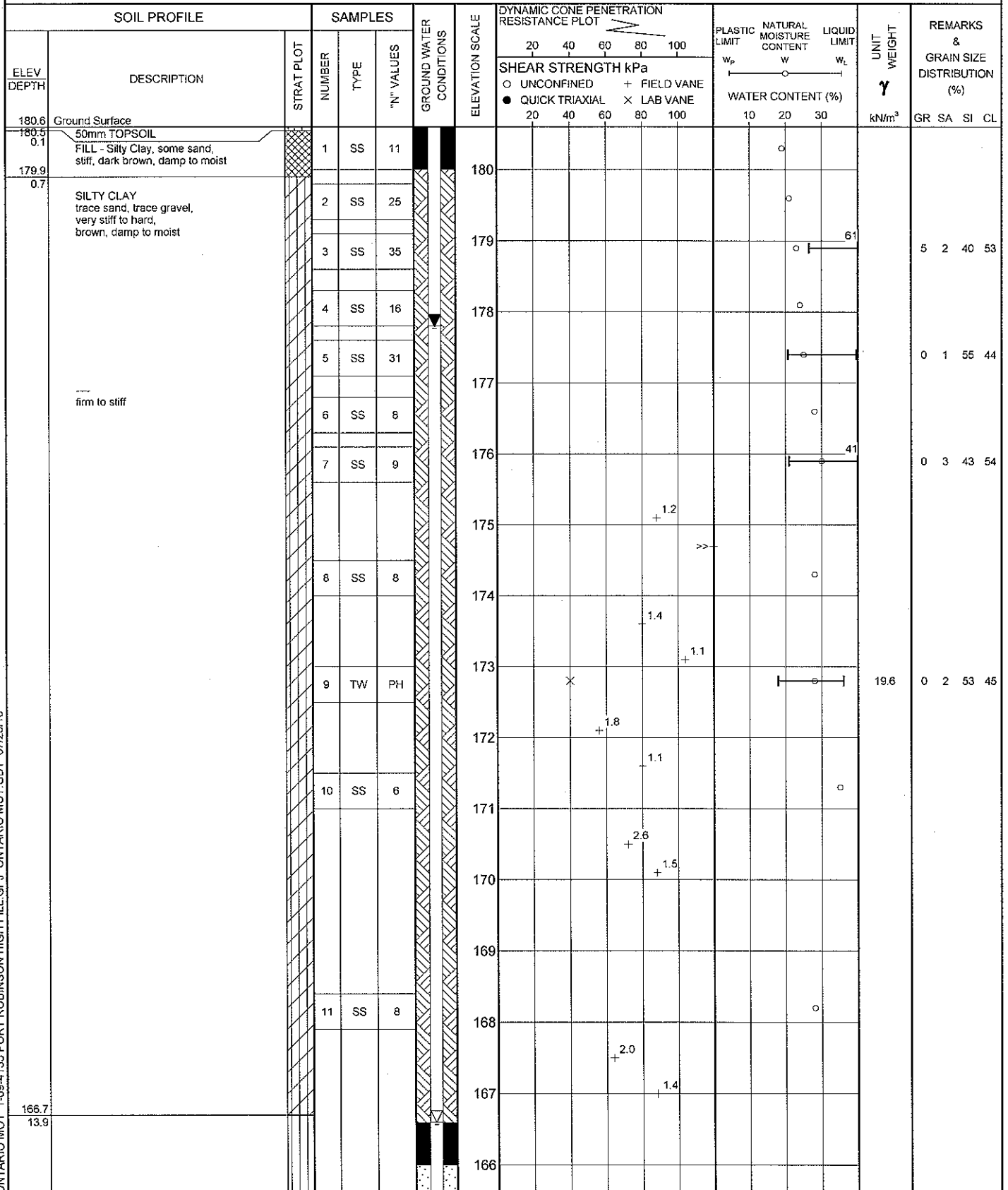
+ 3, X 3: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

RECORD OF BOREHOLE No PR8

1 OF 2

METRIC

W.P. 280-99-00 LOCATION Coords: N:4766748.9 E:326227.6 ORIGINATED BY PK
DIST HWY 406 BOREHOLE TYPE Solid Stem Augers COMPILED BY DB
DATUM Geodetic DATE 07.13.10 CHECKED BY RA



Continued Next Page

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

ONTARIO MOT 1-09-4135 PORT ROBINSON HIGH FILL GPJ ONTARIO MOT.GDT 07/26/10

RECORD OF BOREHOLE No PR9

1 OF 2

METRIC

W.P. 280-99-00 LOCATION Coords: N:4766746.6 E:326427.5 ORIGINATED BY PK
DIST HWY 406 BOREHOLE TYPE Solid Stem Augers COMPILED BY DB
DATUM Geodetic DATE 07.06.10 CHECKED BY RA

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ KN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							WATER CONTENT (%)
								○ UNCONFINED	+ FIELD VANE						
								● QUICK TRIAXIAL	× LAB VANE						
181.6	Ground Surface						20 40 60 80 100							GR SA SI CL	
181.4	200mm TOPSOIL														
0.2	FILL - Silty Clay, sandy, trace organics, stiff, brown, damp to moist		1	SS	11		181							0 32 37 31	
180.9															
0.7	SILTY CLAY trace sand, very stiff to hard, brown, damp to moist		2	SS	31									0 1 26 73	
			3	SS	44		180								
			4	SS	29		179							0 1 44 55	
			5	SS	24		178								
	firm to stiff		6	SS	13		177							0 1 70 29	
			7	SS	12		176								
			8	SS	11		175								
			9	TW	PH		174								
			10	SS	9		173								
			11	SS	8		172								
							171								
							170								
							169								
							168								
167.7							167								
13.9															

ONTARIO MOT 1-09-4135 PORT ROBINSON HIGH FILL GPJ ONTARIO MOT.GDT 07/25/10

Continued Next Page

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

2 OF 2

METRIC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT 	UNIT WEIGHT 	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES						
								SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE 20 40 60 80 100	w _p w w _L 10 20 30	kN/m ³	GR SA SI C

164.6	SILT trace clay, compact, brown, wet	12	SS	20		166		0 0 94 6
17.0		SILTY CLAY TO CLAYEY SILT trace sand, occasional silt seams and partings, very stiff to hard, brown, damp to moist	13	SS		21		165
159.8			14	SS		40		160
21.8	End of Borehole							
Water level at 12.5m (not stabilized) and hole open to 16.8m on completion.								
Piezometer installation consists of a 19mm diameter, Schedule 40 PVC pipe with a 1.52m slotted screen.								
Water Level Readings:								
Date	Depth(m)	Elevation(m)						
Jul.19.10	3.5	178.1						
Jul.26.10	3.3	178.3						

ONTARIO MOT 1-09-4135 PORT ROBINSON HIGH FILL.GPJ ONTARIO MOT GDT 07/26/10

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

1 OF 2

METRIC

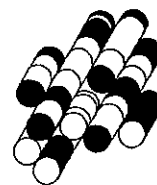
DATUM Geodetic DATE 07.07.10 CHECKED BY RA

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

APPENDIX B

Laboratory Test Results

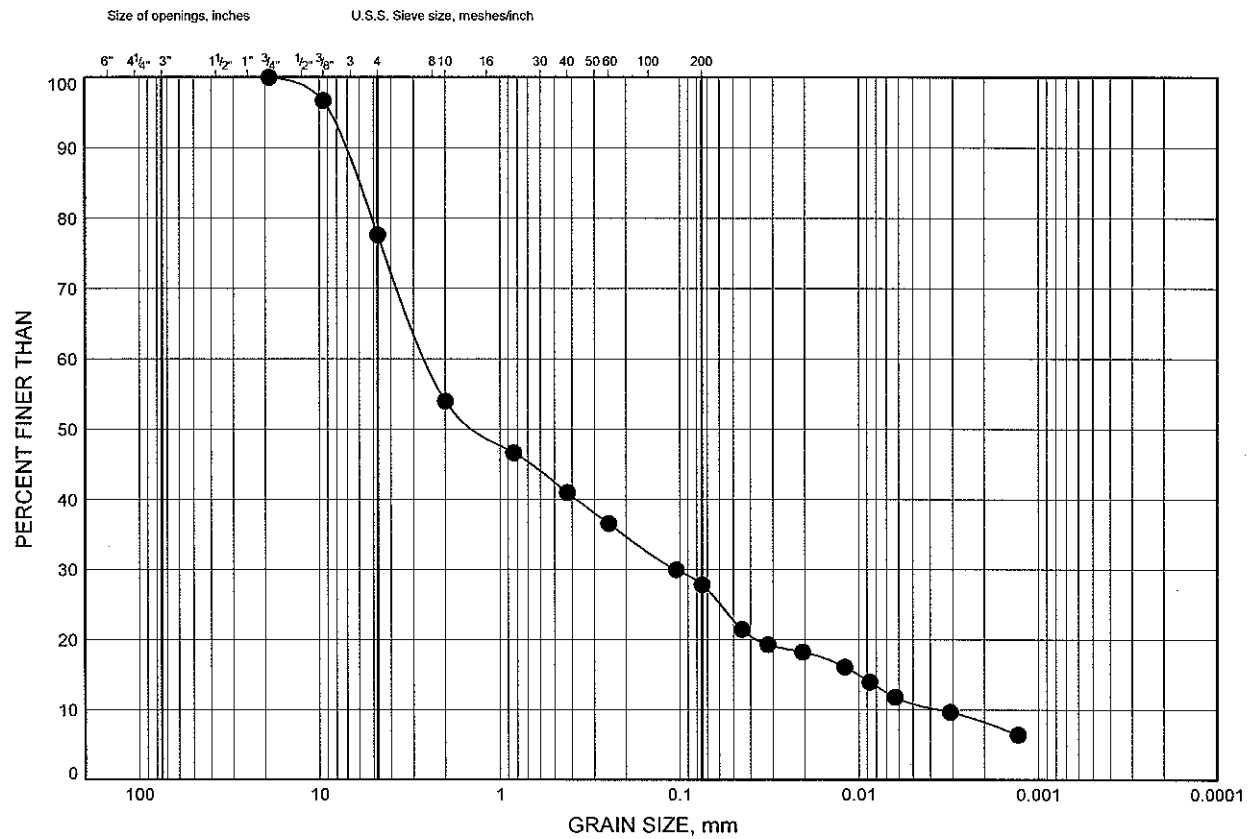
Terraprobe Inc.



GRAIN SIZE DISTRIBUTION

FIGURE B1

FILL - Gravelly Sand

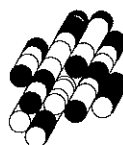


COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	PR4	0.3	181.9

Date July 2010

Project 1-09-4135



Prep'd DB

Chkd. MP

FIGURE B2

Size of openings, inches

U.S.S. Sieve size, meshes/inch

PERCENT FINER THAN

GRAIN SIZE, mm

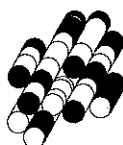
Grain Size (mm)	U.S.S. Sieve Size (meshes/inch)	Size of Opening (inches)	Percent Finer (%)
100	20	0.85	100
60	30	0.60	100
40	40	0.425	98
30	60	0.25	85
20	80	0.18	62
15	100	0.15	52
10	200	0.075	34
7.5	250	0.06	30
6	300	0.05	28
4.75	40	0.0425	26
4	45	0.0375	25
3.0	60	0.025	23
2.0	80	0.018	20
1.5	100	0.015	16

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

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	PR3	0.3	181.0

Date July 2010

Project 1-09-4135...



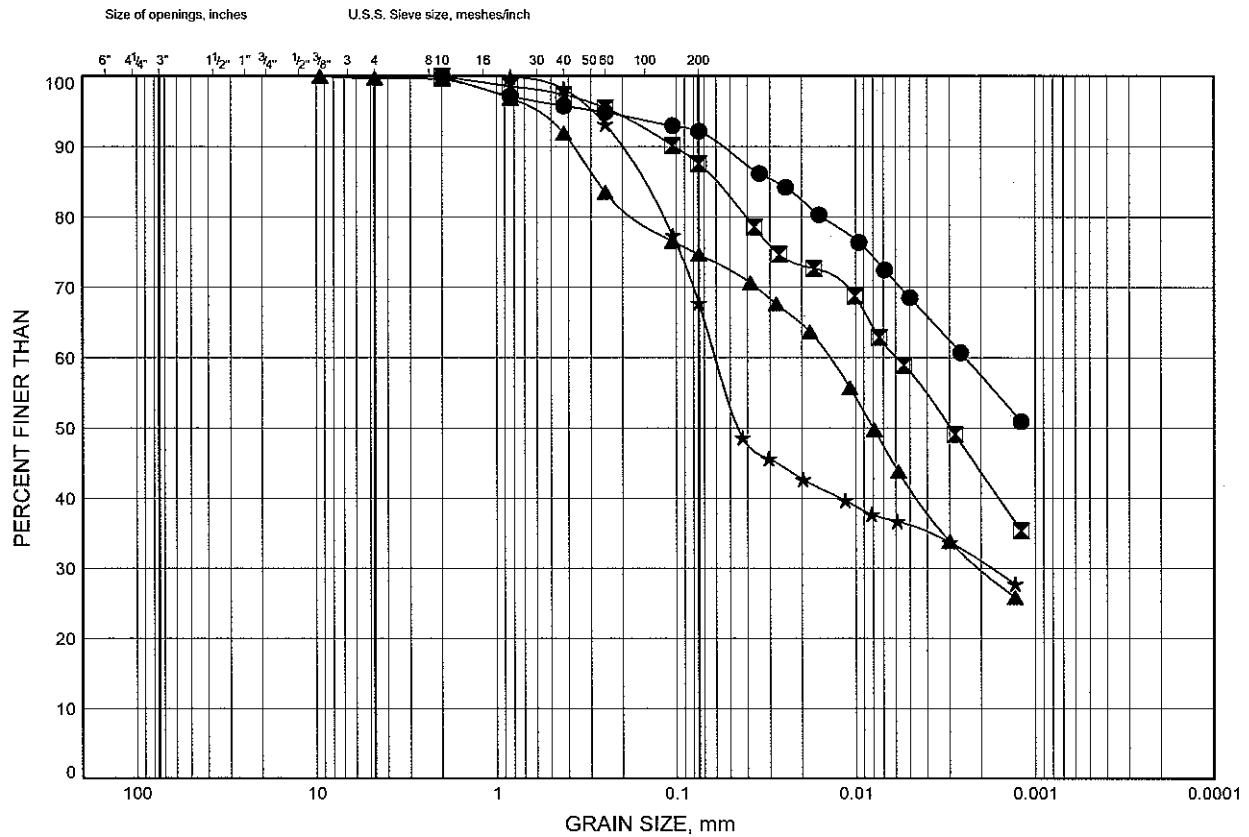
Prep'dDB.....

Chkd.MP.....

GRAIN SIZE DISTRIBUTION

FIGURE B3

FILL - Silty Clay

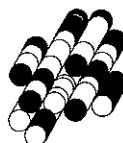


COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	PR2	1.0	180.7
◻	PR4	1.7	180.5
▲	PR6	2.5	176.5
★	PR9	0.3	181.3

Date July 2010

Project 1-09-4135



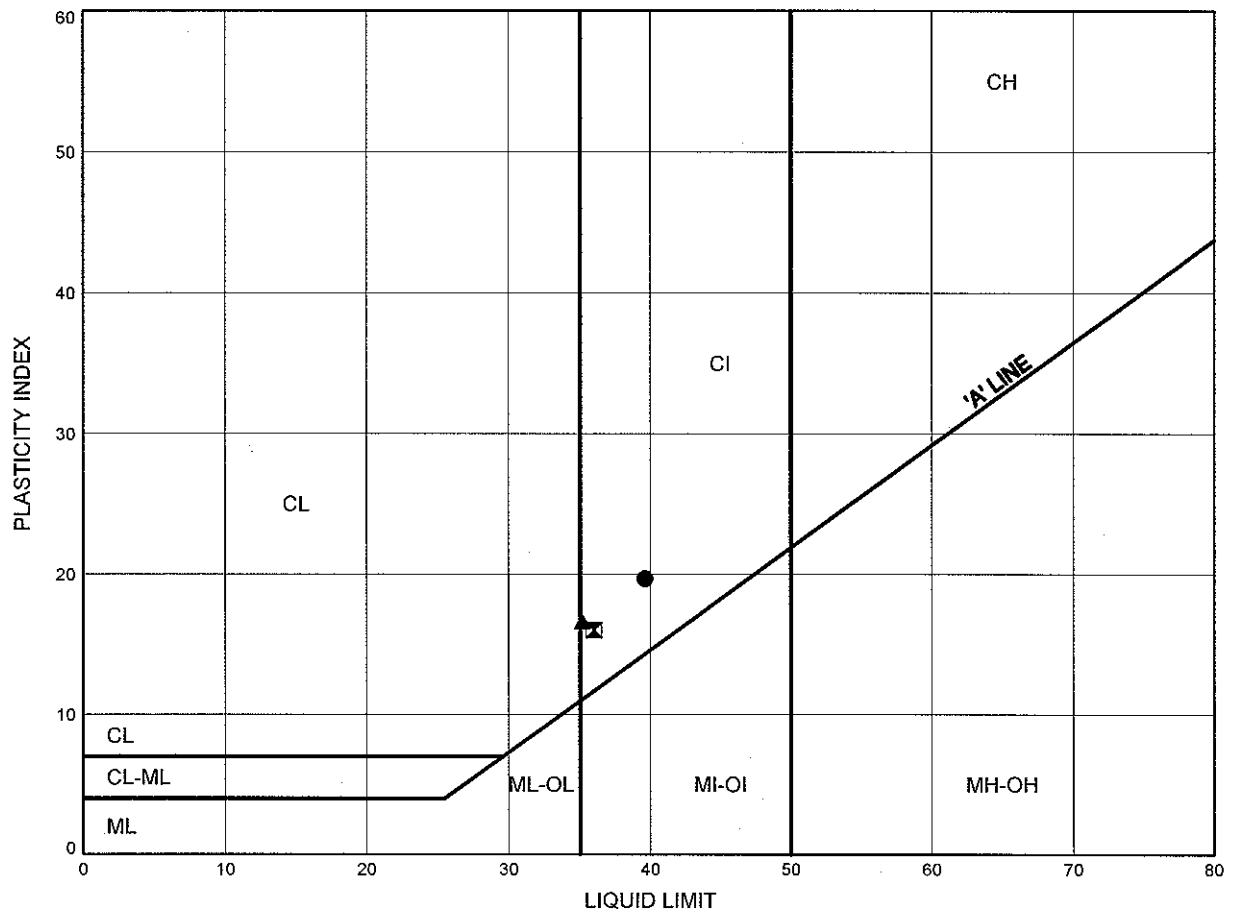
Prep'd DB

Chkd. MP

ATTERBERG LIMITS TEST RESULTS

FIGURE B4

FILL - Silty Clay

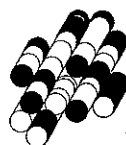


SYMBOL BOREHOLE DEPTH (m) ELEVATION (m)

●	PR4	1.7	180.5
⊠	PR6	2.5	176.5
▲	PR9	0.3	181.3

Date July 2010

Project 1-09-4135



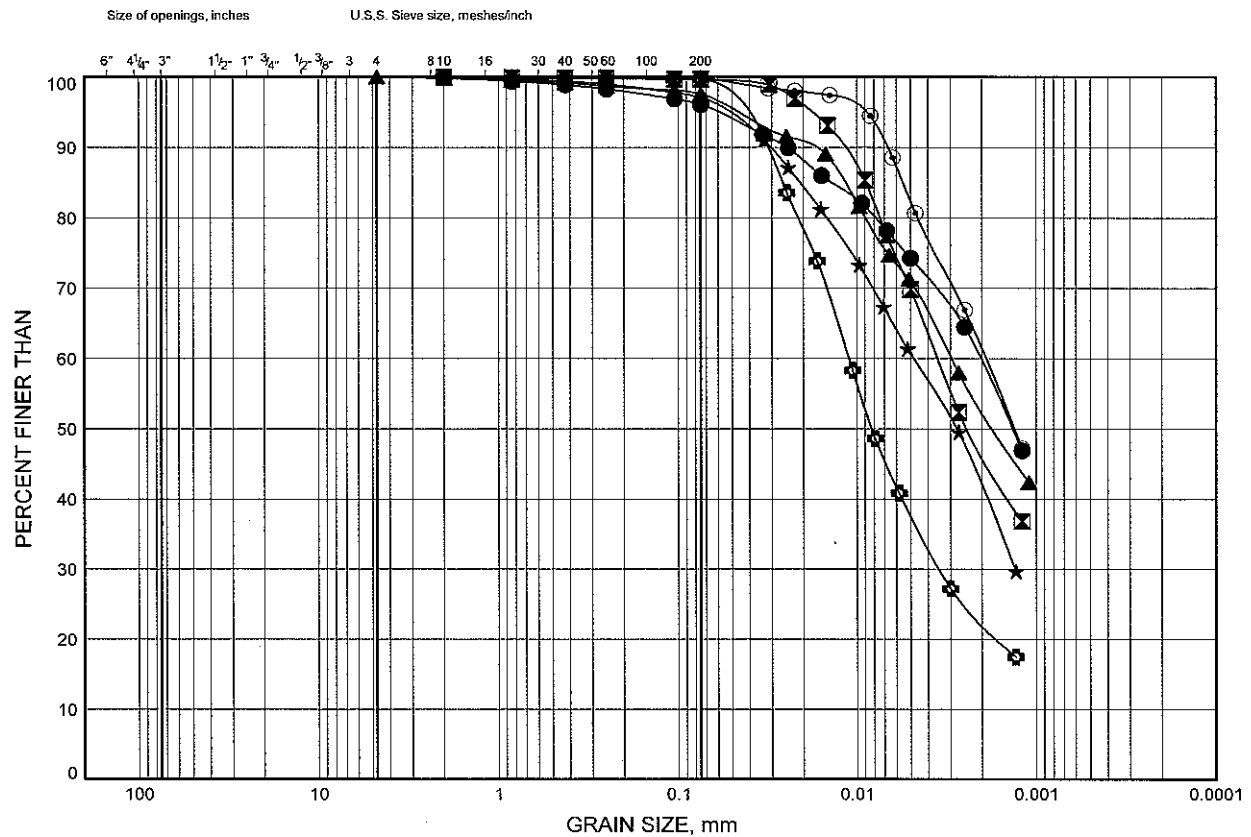
Prep'd DB

Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B5

SILTY CLAY

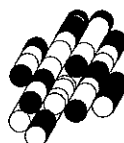


COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	PR1	2.5	179.2
⊠	PR1	4.0	177.7
▲	PR1	6.3	175.4
★	PR1	7.8	173.9
⊙	PR1	10.9	170.8
⊕	PR1	13.9	167.8

Date July 2010

Project 1-09-4135



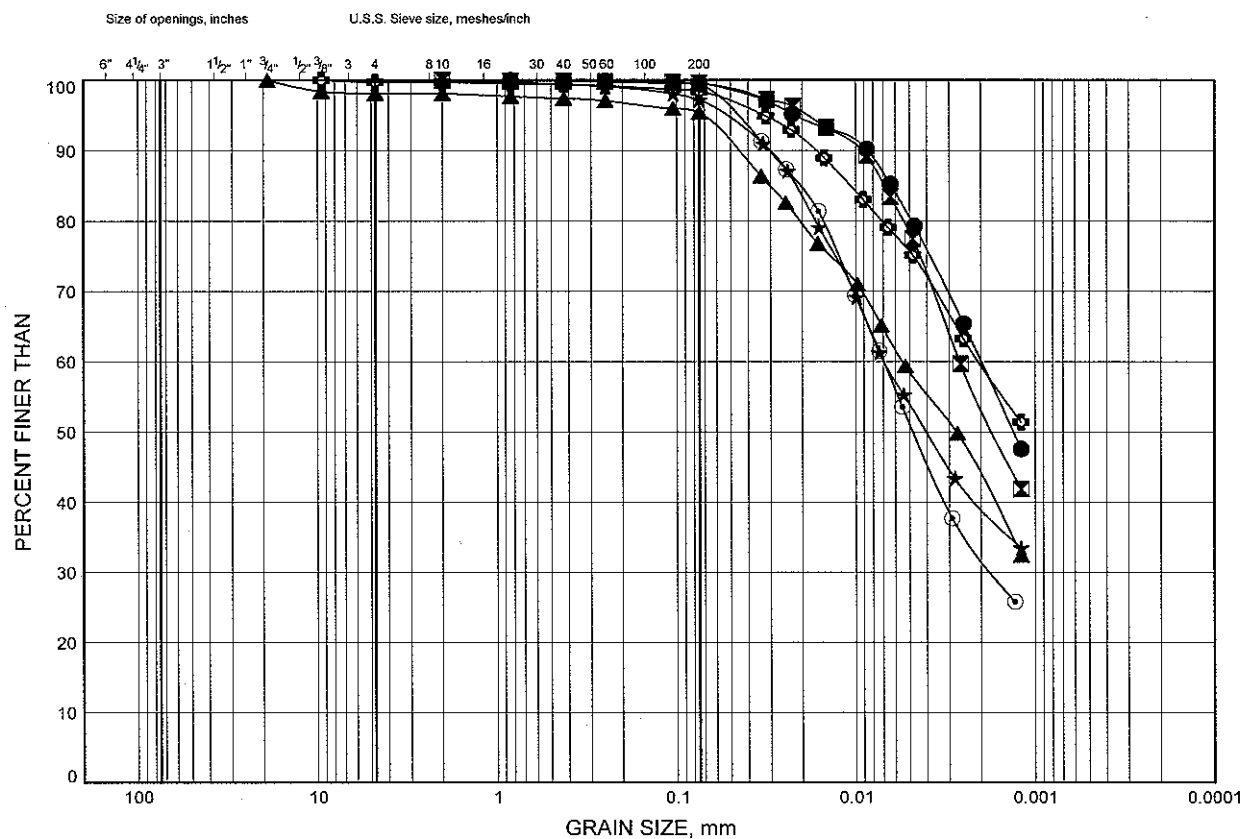
Prep'd DB

Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B6

SILTY CLAY



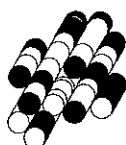
COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL BOREHOLE DEPTH (m) ELEVATION (m)

●	PR2	1.7	180.0
⊠	PR2	3.2	178.5
▲	PR2	6.3	175.4
★	PR2	9.3	172.4
⊙	PR2	13.9	167.8
⊕	PR3	2.5	178.8

Date July 2010

Project 1-09-4135



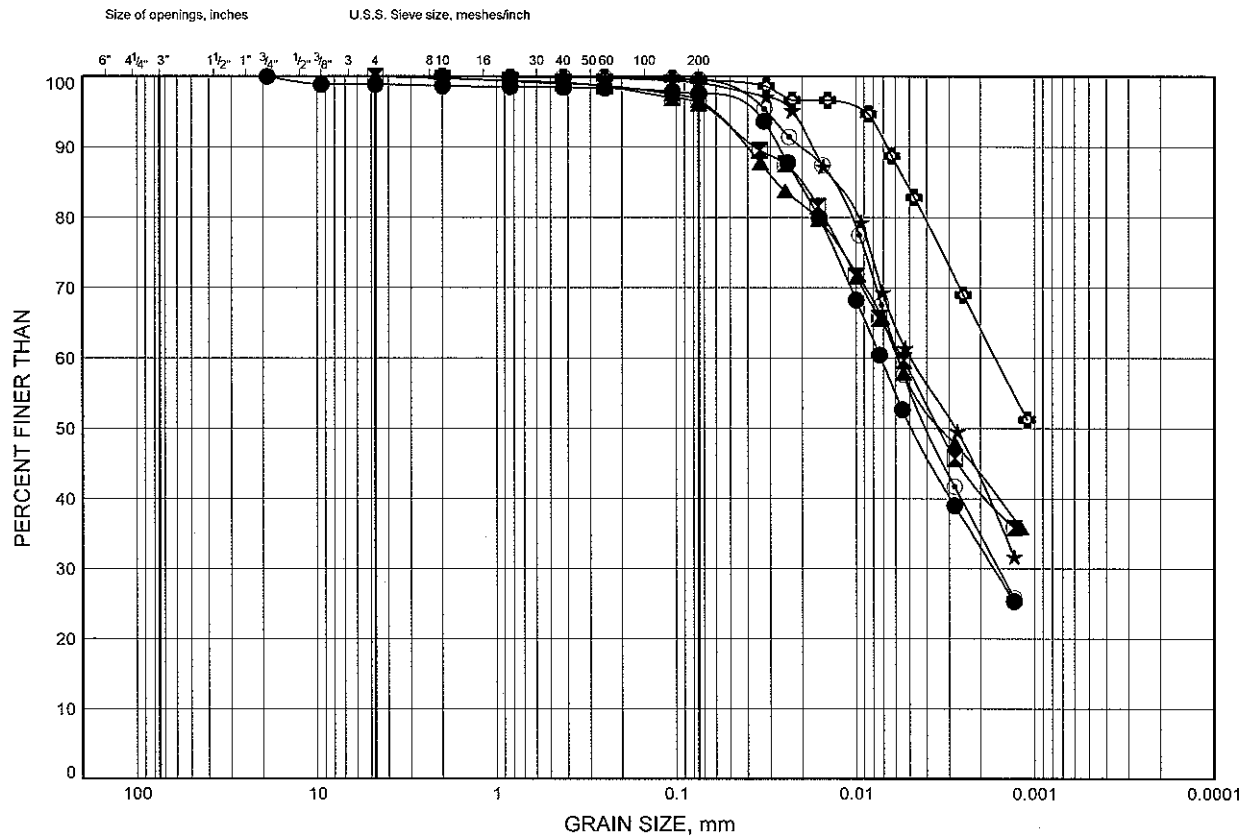
Prep'd DB

Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B7

SILTY CLAY



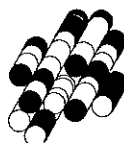
COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL BOREHOLE DEPTH (m) ELEVATION (m)

●	PR3	4.0	177.3
⊠	PR3	6.3	175.0
▲	PR3	7.8	173.5
★	PR3	9.3	172.0
⊙	PR3	12.4	168.9
⊕	PR4	2.5	179.7

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Project 1-09-4135



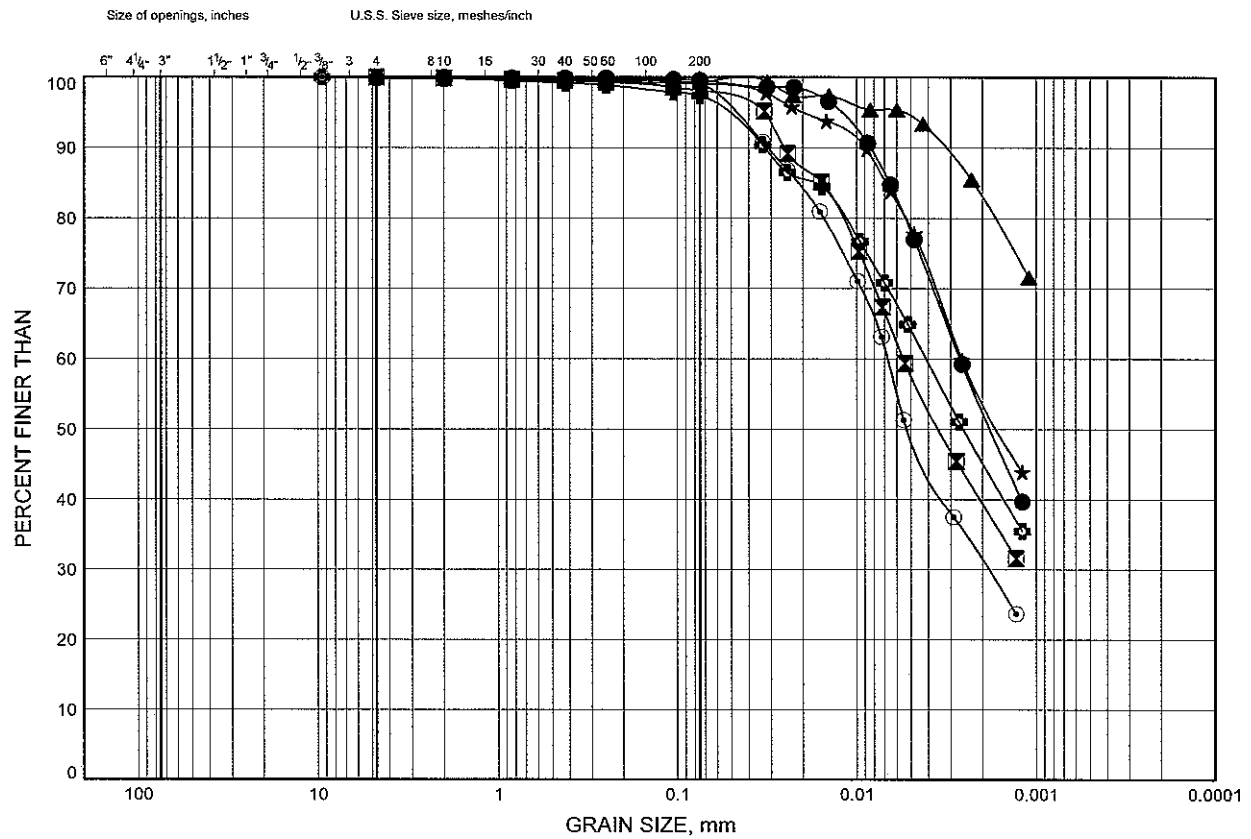
Prep'd DB

Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B8

SILTY CLAY



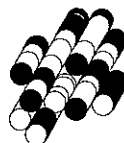
COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL BOREHOLE DEPTH (m) ELEVATION (m)

●	PR4	4.0	178.2
⊠	PR4	7.8	174.4
▲	PR4	10.9	171.3
★	PR5	2.5	178.7
⊙	PR5	4.0	177.2
⊕	PR5	6.3	174.9

Date July 2010

Project 1-09-4135



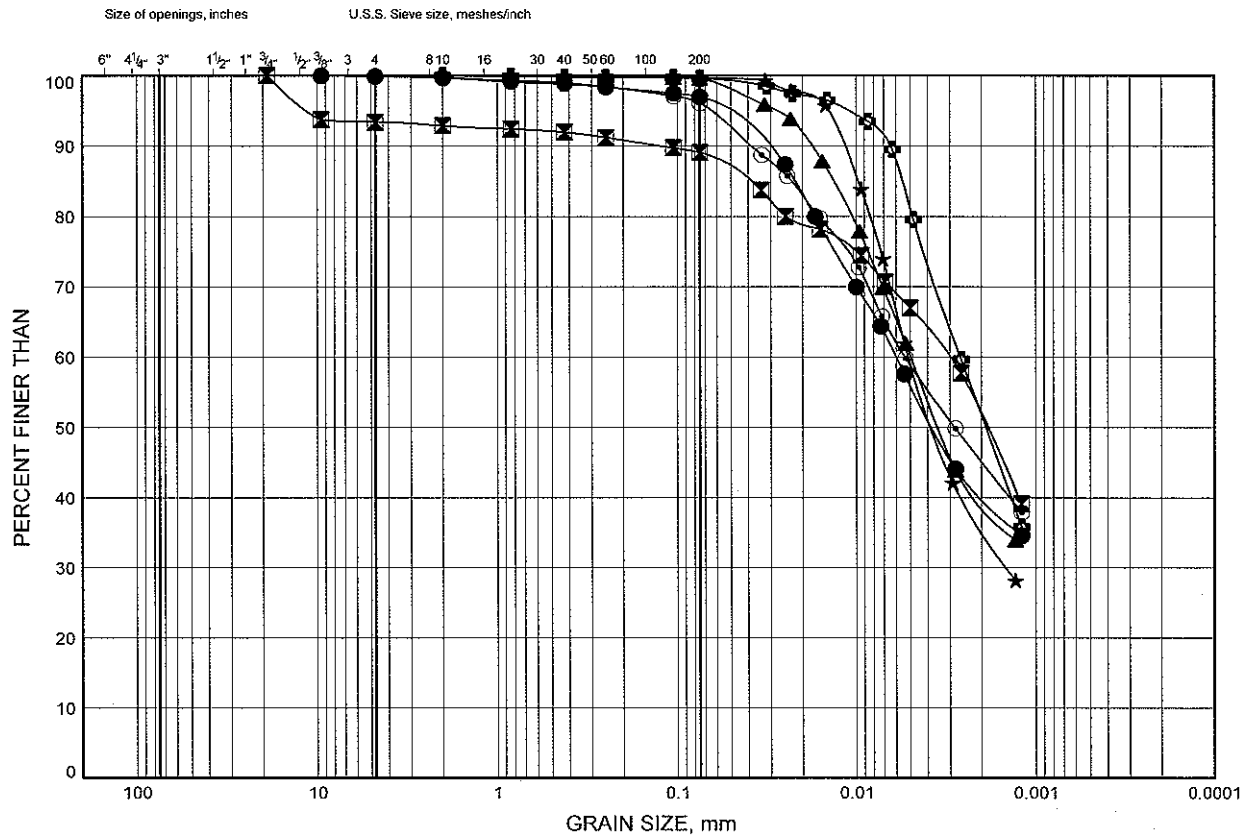
Prep'd DB

Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B9

SILTY CLAY



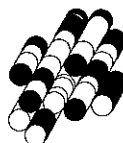
COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL BOREHOLE DEPTH (m) ELEVATION (m)

●	PR5	7.8	173.4
⊠	PR5	9.3	171.9
▲	PR5	12.4	168.8
★	PR5	13.9	167.3
⊙	PR6	4.0	175.0
⊕	PR6	9.3	169.7

Date July 2010

Project 1-09-4135



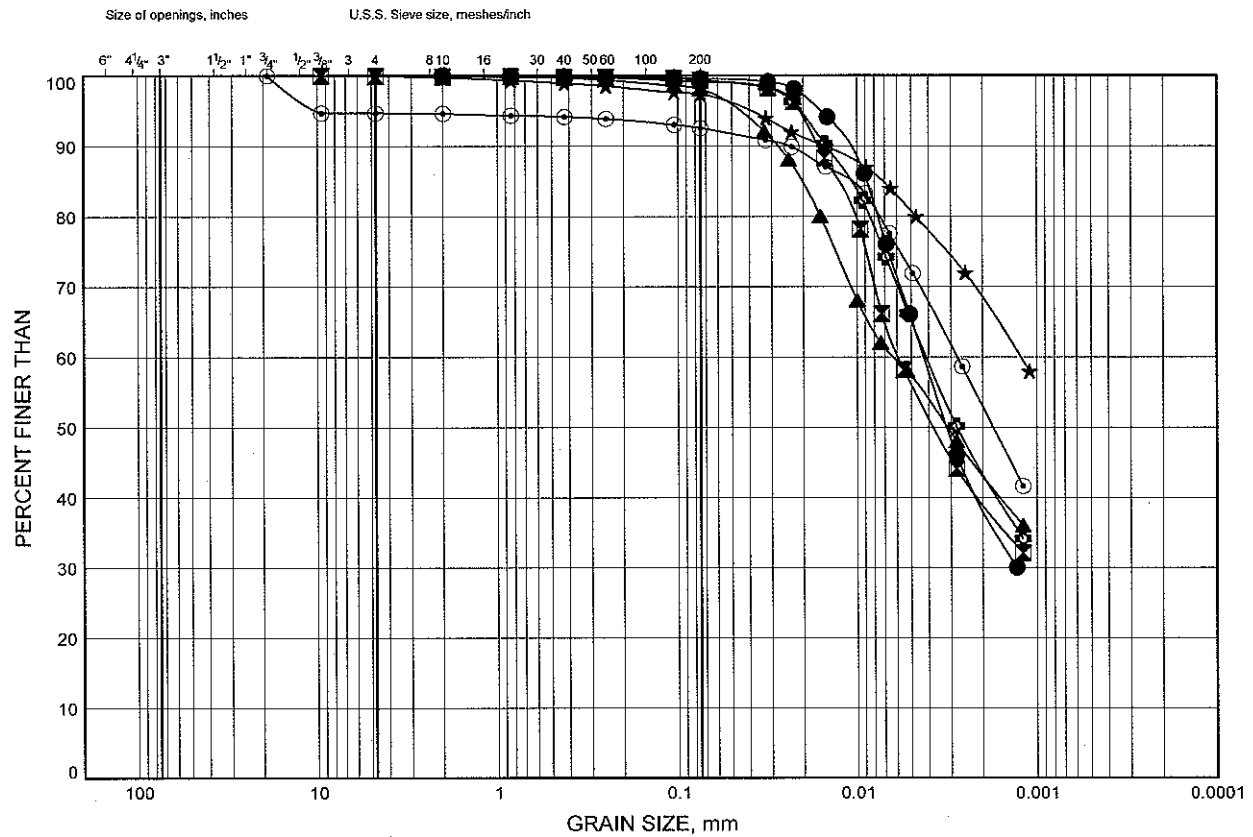
Prep'd DB

Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B10

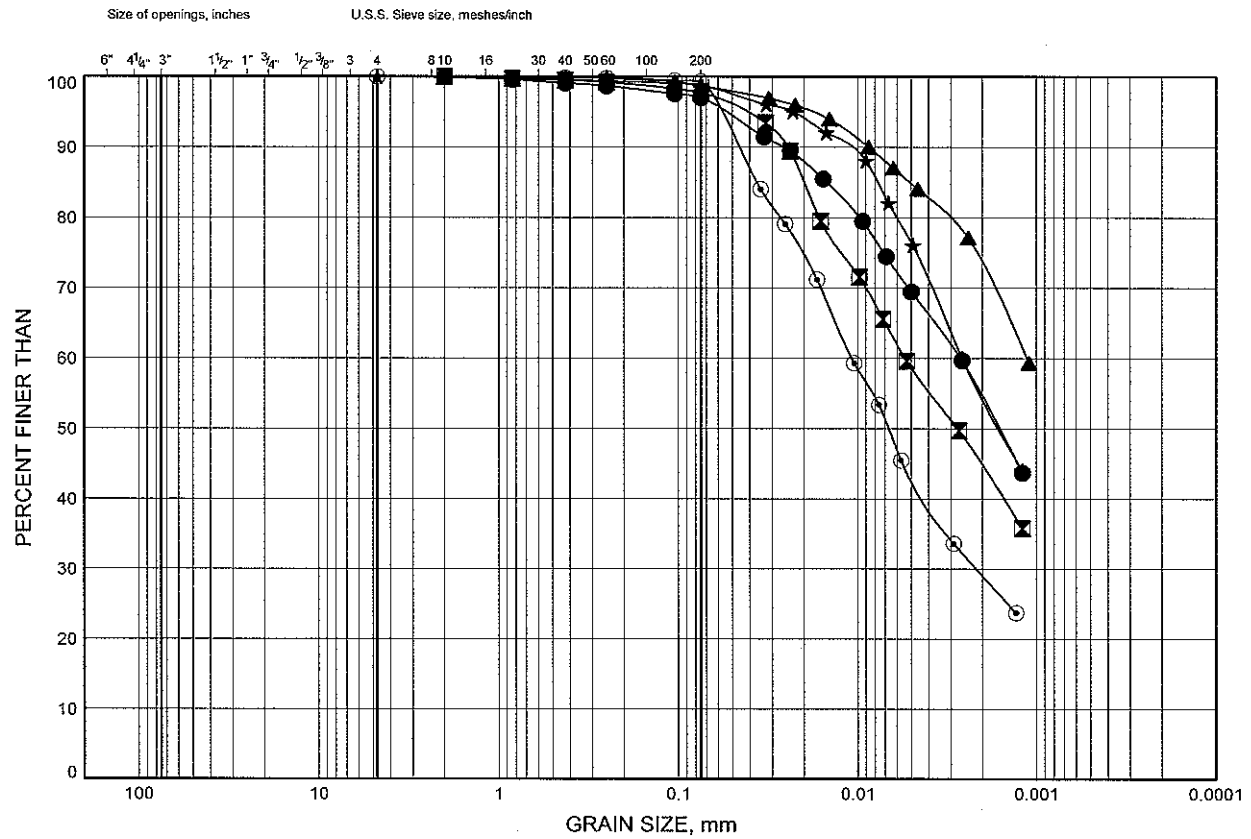
SILTY CLAY



GRAIN SIZE DISTRIBUTION

FIGURE B11

SILTY CLAY

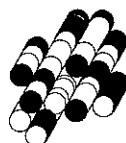


COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	PR8	4.7	175.9
⊠	PR8	7.8	172.8
▲	PR9	1.0	180.6
★	PR9	2.5	179.1
⊙	PR9	4.0	177.6

Date July 2010

Project 1-09-4135



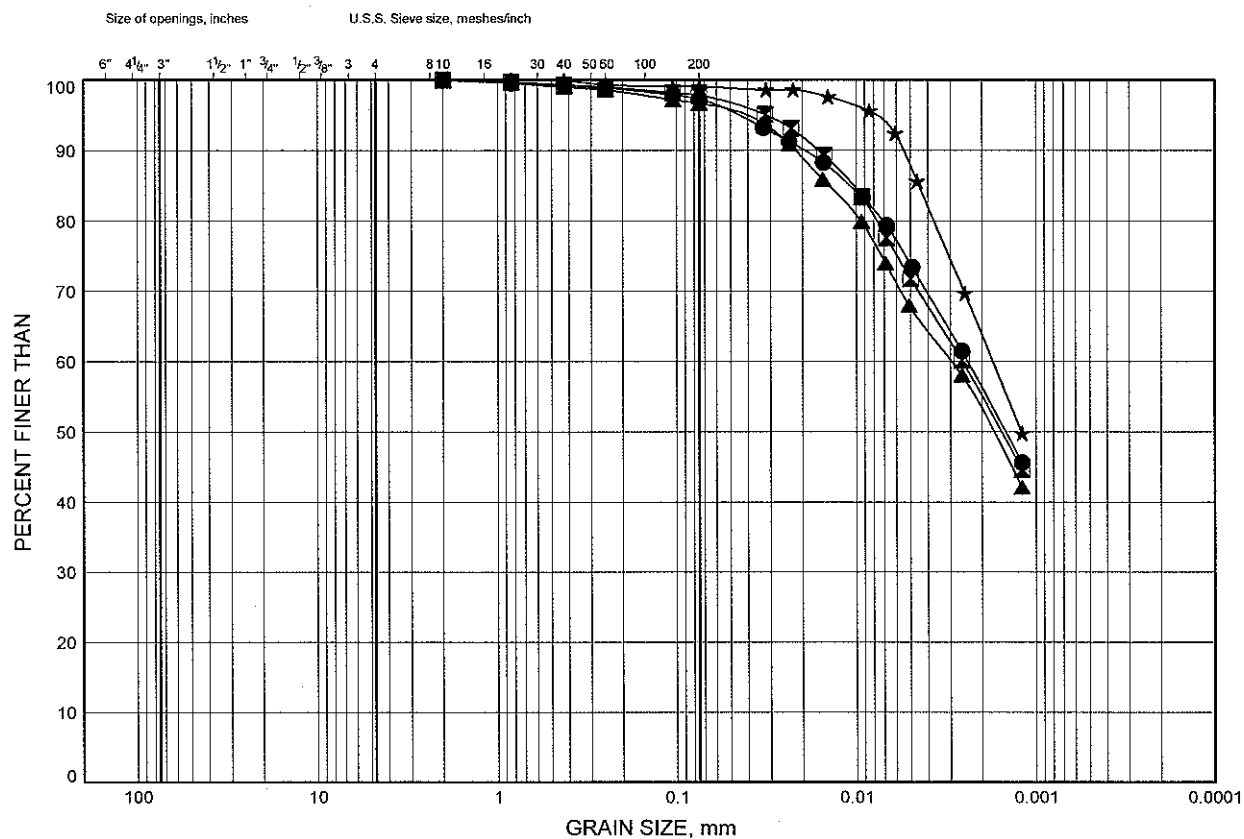
Prep'd DB

Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B12

SILTY CLAY

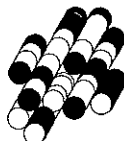


COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	PR10	1.7	179.8
■	PR10	4.0	177.5
▲	PR10	4.7	176.8
★	PR10	9.3	172.2

Date July 2010

Project 1-09-4135



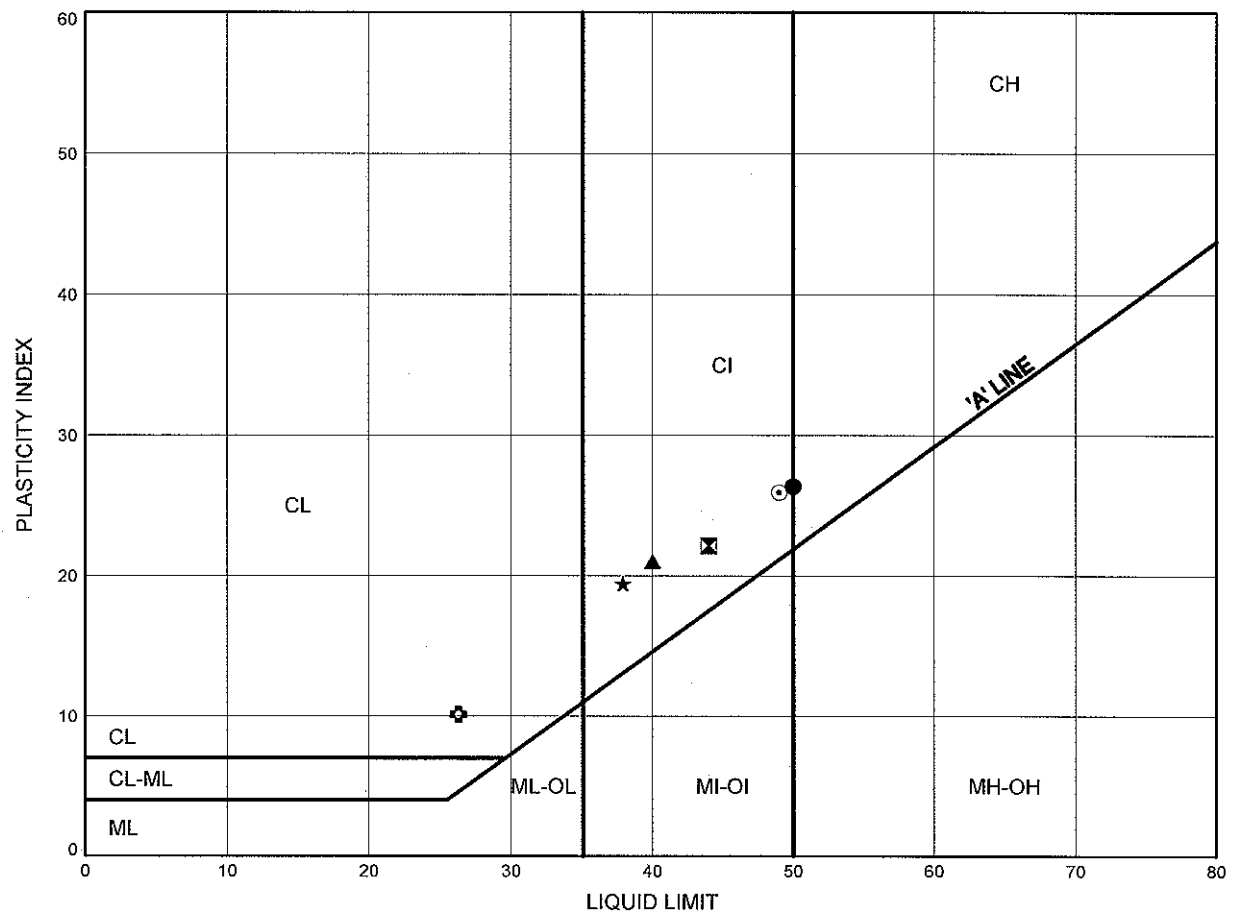
Prep'd DB

Chkd. MP

ATTERBERG LIMITS TEST RESULTS

FIGURE B13

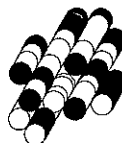
SILTY CLAY



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	PR1	2.5	179.2
⊠	PR1	4.0	177.7
▲	PR1	6.3	175.4
★	PR1	7.8	173.9
⊙	PR1	10.9	170.8
⊕	PR1	13.9	167.8

Date July 2010

Project 1-09-4135



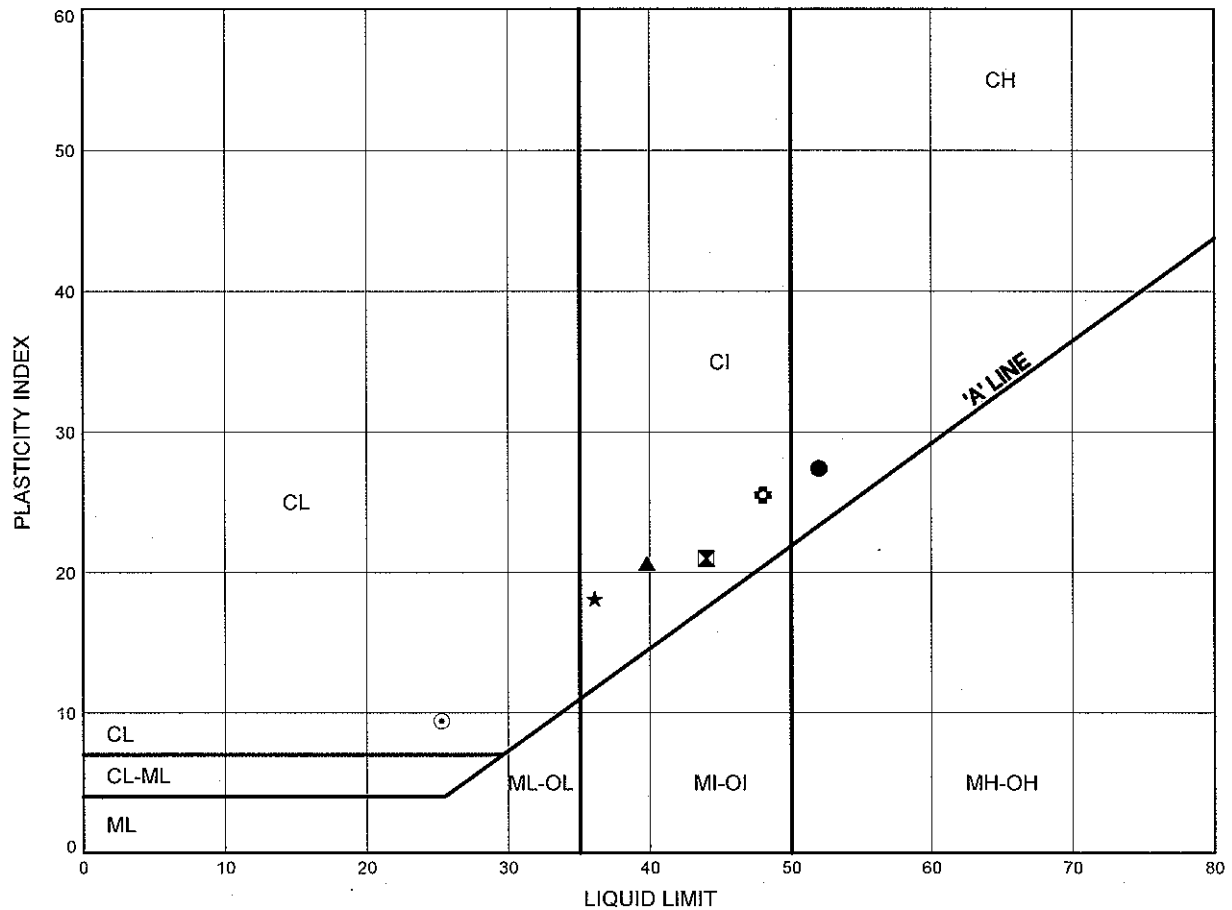
Prep'd DB

Chkd. MP

ATTERBERG LIMITS TEST RESULTS

FIGURE B14

SILTY CLAY

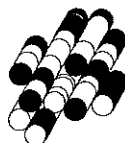


SYMBOL BOREHOLE DEPTH (m) ELEVATION (m)

●	PR2	1.7	180.0
⊠	PR2	3.2	178.5
▲	PR2	6.3	175.4
★	PR2	9.3	172.4
⊙	PR2	13.9	167.8
⊕	PR3	2.5	178.8

Date July 2010

Project 1-09-4135



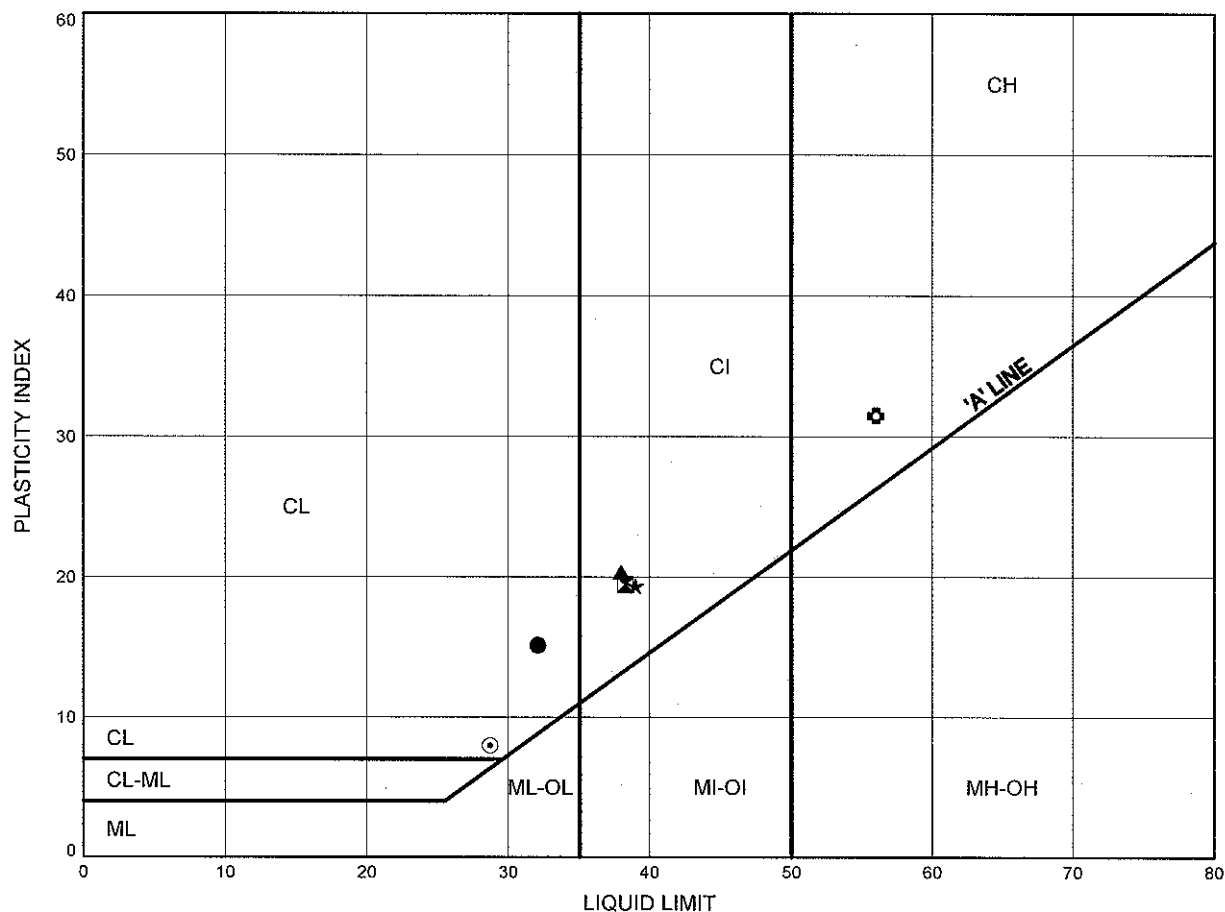
Prep'd DB

Chkd. MP

ATTERBERG LIMITS TEST RESULTS

FIGURE B15

SILTY CLAY

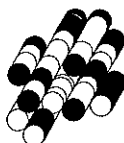


SYMBOL BOREHOLE DEPTH (m) ELEVATION (m)

●	PR3	4.0	177.3
⊠	PR3	6.3	175.0
▲	PR3	7.8	173.5
★	PR3	9.3	172.0
⊙	PR3	12.4	168.9
⊛	PR4	2.5	179.7

Date July 2010

Project 1-09-4135



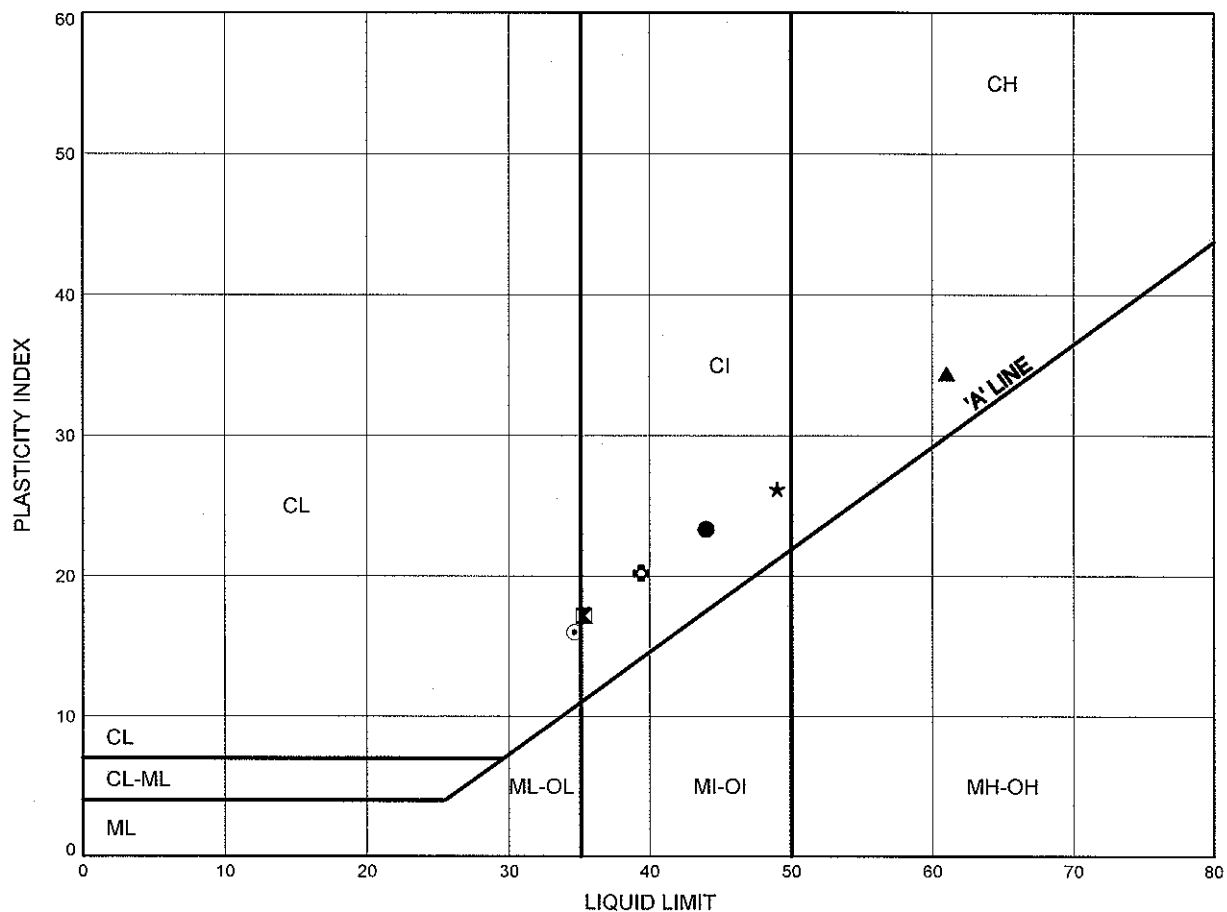
Prep'd DB

Chkd. MP

ATTERBERG LIMITS TEST RESULTS

FIGURE B16

SILTY CLAY

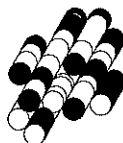


SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	PR4	4.0	178.2
⊠	PR4	7.8	174.4
▲	PR4	10.9	171.3
★	PR5	2.5	178.7
⊙	PR5	4.0	177.2
⊛	PR5	6.3	174.9

ALTR 1-09-4135 PORT ROBINSON HIGH FILL GPJ 07/23/10

Date July 2010

Project 1-09-4135



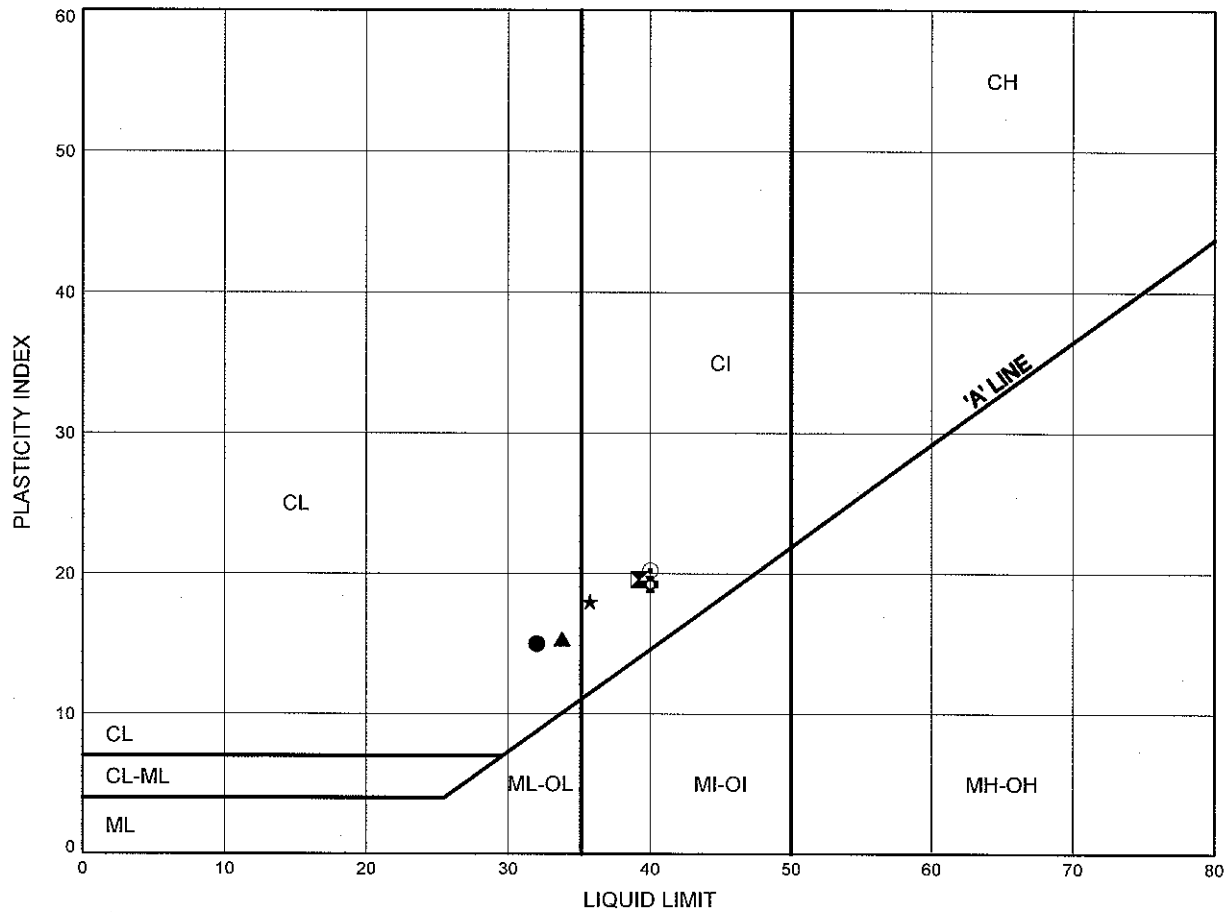
Prep'd DB

Chkd. MP

ATTERBERG LIMITS TEST RESULTS

FIGURE B17

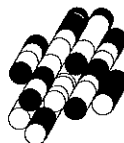
SILTY CLAY



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	PR5	7.8	173.4
⊠	PR5	9.3	171.9
▲	PR5	12.4	168.8
★	PR5	13.9	167.3
⊙	PR6	4.0	175.0
⊕	PR6	9.3	169.7

Date July 2010

Project 1-09-4135



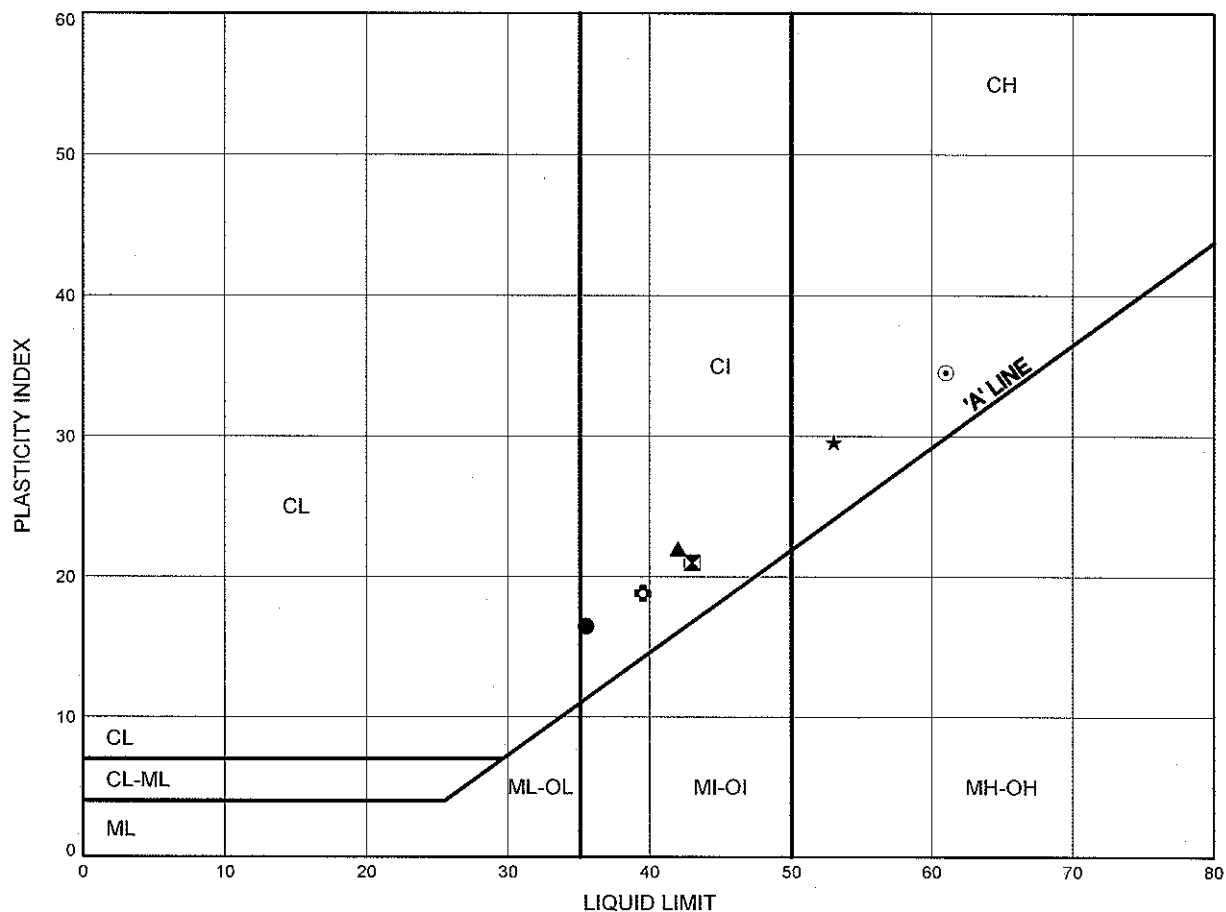
Prep'd DB

Chkd. MP

ATTERBERG LIMITS TEST RESULTS

FIGURE B18

SILTY CLAY

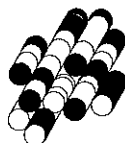


SYMBOL BOREHOLE DEPTH (m) ELEVATION (m)

●	PR6	12.4	166.6
⊠	PR7	2.5	177.6
▲	PR7	4.7	175.4
★	PR7	9.3	170.8
⊙	PR8	1.7	178.9
⊕	PR8	3.2	177.4

Date July 2010

Project 1-09-4135



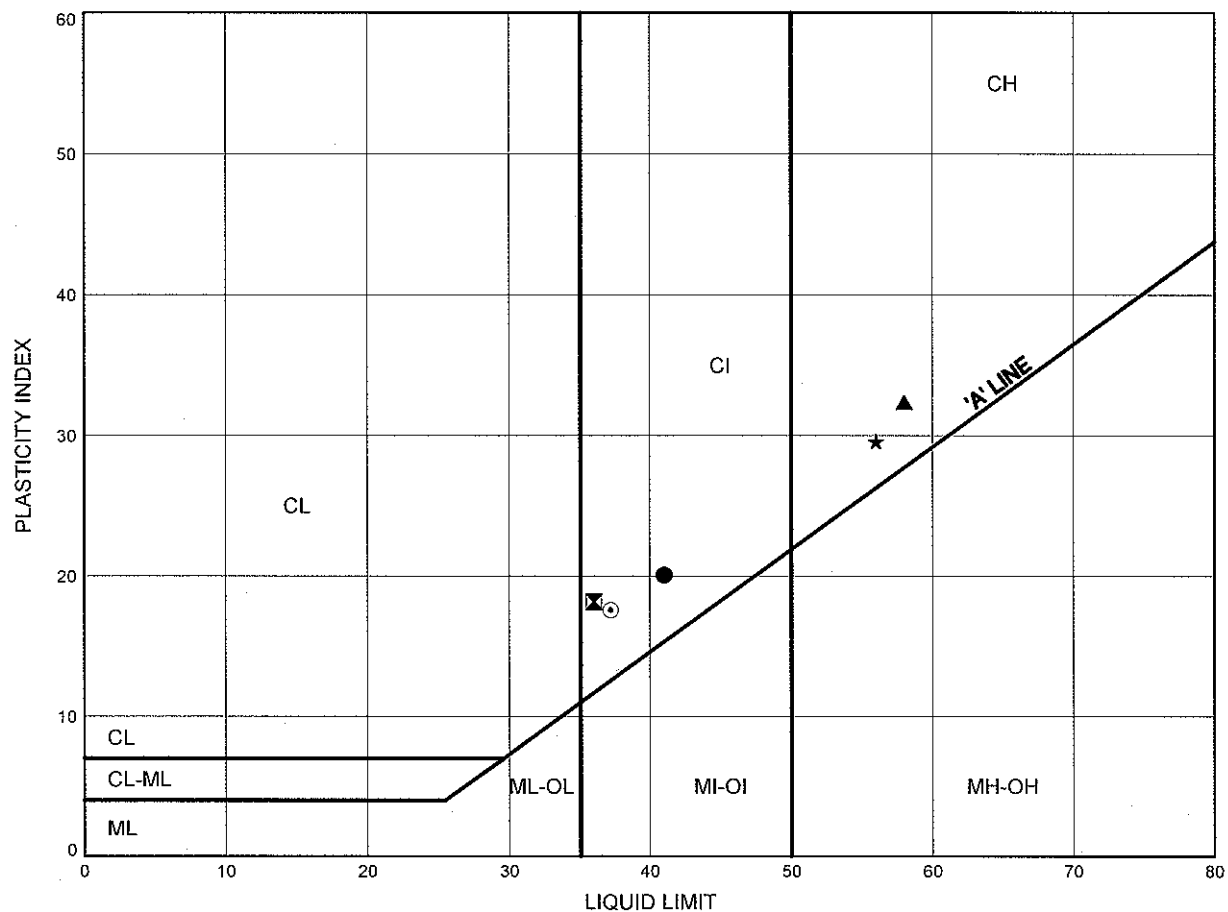
Prep'd DB

Chkd. MP

ATTERBERG LIMITS TEST RESULTS

FIGURE B19

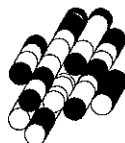
SILTY CLAY



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	PR8	4.7	175.9
⊠	PR8	7.8	172.8
▲	PR9	1.0	180.6
★	PR9	2.5	179.1
⊙	PR9	4.0	177.6

Date July 2010

Project 1-09-4135



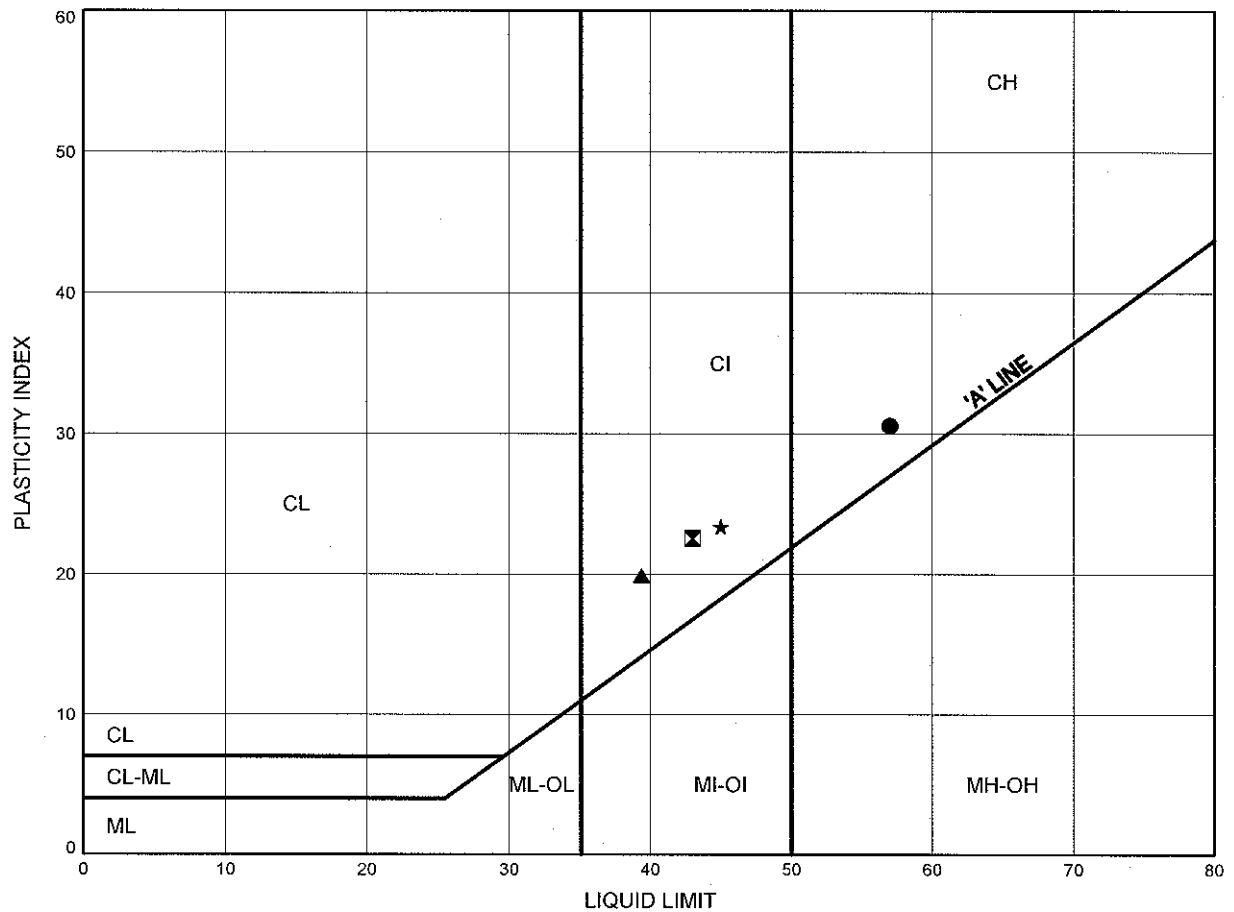
Prep'd DB

Chkd. MP

ATTERBERG LIMITS TEST RESULTS

FIGURE B20

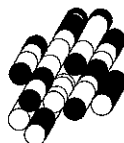
SILTY CLAY



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	PR10	1.7	179.8
⊠	PR10	4.0	177.5
▲	PR10	4.7	176.8
★	PR10	9.3	172.2

Date July 2010

Project 1-09-4135



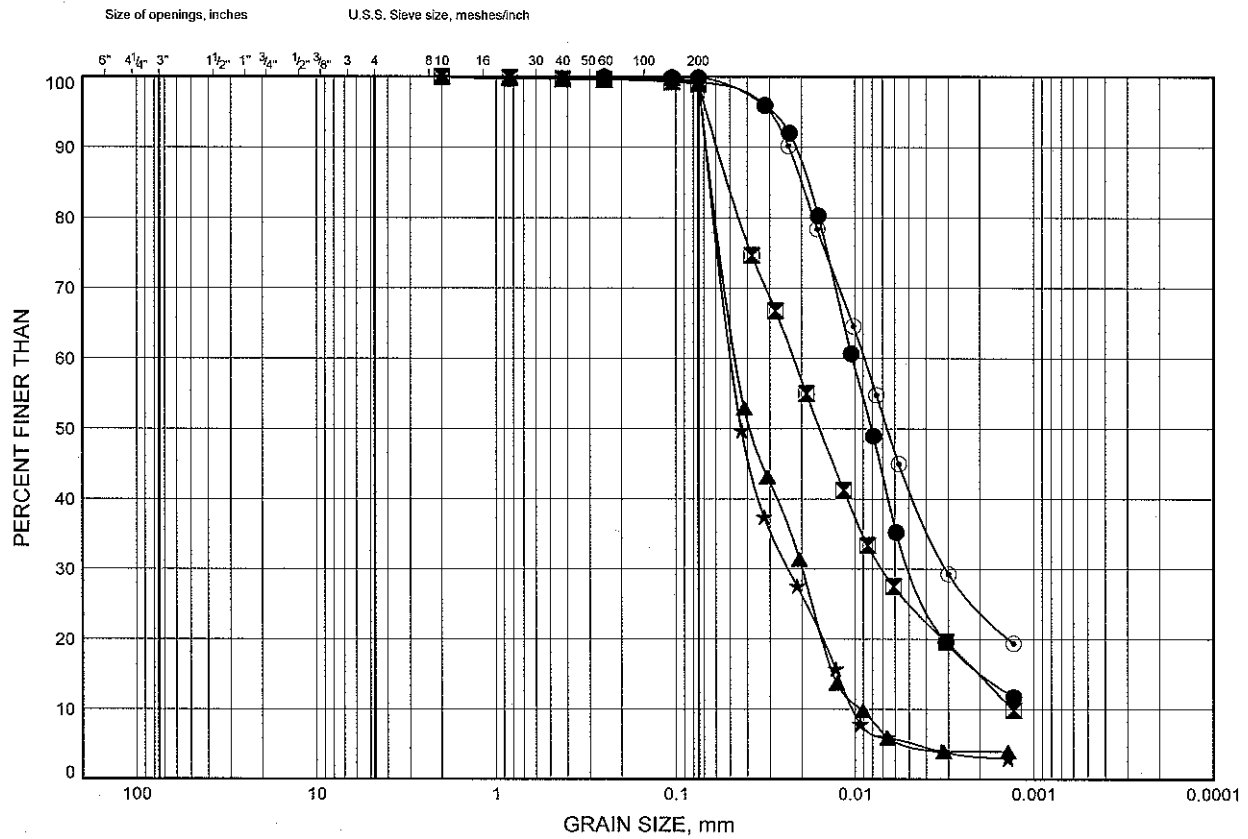
Prep'd DB

Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B21

SILT



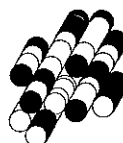
COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL BOREHOLE DEPTH (m) ELEVATION (m)

●	PR1	15.4	166.3
⊠	PR1	17.0	164.7
▲	PR2	17.0	164.7
★	PR3	15.4	165.9
⊙	PR4	15.4	166.8

Date July 2010

Project 1-09-4135



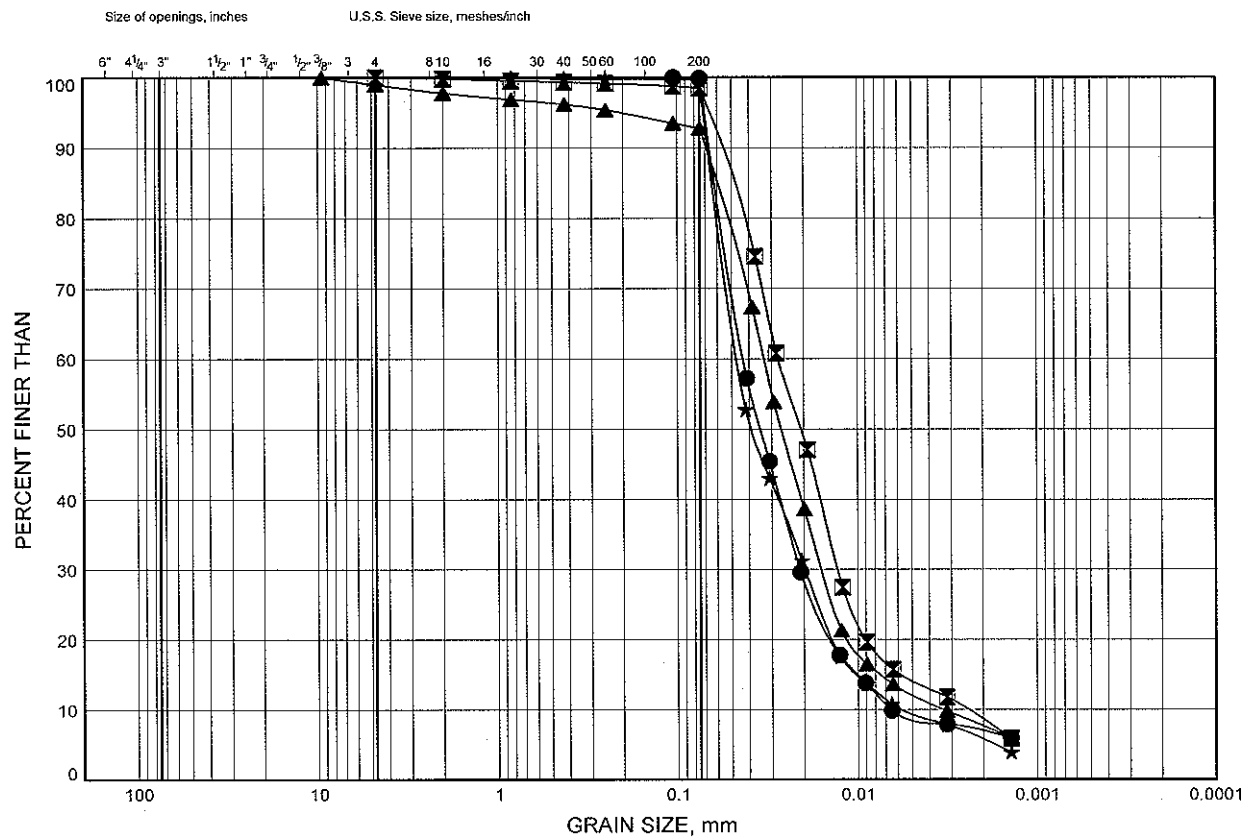
Prep'd DB

Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B22

SILT



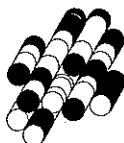
COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL BOREHOLE DEPTH (m) ELEVATION (m)

●	PR5	15.4	165.8
⊠	PR6	15.4	163.6
▲	PR8	15.4	165.2
★	PR9	15.4	166.2

Date July 2010

Project 1-09-4135



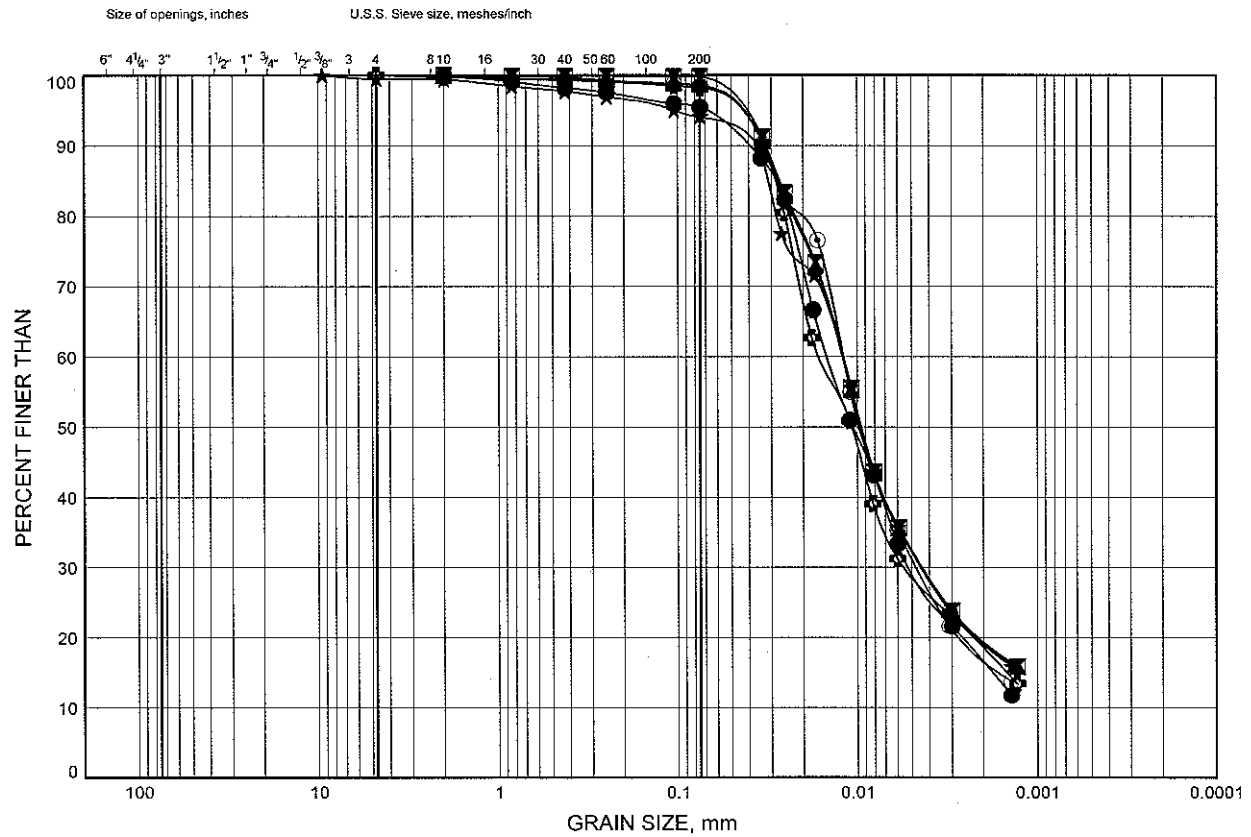
Prep'd DB

Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B23

SILTY CLAY TO CLAYEY SILT



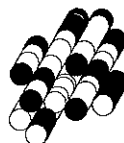
COBBLE SIZE	COARSE	FINE	COARSE	MEDIUM	FINE	SILT and CLAY
	GRAVEL		SAND			FINE GRAINED

SYMBOL BOREHOLE DEPTH (m) ELEVATION (m)

●	PR2	20.0	161.7
⊠	PR2	23.1	158.6
▲	PR2	26.1	155.6
★	PR3	18.5	162.8
⊙	PR3	23.1	158.2
⊕	PR4	21.5	160.7

Date July 2010

Project 1-09-4135



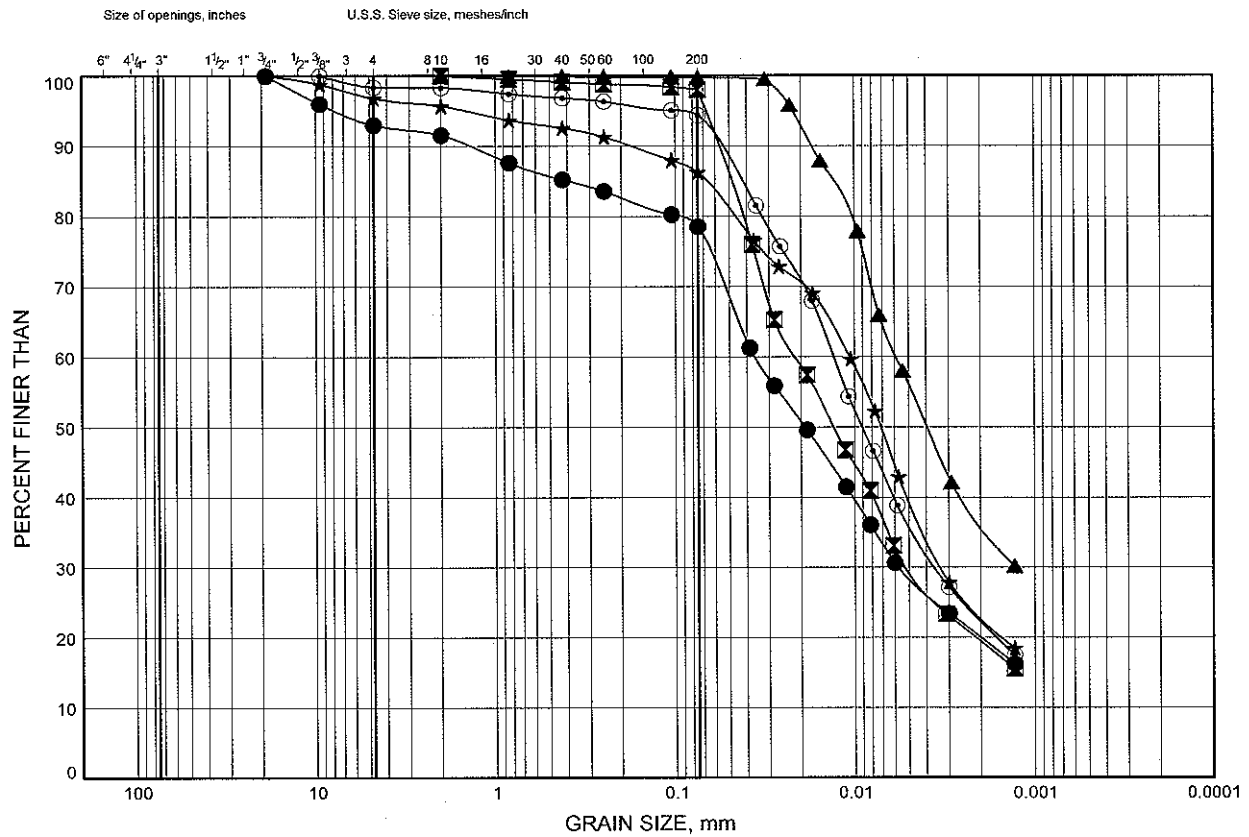
Prep'd DB

Chkd. MP

GRAIN SIZE DISTRIBUTION

FIGURE B24

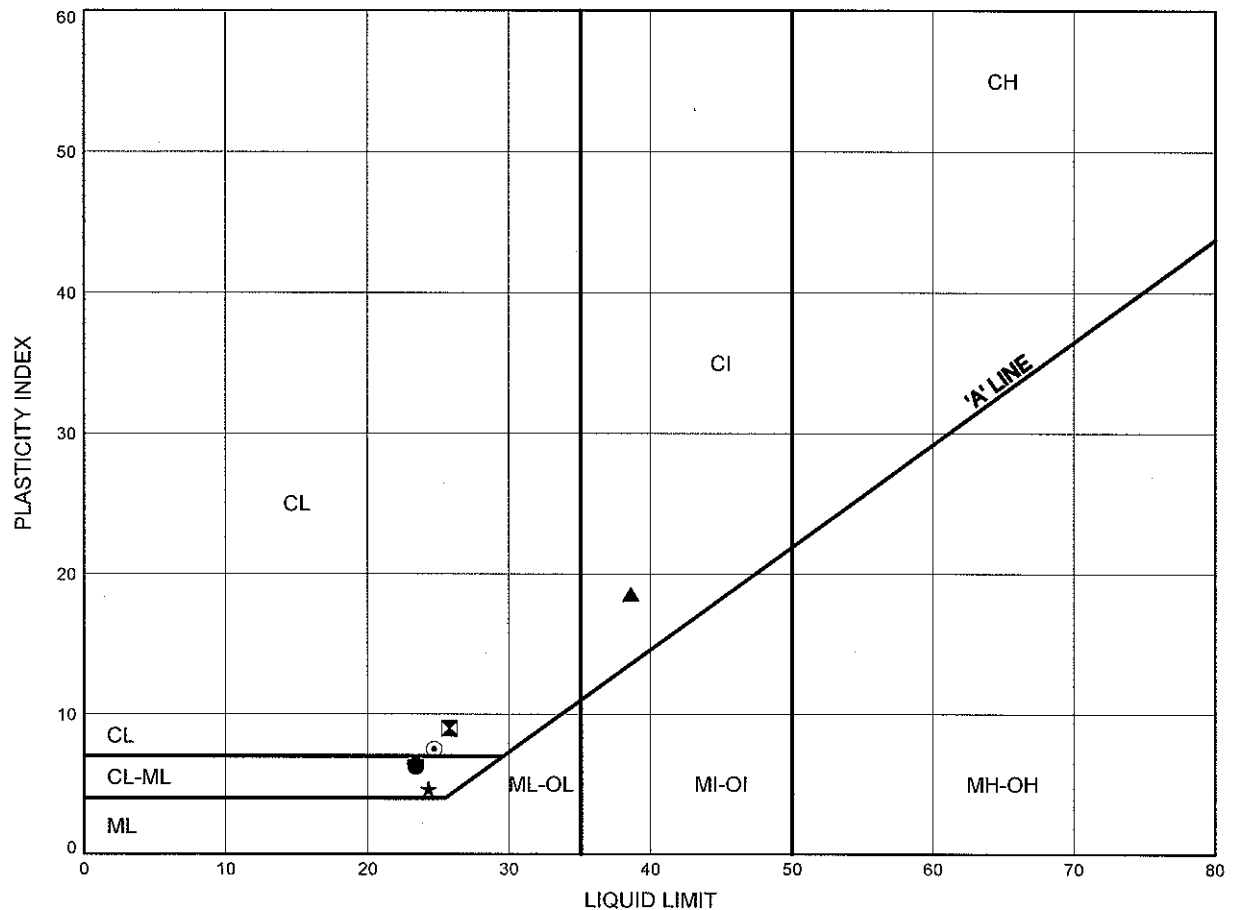
SILTY CLAY TO CLAYEY SILT



ATTERBERG LIMITS TEST RESULTS

FIGURE B25

SILTY CLAY TO CLAYEY SILT

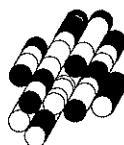


SYMBOL BOREHOLE DEPTH (m) ELEVATION (m)

●	PR2	20.0	161.7
⊠	PR2	23.1	158.6
▲	PR2	26.1	155.6
★	PR3	18.5	162.8
⊙	PR3	23.1	158.2
⊕	PR4	21.5	160.7

Date July 2010

Project 1-09-4135



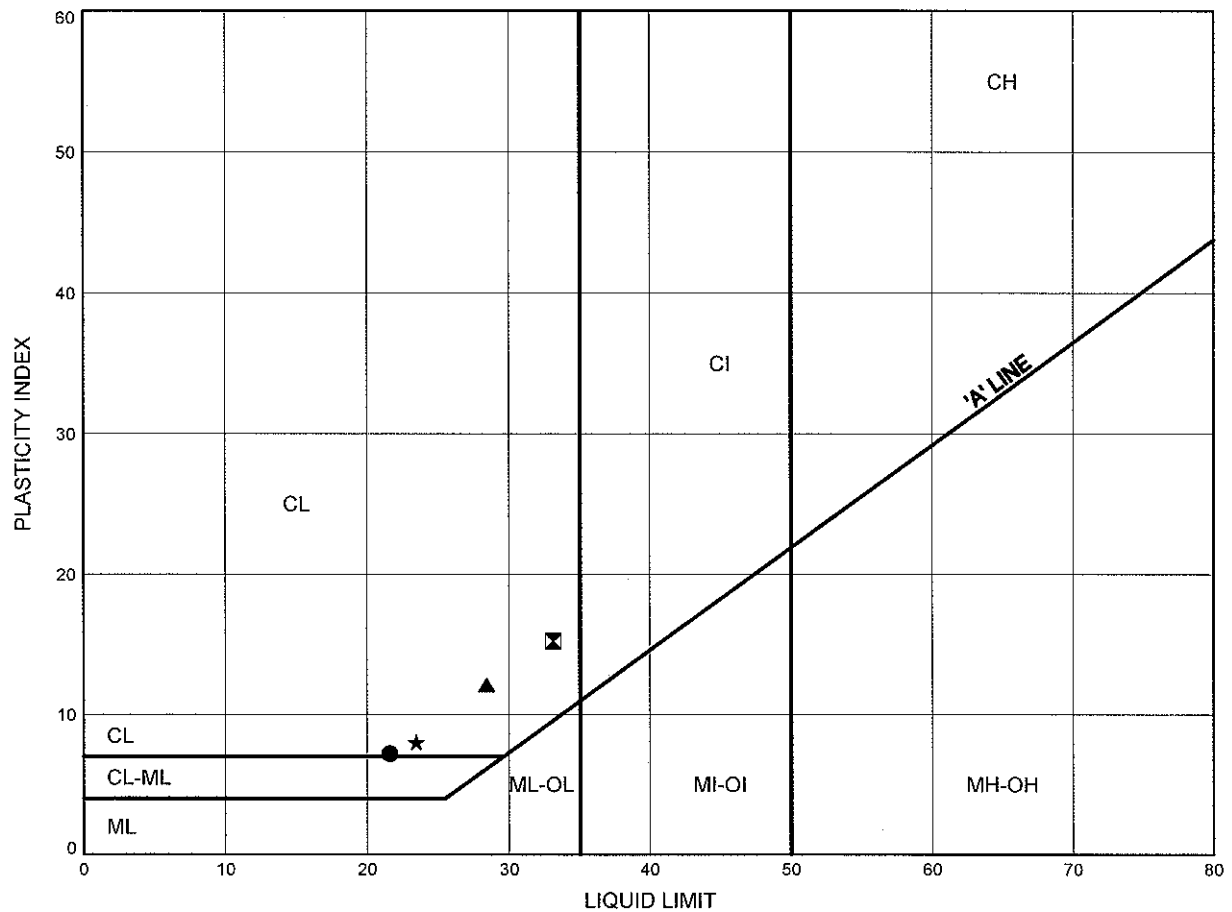
Prep'd DB

Chkd. MP

ATTERBERG LIMITS TEST RESULTS

FIGURE B26

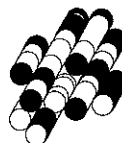
SILTY CLAY TO CLAYEY SILT



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
☒	PR4	24.6	157.6
▲	PR4	27.6	154.6
★	PR7	18.5	161.6
●	PR10	18.5	163.0

Date July 2010

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Prep'd DB

Chkd. MP

FIGURE B27

Size of openings, inches

U.S.S. Sieve size, meshes/inch

6" 4 1/4" 3" 1 1/2" 1" 3/4" 3/8" 3/4" 3 4 8 10 16 30 40 50 60 100 200

100 10 1 0.1 0.01 0.001 0.0001

PERCENT FINER THAN

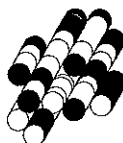
GRAIN SIZE, mm

Grain Size (mm)	Percent Finer (%)
10	100
4.75	98
2.0	94
0.85	90
0.425	88
0.25	86
0.15	81
0.075	78
0.0425	60
0.025	56
0.015	48
0.0075	37
0.00425	32
0.0025	26
0.0015	17
0.00075	13

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

SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	PR3	27.6	153.7

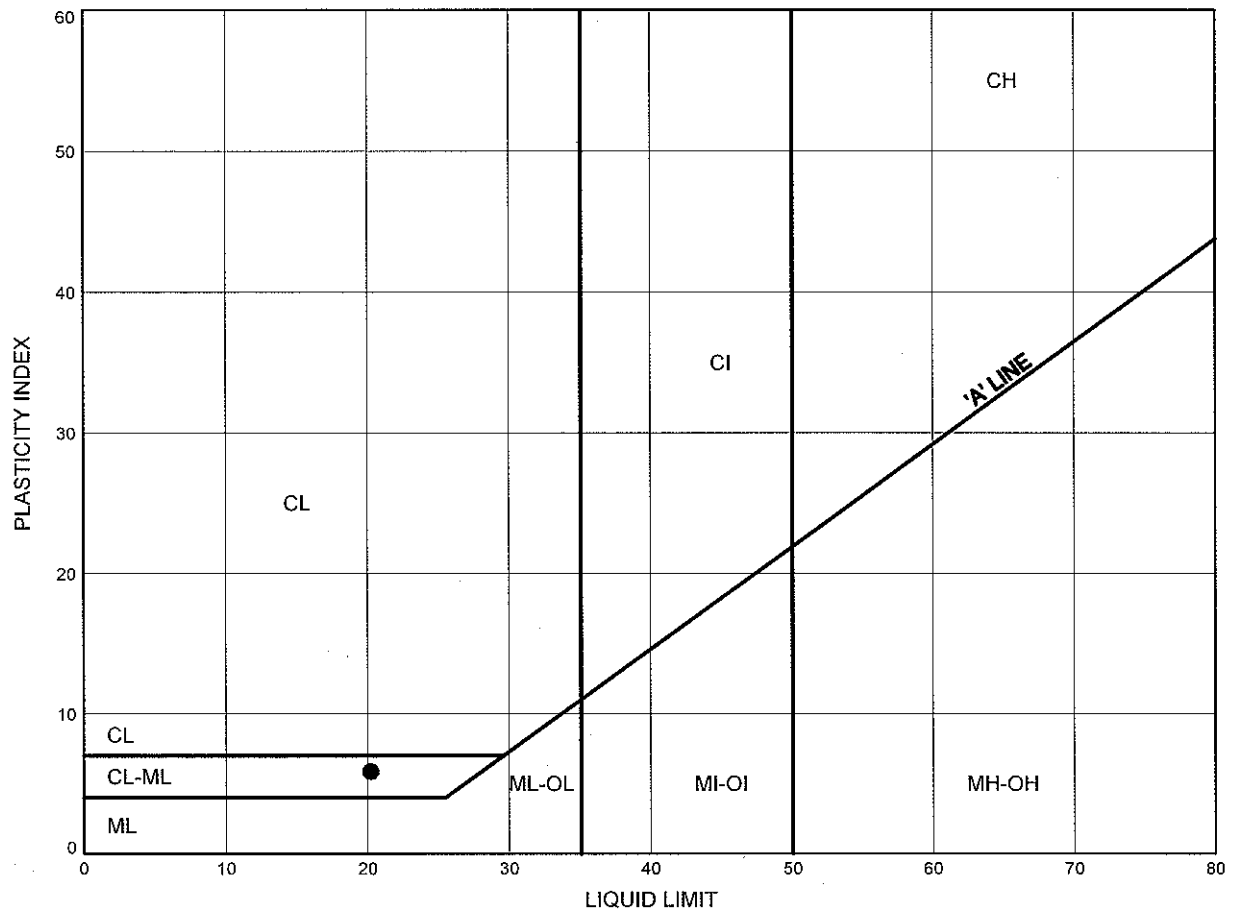
Chkd.MP.....



ATTERBERG LIMITS TEST RESULTS

FIGURE B28

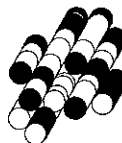
CLAYEY SILT TILL



SYMBOL	BOREHOLE	DEPTH (m)	ELEVATION (m)
●	PR3	27.6	153.7

Date July 2010

Project 1-09-4135



Prep'd DB

Chkd. MP

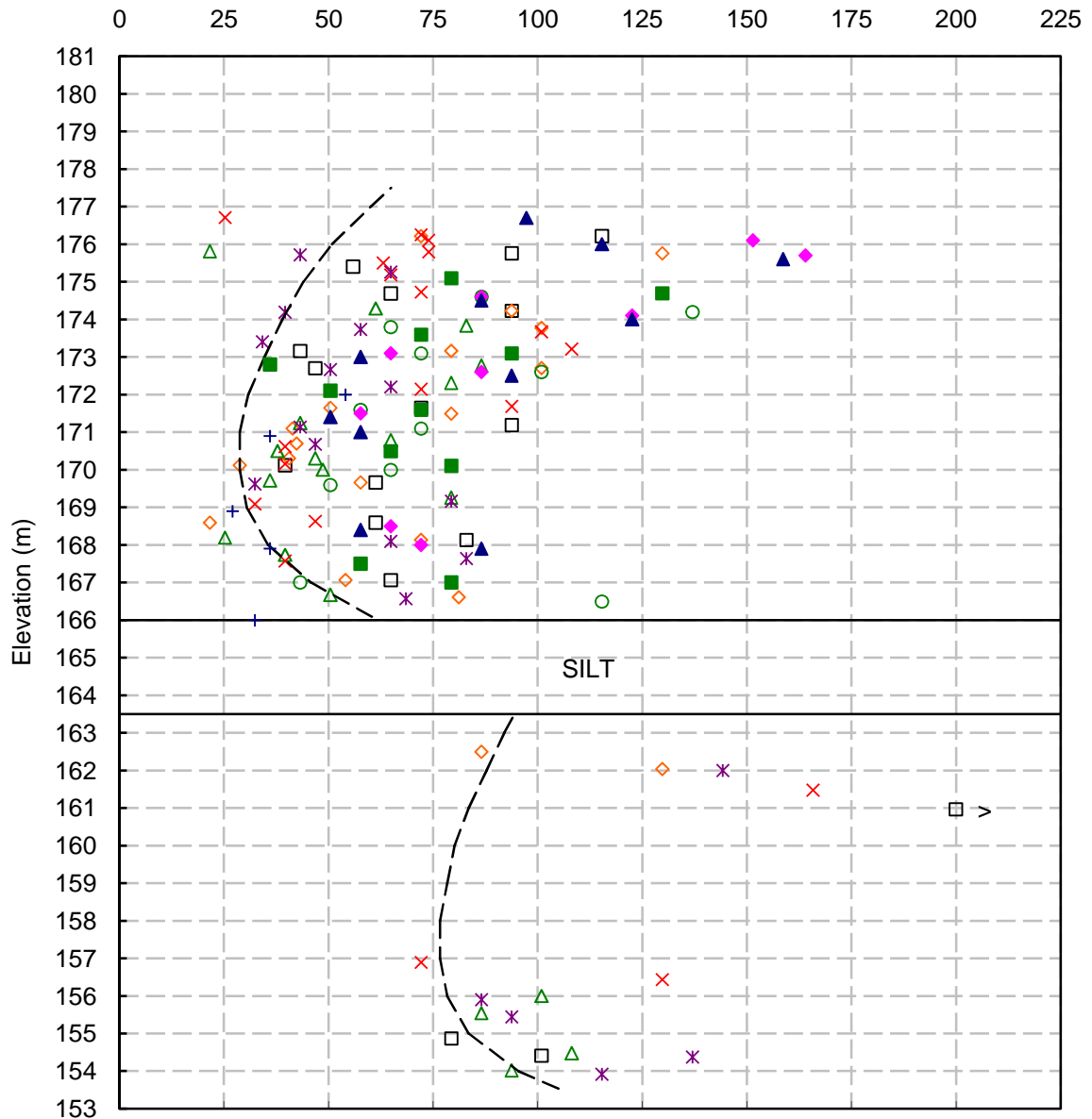
CORRECTED UNDRAINED SHEAR STRENGTH

FIGURE B29

HWY 406 TWINNING - PORT ROBINSON ROAD

Silty Clay

Corrected Cu (kPa)



□ PR1 ◇ PR2 △ PR3 × PR4 * PR5 + PR6 ○ PR7 ■ PR8 ◆ PR9 ▲ PR10

Field Shear Vane Correction

Morris & Williams (1994)

($\mu = 1.18 \text{ EXP}(-0.08 \text{ Ip}) + 0.57$)

Applied Correction Factors

0.72 (Elev.>177.5m)

0.90 (Elev.<177.5m)

Project No. : 1-09-4135

Date : September, 2010



Terraprobe Inc.

Prepared By : HW

Checked By : RA

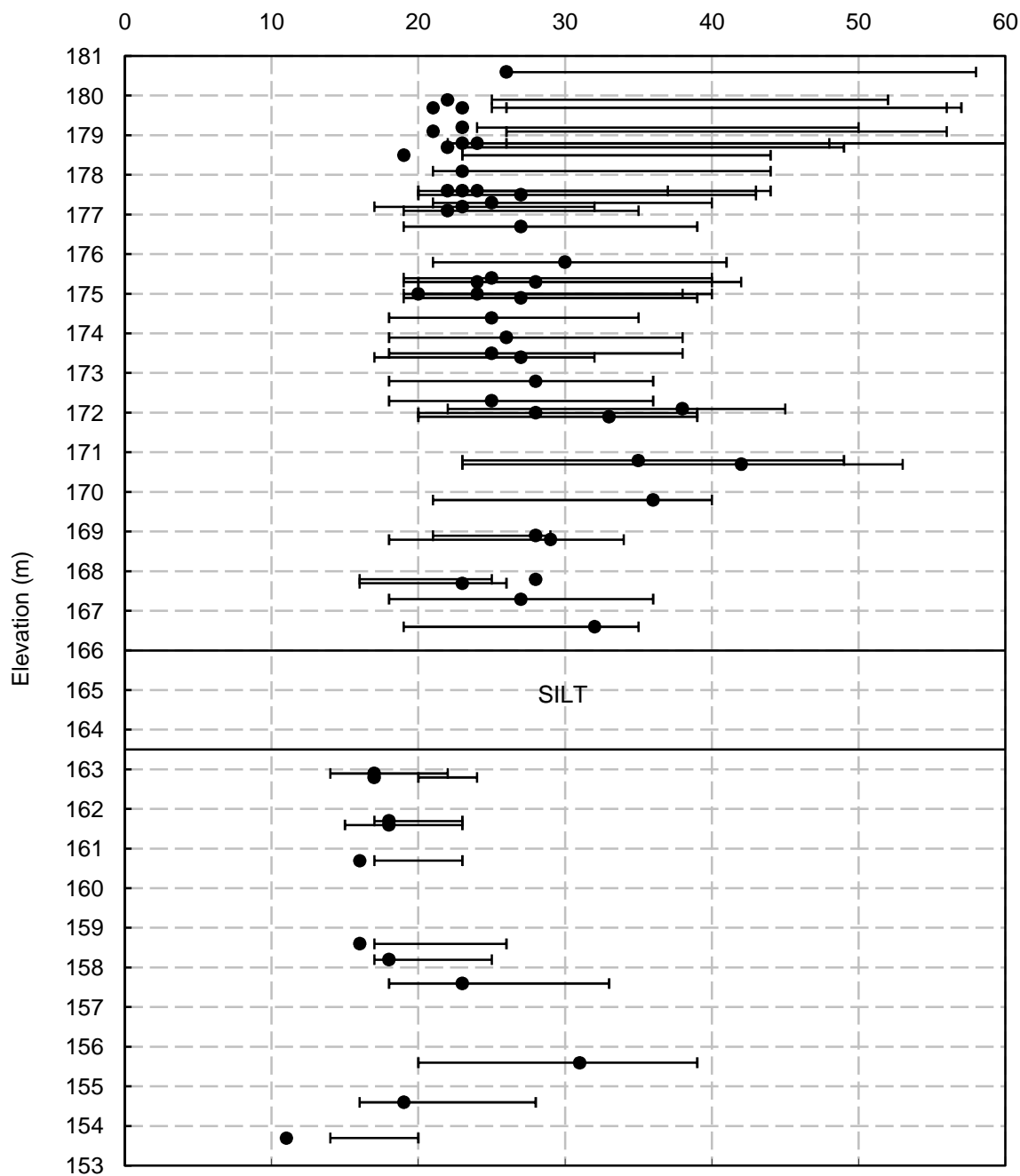
ATTERBERG LIMITS AND WATER CONTENTS

FIGURE B30

HWY 406 TWINNING - PORT ROBINSON ROAD

Silty Clay

Atterberg Limits & Water Contents (%)



Project No. : 1-09-4135

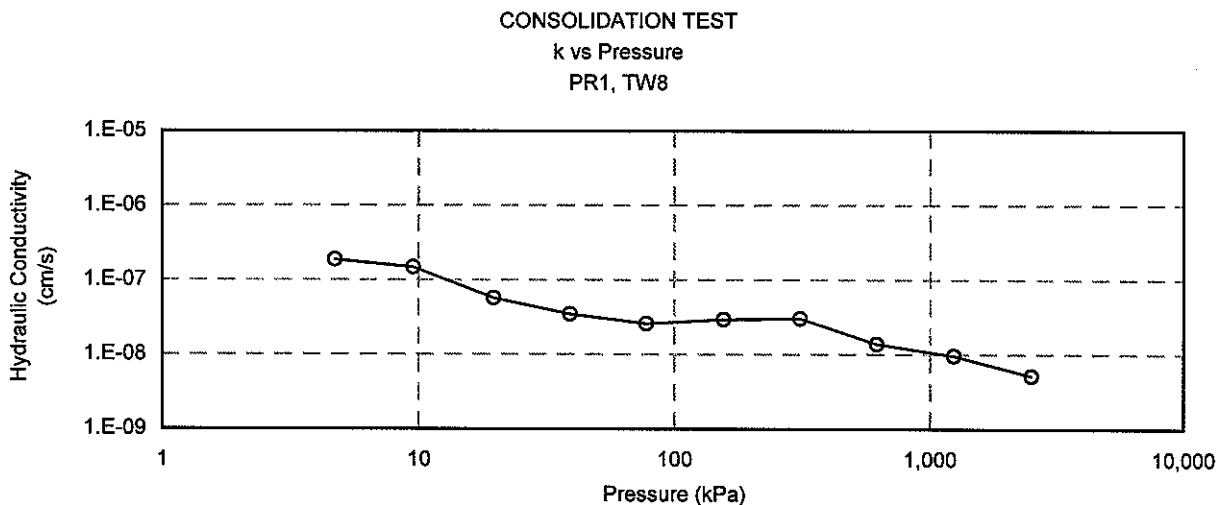
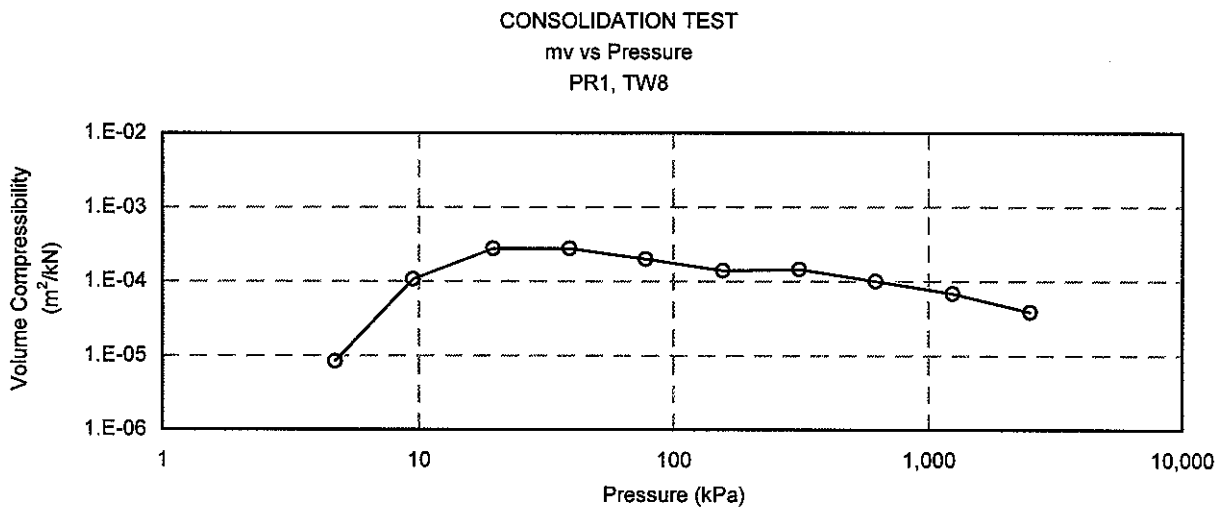
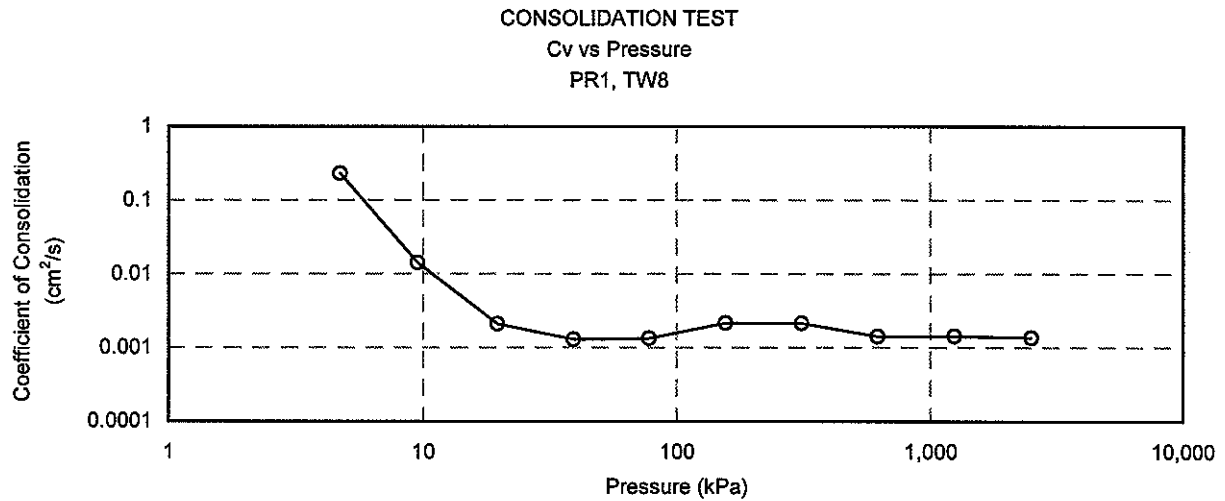
Date : September, 2010



Prepared By : HW

Checked By : RA

C:\Documents and Settings\Hongliu\My Documents\Project 2009\1-09-4135 - HWY 406 Foundations\Bridges\1-09-4135 Soil Parameter Estimation-TSEW1.xls



C:\Documents and Settings\Hongjiu\My Documents\Project 2009\1-09-4135 - HWY 406 Foundations\Port Robinson Rd\1-09-4135 Consolidation Results-PR.xls

Project No. : 1-09-4135
Date : July 2010



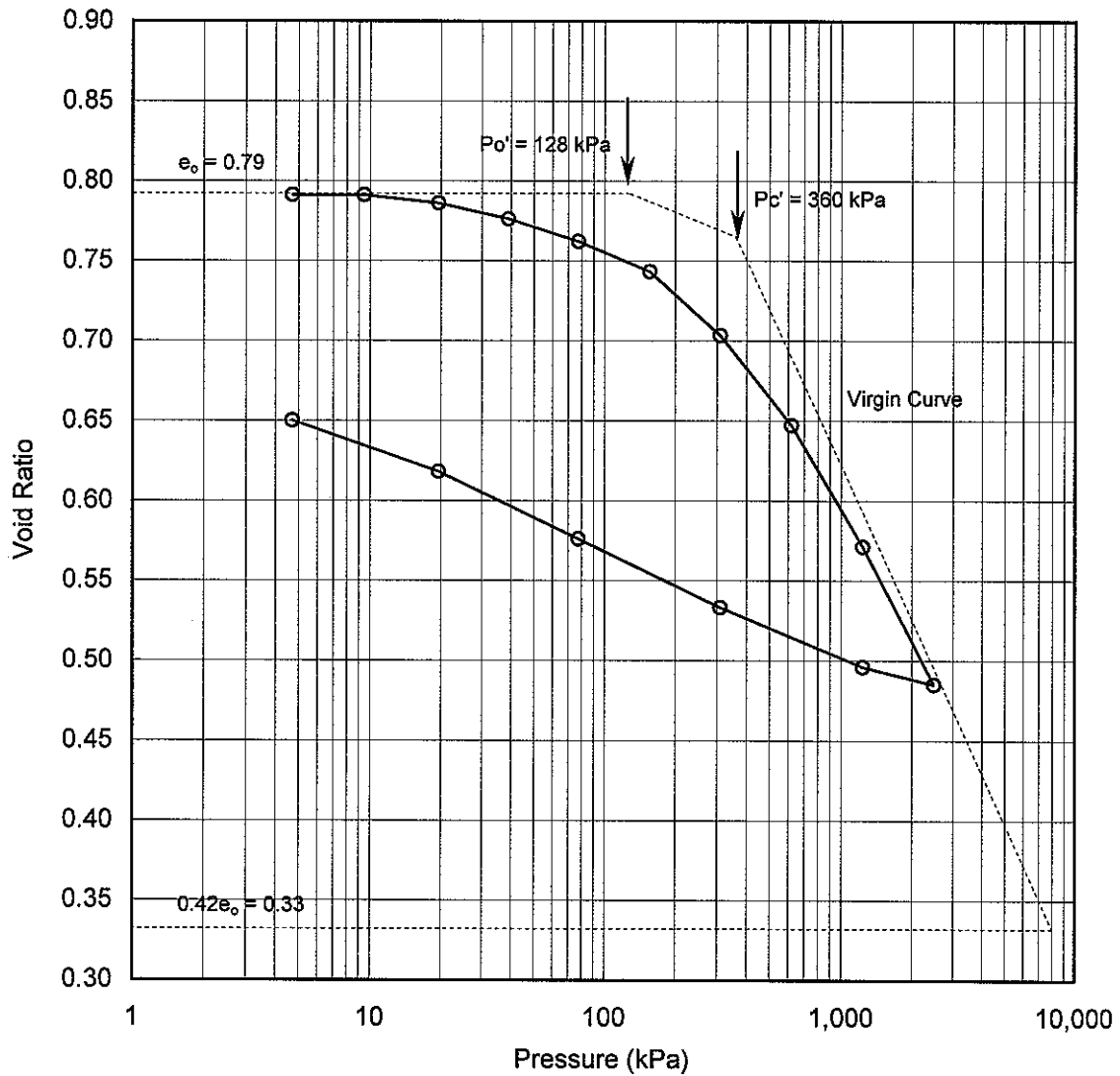
Terraprobe Inc.

Prepared By : HW
Checked By : RA

CONSOLIDATION TEST

e vs Pressure

PR1, TW8



Soil Type : Silty Clay

$e_0 =$	0.79	$\omega_L =$	40%	$P_{o'} =$	128 kPa
$\omega =$	28%	$\omega_p =$	19%	$P_{c'} =$	360 kPa
$\gamma =$	19.5 kN/m ³	PI =	21%	Cc =	0.321
Gs =	2.78			Cr =	0.060

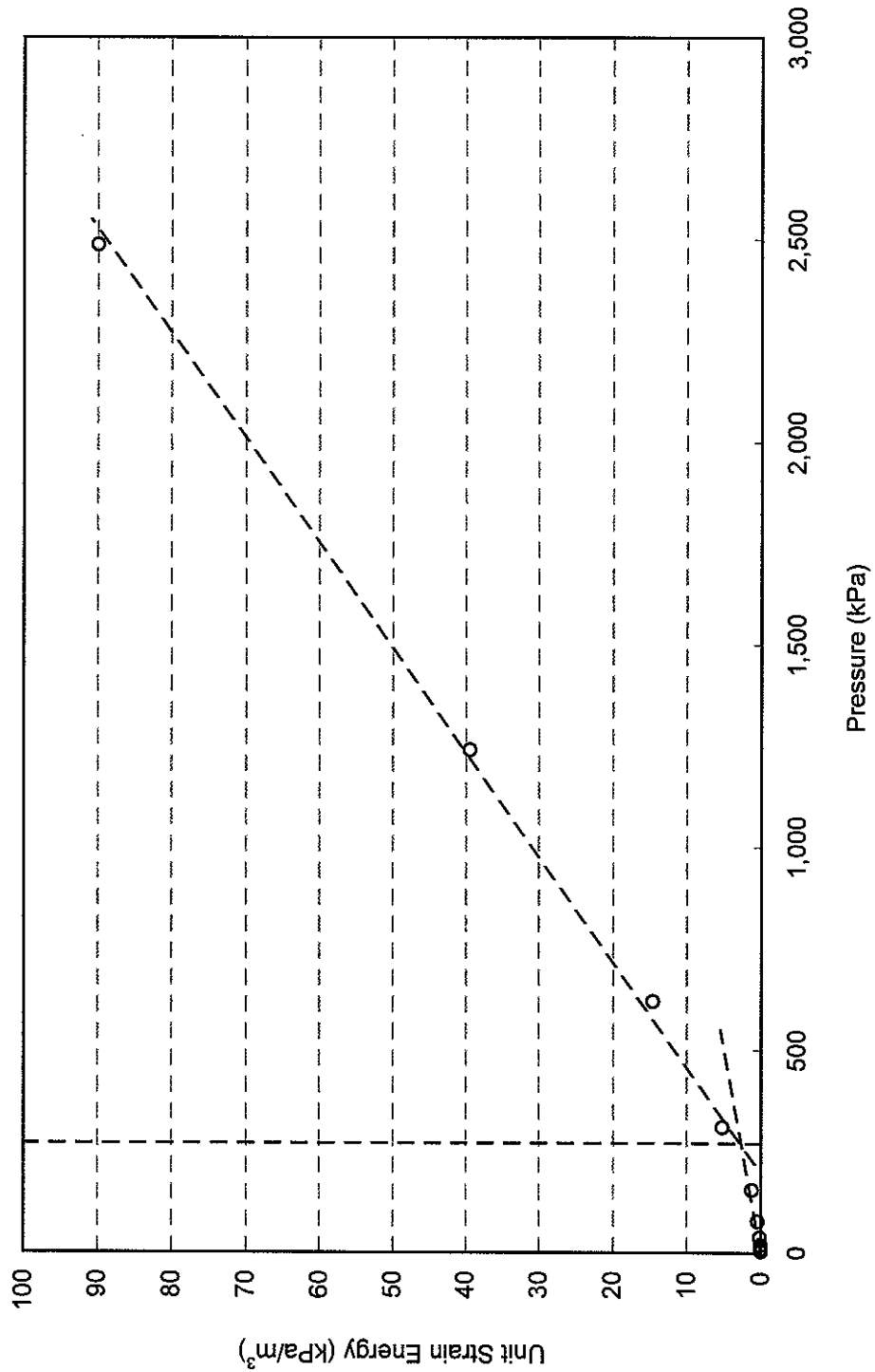
Project No. : 1-09-4135
Date : July 2010



Terraprobe Inc.

Prepared By : HW
Checked By : RA

CONSOLIDATION TEST
Unit Strain Energy vs Pressure
PR1, TW8



$P_c = 270 \text{ kPa}$

Project No. : 1-09-4135

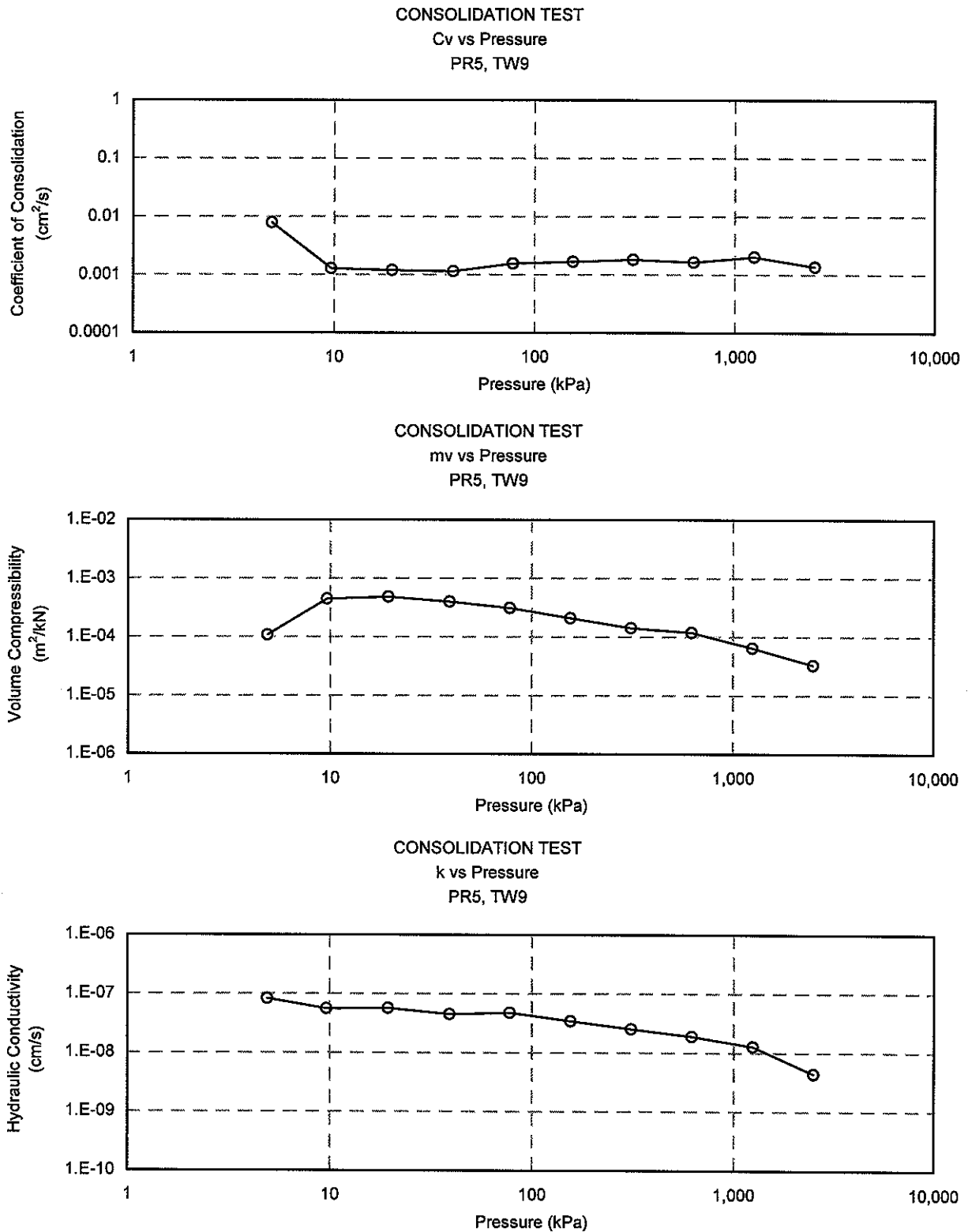
Date : July 2010



Terraprobe Inc.

Prepared By : HW

Checked By : RA



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Project No. : 1-09-4135
Date : July 2010



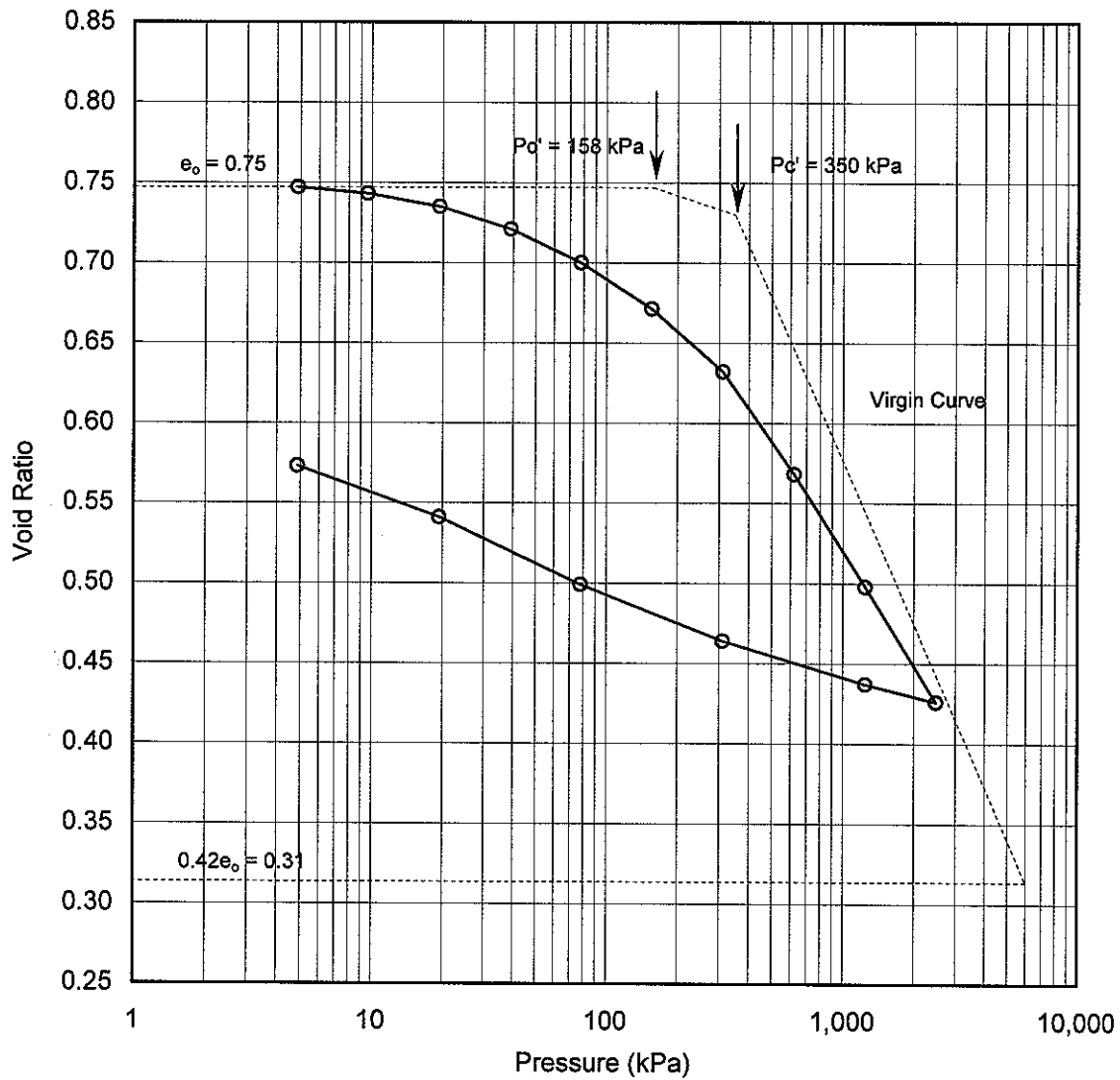
Terraprobe Inc.

Prepared By : HW
Checked By : RA

CONSOLIDATION TEST

e vs Pressure

PR5, TW9



Soil Type : Silty Clay

$e_o =$	0.75	$\omega_L =$	32%	$P_o' =$	158 kPa
$\omega =$	27%	$\omega_P =$	16%	$P_c' =$	350 kPa
$\gamma =$	19.7 kN/m ³	PI =	15%	Cc =	0.337
Gs =	2.76			Cr =	0.049

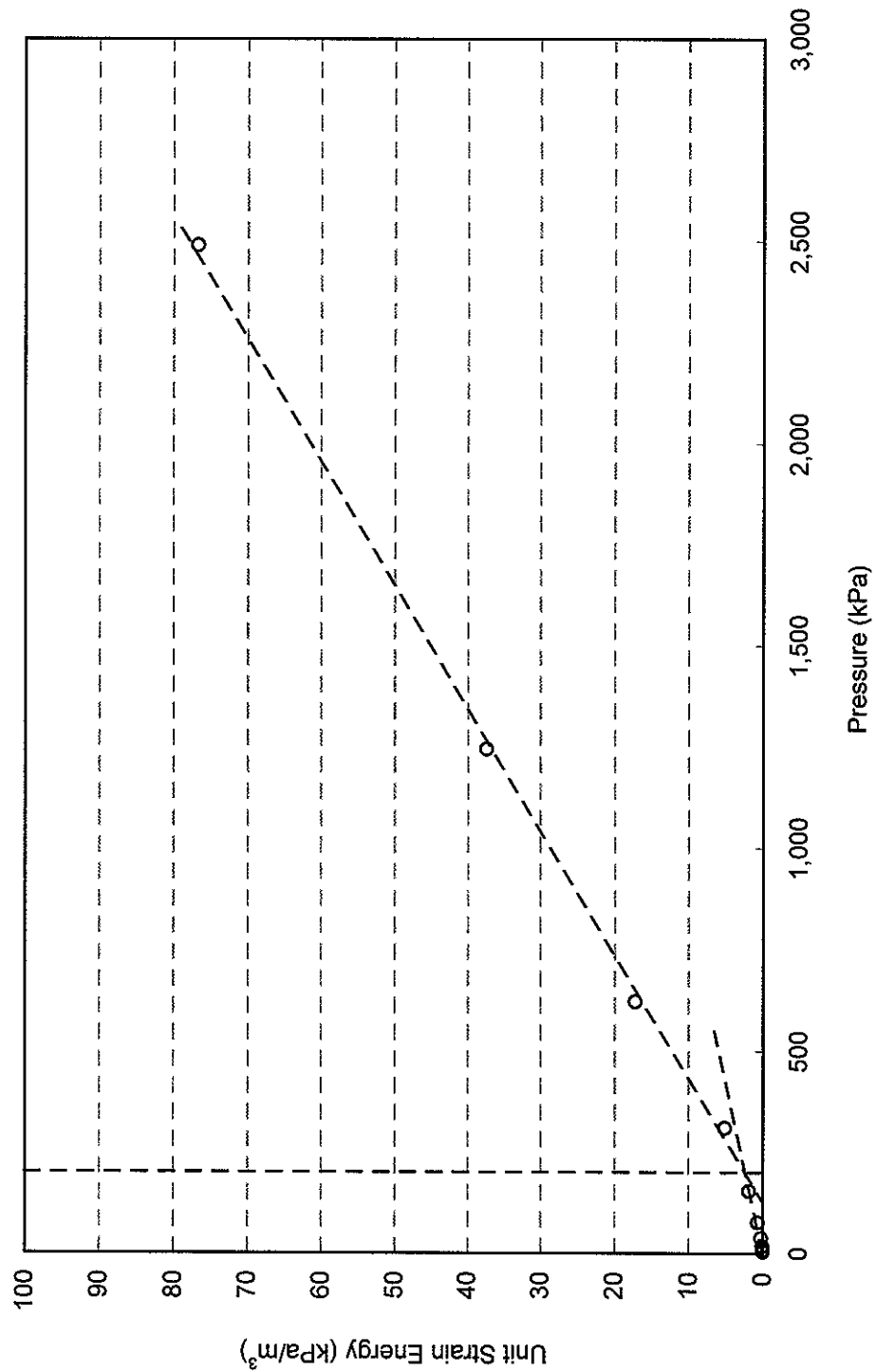
Project No. : 1-09-4135
Date : July 2010



Terraprobe Inc.

Prepared By : HW
Checked By : RA

CONSOLIDATION TEST
Unit Strain Energy vs Pressure
PR5, TW9



$P_c = 200 \text{ kPa}$

Project No. : 1-09-4135

Date : July 2010



Terraprobe Inc.

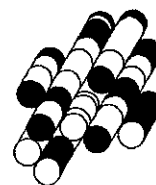
Prepared By : HW

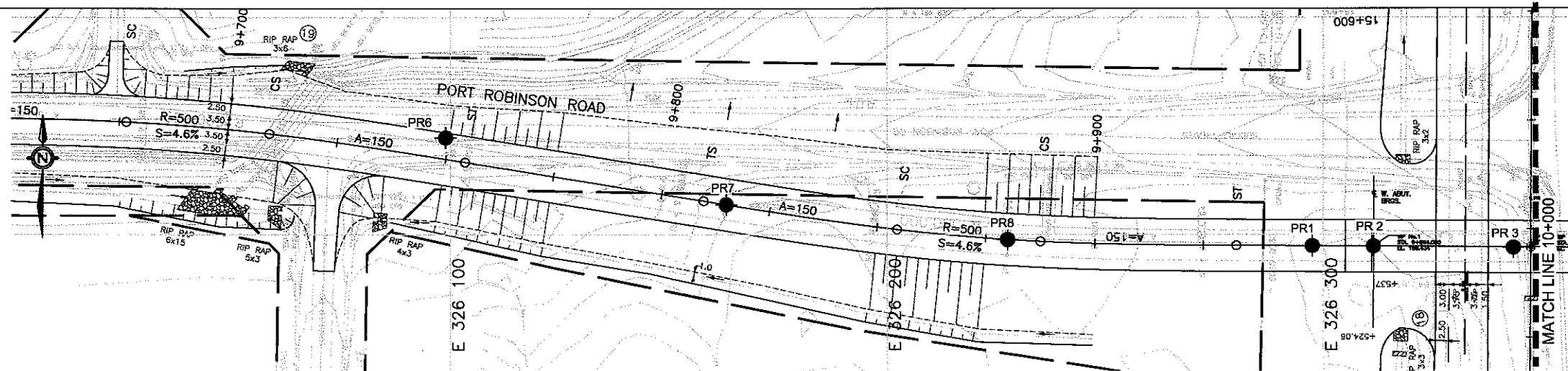
Checked By : RA

APPENDIX C

**Drawings titled “Borehole
Locations and Soil Strata”**

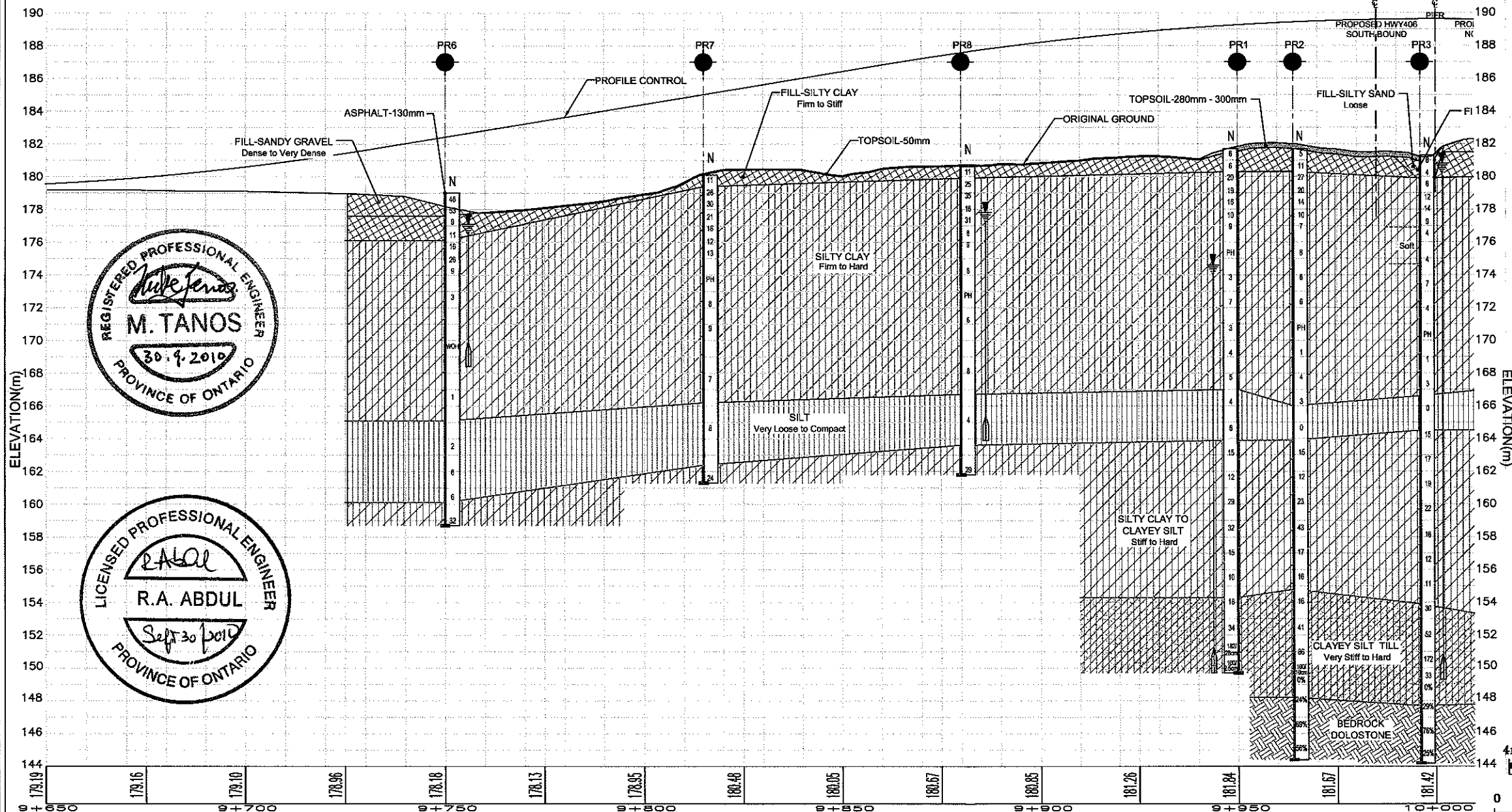
Terraprobe Inc.





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

PLAN
SCALE
0 10 20 30 40m



CONT No
WP No 280-99-00

HIGHWAY 406
PORT ROBINSON HIGH FILL
BOREHOLE LOCATIONS AND SOIL STRATA

Giffels Associates Limited
Consulting Engineers and Architects
An IBI Group Company

Terraprobe
Consulting Geotechnical & Environmental Engineering
Construction Vehicle Engineering, Inspection & Testing



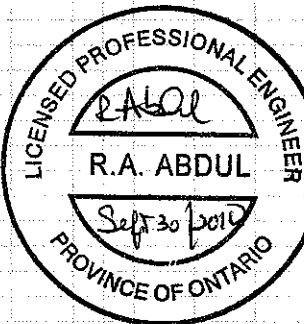
KEY PLAN

LEGEND			
	Bore Hole		
	Dynamic Cone Penetration Test		
	Bore Hole And Cone		
	Blows/0.3m (Std Pen Test, 475 J/blow)		
	Blows/0.3m (60' Cone, 475 J/blow)		
	WL at Time of Investigation		
	WL in Piezometer (JULY, 2010)		
	Piezometer		
	90% Rock Quality Designation		
	A/R Auger Refusal		

No	ELEV.	COORDINATES	
		NORTHING	EASTING
PR1	181.7	4 766 747.4	326 297.5
PR2	181.7	4 766 747.3	326 311.5
PR3	181.3	4 766 747.0	326 343.5
PR4	182.2	4 766 752.2	326 382.2
PR5	181.2	4 766 743.3	326 398.5
PR6	179.0	4 766 772.3	326 098.9
PR7	180.1	4 766 756.9	326 163.1
PR8	180.6	4 766 748.9	326 227.6
PR9	181.6	4 766 746.6	326 427.5
PR10	181.5	4 766 748.2	326 497.5

NOTE
The boundaries between soil strata have been established only at Bore Hole locations. Between Bore Holes the boundaries are assumed from geological evidence.
This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

REVISIONS			
DATE	BY	DESCRIPTION	
DESIGN R.A.	CODE CHBDC2006	LOAD	DATE SEPT. 2010
DRAWN K.C.	CHK R.A.	STRUCT	



C PROFILE PORT ROBINSON ROAD

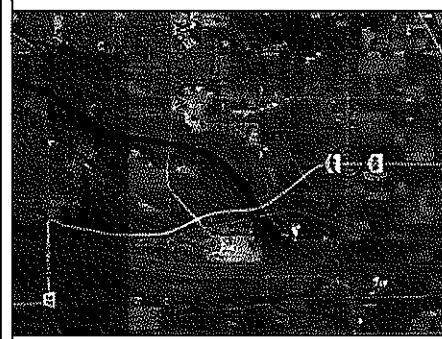
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETERS
UNLESS OTHERWISE SHOWN

CONT No
WP No 280-99-00

HIGHWAY 406
PORT ROBINSON HIGH FILLS
BOREHOLE LOCATIONS AND SOIL STRATA

Giffels Associates Limited
Consulting Engineers and Architects
An IBI Group Company

SHEET
2 OF 2



KEY PLAN

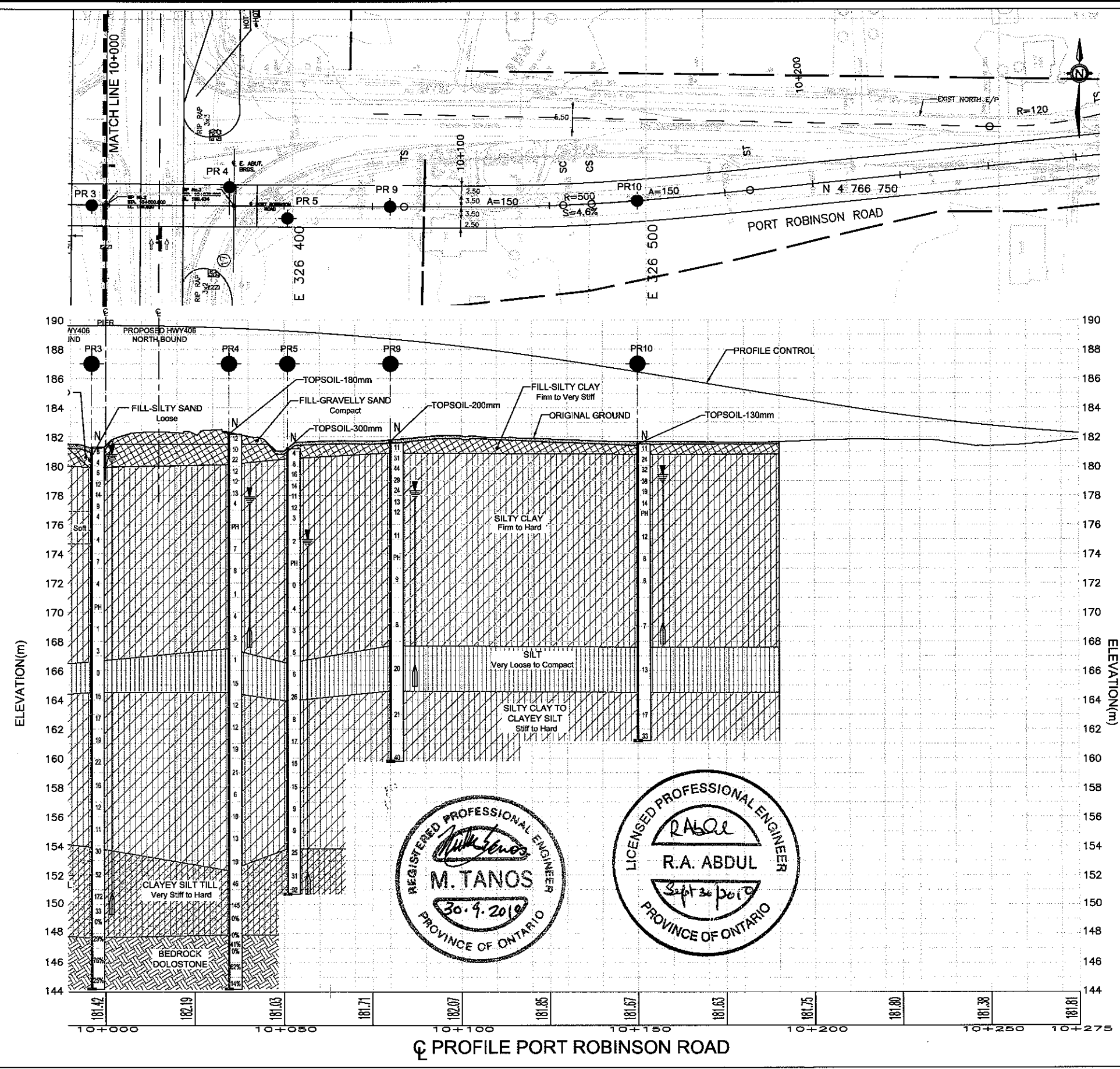
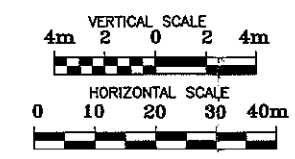
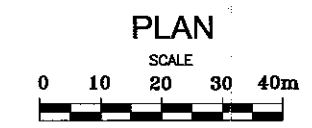
LEGEND

- Bore Hole
- Dynamic Cone Penetration Test
- Bore Hole And Cone
- Blows/0.3m (Std Pen Test, 475 J/blow)
- Blows/0.3m (60' Cone, 475 J/blow)
- WL at Time of Investigation
- WL in Piezometer (JULY, 2010)
- Piezometer
- 90% Rock Quality Designation
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No	ELEV.	COORDINATES	
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PR1	181.7	4 766 747.4	326 297.5
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PR6	179.0	4 766 772.3	326 098.9
PR7	180.1	4 766 756.9	326 163.1
PR8	180.6	4 766 748.9	326 227.6
PR9	181.6	4 766 746.6	326 427.5
PR10	181.5	4 766 748.2	326 497.5

NOTE
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This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

REVISIONS	DATE				DESCRIPTION	
	DATE	BY	LOAD	DATE	SEPT. 2010	
DESIGN	RA	CODE	CHBDC2006	LOAD	DATE	SEPT. 2010
DRAWN	K.C.	CHK	RA	STRUCT		



REGISTERED PROFESSIONAL ENGINEER
M. TANOS
30.9.2010
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
R.A. ABDUL
Sept 30 2010
PROVINCE OF ONTARIO