



THURBER ENGINEERING LTD.

**FOUNDATION INVESTIGATION AND DESIGN REPORT
HIGH MAST LIGHT POLE SUPPORTS
CONTRACT 2
HIGHWAY 404 HOV LANE EXPANSION AND REHABILITATION
FROM MAJOR MACKENZIE DRIVE TO SOUTH OF HIGHWAY 7
MARKHAM, ONTARIO
G.W.P. 2930-17-00**

GEOCRES NO. 30M14-494

**Latitude: 43.86527
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Report

to

WSP Canada Inc.

**Date: January 24, 2019
File: 15786**



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PART 1: FACTUAL INFORMATION

1. INTRODUCTION

This report presents the factual findings obtained from a foundation investigation conducted for detailed design of fifteen (15) high mast lighting pole (HML) support structures along Highway 404 from 1.1 km south of Major Mackenzie Drive to 1.1 km north of Highway 7 in the City of Markham, Ontario.

The purpose of this investigation was to explore the subsurface conditions near the HML locations along the highway alignment, and based on the data obtained, to provide a borehole location plan, records of boreholes, laboratory test results, and a written description of the subsurface conditions.

Thurber has been retained by WSP Canada Inc. (WSP) to carry out this foundation investigation under the MTO Assignment Number 2016-E-0014.

For preparation of this report, reference has been made to subsurface information contained in other reports for this Highway 404 project listed in the following:

- Foundation Investigation Report for Highway 404 16th Avenue Overpass, Replacement and Widening, Highway 404 HOV Lane Expansion and Rehabilitation, Contract 2, Markham, Ontario, Site 37-666, G.W.P. 2930-17-00, prepared by Thurber Engineering, dated January 2019 (Reference 1).

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- Foundation Investigation Report for Rouge River NBL and SBL Bridges, Replacement and Widening, Highway 404 HOV Lane Expansion and Rehabilitation, Contract 2, Markham, Ontario, Sites 37-347/1 and 34-347/2, G.W.P. 2930-17-00, prepared by Thurber Engineering, dated January 2019 (Reference 2).
- Foundation Investigation Report for Median Sewer, Highway 404 HOV Lane Expansion and Rehabilitation, Contract 2, Markham, Ontario, Sites 37-347/1 and 34-347/2, G.W.P. 2930-17-00, prepared by Thurber Engineering, dated January 2019 (Reference 3).
- Foundation Investigation Report for Overhead, High Occupancy Message, Emergency Detour Route, Highway 407 ETR. And Toll Station Sign Supports, Highway 404 HOV Lane Expansion and Rehabilitation, Contract 2, Markham, Ontario, Sites 37-347/1 and 34-347/2, G.W.P. 2930-17-00, prepared by Thurber Engineering, dated January 2019 (Reference 4).

2. PROJECT AND SITE DESCRIPTION

The HML support structures covered in this report are located along Highway 404 from approximately 1.1 km south of Major Mackenzie Drive to 1.1 km north of Highway 7. The general locations of the proposed HML are shown on the key plan on the Borehole Location Plan drawings in Appendix C.

The project limits are located within the physiographic region known as the Peel Plain. The topography is flat and gently undulating. The soil cover in the region typically comprises silty clay glacial tills with sand and silt layers. Shale bedrock of the Georgian Bay Formation is anticipated at an approximate depth of 50 m.

The land use adjacent to this section of Highway 404 is largely rural and agricultural, although there is increasing residential and commercial developments in recent years. The vegetation cover beyond the paved areas of the highway comprises grass, shrubs and stands of trees.

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3. SITE INVESTIGATION AND FIELD TESTING

The borehole investigation and field testing program for this project was carried out from July 9 to August 9th, 2018, and consisted of drilling and sampling twenty two (22) boreholes to approximate depths ranging from 6.5 m to 12.8 m below existing grade. It is noted that many of the boreholes covered by this report have also been used for addressing other aspects of this Highway 404 project (References 1 to 4).

Based on an email from WSP dated December 5, 2018, the number and locations of the HML poles have been increased to eighteen (18). Due to this revision, some of the borehole information in Reference 1 to Reference 4 will be interpolated for the purposes of this report.

Lane closures and traffic control were planned for drilling each borehole. Prior to commencement of drilling, utility clearances were obtained for all borehole locations.

The approximate locations of the boreholes are shown on the Borehole Location Plan drawings included in Appendix C. Northing and easting co-ordinates at the borehole locations were obtained by Thurber using a hand-held Garmin GPS, and the corresponding ground surface elevations were provided by WSP based on the project DTM survey. The coordinates and elevations of the boreholes are given on these drawings in Appendix C and on the individual Record of Borehole Sheets in Appendix A.

The boreholes were advanced using truck-mounted Marl 5 and D-90 drill rigs. Solid and hollow stem augers were used to advance the boreholes, and soil samples were obtained at selected intervals using a 50 mm diameter split spoon sampler in conjunction with the Standard Penetration Test (SPT).

A member of Thurber's engineering staff supervised the drilling and sampling operations on a full-time basis. The supervisor logged the boreholes, visually examined the recovered soil samples, and transported them to Thurber's laboratory for further examination and testing.

Groundwater conditions in the open boreholes were observed during the drilling operations. Standpipe piezometers were installed in selected boreholes to permit monitoring of groundwater levels. The piezometers consisted of 19 mm and 50 mm diameter PVC pipes with slotted screens. Upon completion, the boreholes were abandoned in general accordance



with Ontario Regulation 903 amended by Ontario Reg. 372 (O.Reg. 903) after the final water level readings are taken. All piezometer installations will be decommissioned in general accordance with O.Reg. 903. The details of piezometer installations for boreholes covered in this report are summarized in Table 3.1.

Table 3.1 – Borehole Completion Details

Borehole No.	Borehole Depth / Base Elevation (m)	Piezometer Tip Depth / Elevation (m)	Completion Details
MS2-12	12.3 / 189.7	11.0/191.0	Borehole backfilled with sand filter from 11.0 m to 7.9 m, bentonite seal from 7.9 m to 6.7 m, then bentonite holeplug and auger cuttings from 6.7 m to 0.2 m, then dry mix concrete and cold patch asphalt to surface.
MS2-22	6.7 / 186.3	6.1 / 186.9	Borehole backfilled with sand filter from 6.7 m to 2.4 m, bentonite seal from 2.4 m to 1.5 m, then bentonite holeplug and auger cuttings from 1.5 m to 0.3 m, then dry mix concrete to surface.
MS2-29	7.9 / 181.9	6.1 / 183.6	Borehole caved to 6.1 m, backfilled with sand filter from 6.1 m to 2.4 m, bentonite seal from 2.4 m to 0.9 m, then bentonite holeplug and auger cuttings from 0.9 m to 0.2 m, then dry mix concrete and cold patch asphalt to surface.
MS2-32	12.5 / 177.0	6.1 / 183.4	Borehole backfilled with sand filter from 6.7 m to 2.4 m, bentonite seal from 2.4 m to 0.3 m, then dry mix concrete and cold patch 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 analysis and Atterberg Limits testing. All the laboratory tests were carried out in accordance to MTO and/or ASTM Standards, as appropriate. The results of the laboratory testing are summarized on the Record of Borehole sheets and on the accompanying figures in Appendices A to C.

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5. DESCRIPTION OF SUBSURFACE CONDITIONS

This section presents a generalized summary of the subsurface conditions encountered at the borehole locations that are relevant to the proposed HML supports. Borehole location along Highway 404 are presented on the Borehole Location Plan drawings in Appendix C. The attached Table 1 indicates the boreholes relevant to each pole location. Records of Borehole sheets and laboratory testing data are also included in the Appendices A and B.

The factual data presented in the Record of Borehole Sheets governs any interpretation of the site conditions. It must be recognized that soil conditions will vary between and beyond the borehole locations.

In general, the soil stratigraphy encountered along this section of Highway 404 consists of a pavement structure (asphalt on granular) and embankment fill overlying native, typically stiff to hard silty clay till, and/or compact to very dense sand and silt tills. Sand, silt and silty clay interlayers and lenses are present between and/or within the glacial till deposits. Groundwater levels measured in the standpipe piezometers are up to 2 m depth below existing grade.

More detailed descriptions of the stratigraphy are presented below.

5.1 Asphalt

Boreholes MS2-09, HMP2-01, MS2-12, MS2-13, MS2-14, MS2-15, MS2-17, MS2-18, MS2-19, TS2-02, MS2-21, MS2-22, MS2-24, MS2-25, MS2-26, MS2-27, MS2-28, MS2-29, MS2-30, MS2-31, MS2-32, HMP2-02 were drilled through an approximately 125 mm to 175 mm thick layer of asphalt pavement.

5.2 Cohesionless Fill

Sand and gravel (pavement granular) fill, sand and silt fill, and silty sand fill were encountered below the asphalt in all the boreholes. The thickness of the cohesionless fill at the boreholes typically varied between 0.2 m and 1.3 m, and up to 2.1 m to 10.0 m in Boreholes MS2-09, MS2-12, MS2-14, MS2-19 and HMP2-01. The base of the cohesionless fill was encountered at depths ranging between 0.4 m and 3.0 m (Elevations 201.0 m to 188.1 m), except for Borehole HMP 2-01, where the base of fill was contacted at 10.2 m depth (Elevation 193.0m).

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SPT 'N' values recorded in the cohesionless fill ranged from 10 blows to 52 blows per 0.3 m penetration indicating compact to very dense conditions. The measured moisture contents of selected samples of this fill varied between 2 percent and 21 percent.

The results of grain size distribution analyses carried out on selected samples of cohesionless fills are presented on Record of Borehole Sheets in Appendix A and on Figures B1 and B2 in Appendix B. The results of laboratory gradation tests are summarized as follows:

Soil Particles	Percentage (%) Sand and Silt	Percentage (%) Sand and Gravel
Gravel	0 to 1	29
Sand	27 to 40	60
Silt	52 to 64	11
Clay	8 to 9	

5.3 Silty Clay Fill

Fill materials consisting of silty clay was encountered below the pavement granulars in Boreholes HMP 2-02 and MS2-28. The thickness of the silty clay fill were 0.7 m and 3.4 m with the base at 1.4 m and 4.1 m depths (Elevations 188.7 m and 185.9 m) in Boreholes MS2-28 and HMP 2-02, respectively.

SPT 'N' values recorded in the silty clay fill ranged from 4 blows to 17 blows per 0.3 m penetration indicating firm to very stiff consistency. The measured moisture contents of samples of this fill varied between 7 percent and 21 percent.

The results of grain size distribution analyses carried out on a sample of this fill are presented on Record of Borehole Sheets in Appendix A and on Figure B3 in Appendix B. Atterberg Limit test results are presented on Figure B12 in Appendix B. These results are summarized below.

Soil Particles	Percentage (%)
Gravel	0
Sand	15
Silt	33
Clay	52



Index Property	Percentage (%)
Liquid Limit	45
Plasticity Index	25

The above results show that the silty clay fill has medium plasticity with a group symbol of CI.

5.4 Sands and Silts

Layers of brown to greyish brown native sand, silty sand, sandy silt, sand and silt, with trace to some clay and trace gravel, were encountered in Boreholes MS2-09, HMP2-01, MS2-15, MS2-17, MS2-19, TS2-02, MS2-21, MS2-22, MS2-24, MS2-26, MS2-27, MS2-28, MS2-30, MS2-31, MS2-32 and HMP2-02. Where fully penetrated in all but Boreholes HMP2-01 and MS2-19, the thickness of these cohesionless deposits ranged from 1.1 m to 5.6 m, with the bases at 2.2 m to 8.7 m depths (Elevations 198.3 m to 182.3 m). Boreholes HMP2-01 and MS2-19 were terminated within the sands and silts at depths of 12.8 m and 6.7 m (Elevations 190.4 m to 190.8 m), respectively.

SPT 'N' values recorded in these sand and silt layers typically ranged from 10 blows to 31 blows per 0.3 m penetration indicating compact to dense conditions. There are randomly occurring loose zones as indicated by 'N' values ranging from 7 blows to 9 blows per 0.3 m penetration. A high 'N' value of greater than 100 blows for less than 0.3 m penetration was measured in Borehole MS2-28 at about 6 m depth indicating the potential presence of cobbles and boulders within the silt deposit. The measured moisture contents of samples of these deposits varied between 7 percent and 36 percent.

The results of grain size distribution analyses carried out on samples containing varying proportions of sands and silts are presented on Record of Borehole Sheets in Appendix A and on Figures B4 to B7 in Appendix B. The results of laboratory gradation tests are summarized as follows:

Soil Particles	Percentage (%) Silt	Percentage (%) Sand	Percentage (%) Sand and Silt	Percentage (%) Sandy Silt to Silty Sand
Gravel	0 to 2	2	0	0 to 5
Sand	0 to 16	91	32 to 54	23 to 70
Silt	77 to 91	7	42 to 64	20 to 67
Clay	6 to 13		4 to 5	5 to 10

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Caving was noted within these cohesionless layers in most of the boreholes.

5.5 Silty Clay Till

Deposits of brown to grey native silty clay till with sand and trace gravel were encountered in all boreholes, with the exception of Borehole HMP2-01. In Boreholes MS2-09, MS2-19, MS2-25, MS2-28, MS2-30, MS2-31 and HMP2-02, the thickness of an upper layer of this till ranged from 1.5 m to 4.9 m, with the base at 2.5 m to 8.7 m depths (Elevations 195.4 m to 181.3 m). This cohesive till was interlayered with sands and silts in many boreholes. The remaining boreholes were terminated within this till at 6.5 m to 12.8 m depths (Elevations 194.9 m to 177.0 m).

Most of the SPT 'N' values recorded in the silty clay till ranged from 15 blows per 0.3 m of penetration to greater than 100 blows for less than 0.3 m of penetration, indicating a typical very stiff to hard consistency. 'N' values greater than 100 blows may indicate the presence of cobbles and boulders in Boreholes MS2-12, MS2-13, MS2-14, MS2-15, MS2-26, MS2-27, MS2-29 and MS2-32. Occasional firm to stiff zones were encountered within this till as indicated by 'N' values ranging from 4 blows to 12 blows. The measured moisture contents of samples of this till varied between 7 percent and 27 percent.

Grain size distribution results for selected cohesive till samples are presented on the Record of Borehole sheets in Appendix A and on Figures B8 and B10 in Appendix B. Atterberg Limit test results are presented on Figures B13 and B14 in Appendix B. The results of laboratory gradation and Atterberg Limits tests are summarized as follows:

Soil Particles	Percentage (%)
Gravel	0 to 5
Sand	9 to 36
Silt	24 to 51
Clay	22 to 67
Index Property	Percentage (%)
Liquid Limit	18 to 39
Plasticity Index	7 to 21

The above results show that this till has low to medium plasticity with group symbols of CL and CI.



Glacial tills inherently contain cobbles and boulders.

5.6 Sand and Silt Till

Brown to grey native sand and silt till with trace to some gravel and trace clay were encountered in Boreholes MS2-09, MS2-24, MS2-25, MS2-28, MS2-30, MS2-31, MS2-32, HMP2-02 and TS2-02. Where fully penetrated in Boreholes MS2-24, MS2-32 and TS2-02, the thickness of the cohesionless till varied between 2.9 m to 3.0 m, and the base ranged from 8.5 m to 11.7 m (Elevations 184.0 m to 179.5 m). Boreholes MS2-09, MS2-25, MS2-28, MS2-30, MS2-31 and HMP2-02 were terminated at depths of 8.2 m to 12.8 m (Elevations 191.2 m to 177.2 m).

Most of the SPT 'N' values recorded in the sand and silt till ranged from 37 blows per 0.3 m penetration to more than 100 blows for less than 0.3 m penetration, indicating typical dense to very dense conditions. 'N' values greater than 100 blows may indicate the presence of cobbles and boulders in Boreholes MS2-30, MS2-32, HMP2-02 and TS2-02. Occasional compact zones were encountered in Boreholes MS2-25 and HMP2-02 as indicated by 'N' values ranging from 14 blows to 23 blows. The measured moisture contents of samples of this till varied between 7 percent and 22 percent.

Grain size distribution results for selected cohesionless till samples are presented on the Record of Borehole sheets in Appendix A and on Figure B11 Appendix B. The results of laboratory gradation and Atterberg Limits tests are summarized as follows:

Soil Particles	Percentage (%)
Gravel	1 to 12
Sand	20 to 45
Silt	36 to 61
Clay	7 to 18

Glacial tills inherently contain cobbles and boulders.

5.7 Water Levels

The groundwater level in open boreholes was observed and noted during and upon completion of drilling. Piezometers were installed in Borehole MS2-12, MS2-22, MS2-29 and



MS2-32. The water levels measured in these and other installed piezometers in the area (References 2, 3 and 4) are summarized in Table 5.2.

Table 5.2 - Measured Groundwater Levels

Approximate Station	Borehole	Date	Water Level (m)	
			Depth	Elevation
17+275	RR-2	2014-12-18	9.9	193.3
17+000	MS2-12	2018-09-30	8.1	193.9
16+240	16TH-01	2018-08-22	5.7	189.8
15+890	MS2-22	2018-09-30	2.6	190.4
		2018-11-22	1.9	191.1
15+400	MS2-29	2018-09-30	2.4	187.3
		2018-11-23	2.2	187.5
15+170	MS2-32	2018-09-30	2.2	187.3
		2018-11-22	2.9	186.6

Unstabilized water levels recorded in open boreholes upon completion of drilling are shown below.

Borehole	Water Level (m)	
	Depth	Elevation
MS2-09	10.7	193.3
HMP2-01	10.7	192.5
MS2-13	4.6	196.8
MS2-14	6.1	194.6
MS2-15	Dry	-
MS2-17	2.1	196.9
MS2-18	3.0	195.2
MS2-19	4.6	192.7
TS2-02	4.6	190.7
MS2-21	3.6	190.4
MS2-24	4.6	188.0
MS2-25	4.6	186.8
MS2-26	2.3	189.0
MS2-28	3.4	186.8
MS2-30	3.4	186.1
MS2-31	3.4	186.0
HMP2-02	6.2	183.8



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

Thurber staked and/or marked the borehole locations in the field and obtained utility clearances prior to drilling. Northing and easting coordinates at the borehole locations were obtained by Thurber using a Garmin GPSMAP 62sc, and the corresponding ground surface elevations were provided by WSP.

Walker Drilling of Utopia, Ontario and Drill Tech Drilling Ltd. of Newmarket, Ontario, supplied and operated a truck-mounted D-90 drill rig and a truck-mounted Mar15 drill rig, respectively, to carry out the drilling, sampling and in-situ testing operations for the boreholes.

The field operations were supervised on a full-time basis by Messrs. Bryan Lui, Stephen Jones and Kevin Kweon of Thurber. Geotechnical laboratory testing was carried out by Thurber in its MTO approved laboratory. Overall supervision of the field program was carried out by Mr. Stephane Loranger, CET.

Overall project management was provided by Dr. Sydney Pang, P.Eng. Interpretation of the field data and preparation of this report was completed by Mr. Rod de Castro, P.Eng. The report was reviewed by Messrs. Sydney Pang, P.Eng. and P.K. Chatterji, P.Eng., a Designated Principal Contact for MTO Foundations Projects.



THURBER ENGINEERING LTD.



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PART 2: ENGINEERING DISCUSSION AND RECOMMENDATIONS

7. GENERAL

This section of the report presents interpretation of the geotechnical data presented in the factual information section and provides foundation recommendations for the detailed design of High Mast Lighting (HML) support structures along Highway 404 from 1.1 km south of Major Mackenzie Drive to 1.1 km north of Highway 7 in the City of Markham, Ontario.

Originally, fifteen (15) HML poles have been referenced for foundation design of the proposed pole supports. Based on an email from WSP dated December 5, 2018, the number of HML poles have been increased to eighteen (18) and some pole locations revised. The Borehole Location Plan drawings in Appendix C and the attached Table 1 illustrate the approximate locations of the relevant boreholes near each HML pole location.

Information on the proposed locations of the HML supports was provided to Thurber by WSP. Based on the proposed HML layout, boreholes drilled during the present and other investigations, that were in proximity to each proposed HML location, have been selected to provide subsurface information for foundation design. The Record of Borehole sheets for these boreholes are presented in Appendix A. Table 1 immediately following the text of this report provides foundation design parameters for each HML support locations.

This foundation investigation and design report with the interpretation and recommendations are intended for the use of the Ministry of Transportation, and shall not be used or relied upon for any other purposes or by any other parties including the construction contractor. The

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contractor must make their own interpretation based on the factual data in Part 1 of the report. Where comments are made on construction, they are provided only in order to highlight those aspects which could affect the design of the project. Contractors must make their own interpretation of the factual information provided as it may affect equipment selection, proposed construction methods and scheduling.

The discussion and recommendations presented in this report are based on information provided by WSP to Thurber, and on the factual data obtained during the course of this investigation.

7.1 Foundation Design Parameters

Design of the HML support foundations should be carried out in accordance with the following document.

- Ministry of Transportation, Ontario (2004) "Guidelines for the Design of High Mast Pole Foundations", Fourth Edition, BRO-009, Engineering Standards Branch, Bridge Office (Reference 5).

Reference should also be made to the following documents.

- Canadian Highway Bridge Design Code and Commentary (2014). CAN/CSA-S6-14 and S6.1-14 (Reference 6).

It is understood that a typical HML support consists of a single conventional augered caisson (drilled shaft). Table 1 following the text of this report presents the recommended parameters for foundation design of such caissons.

In order to take into account frost action and surficial disturbance, the ultimate lateral passive resistance in front of a caisson within the upper 1.4 m below final grade should be neglected in the foundation design. It is recommended that any topsoil and organics, if present, be neglected in determining lateral resistance.

Where downward sloping fill or native soil exists in front of a caisson, reduction of lateral passive resistance should be taken into consideration during design. For foundation design at the caissons, it should be assumed that full lateral resistance can only be mobilized where



the width of the soil in front of or behind the caisson is equal to or greater than approximately four (4) times the diameter of the caissons. For sloping ground in front of a caisson, the magnitude of the mobilized passive resistance can be estimated by interpolating between zero passive resistance at the level where the slope face intersects the pile, and full passive resistance at the level where the slope face is at a horizontal distance equal to or greater than four (4) times the diameter of the caisson.

Where an unconfined compressive strength, q_u , ($q_u = 2 \times C_u$, undrained shear strength) is provided for cohesive soils (clayey silt to silty clay fill and native silty clay till), the ultimate lateral passive resistance should be calculated in conjunction with the total soil unit weight. When designing for portions of the caissons below the groundwater level in cohesionless sands and silts, the submerged soil unit weight, γ' , should be used. The required depth of the caisson will be governed by lateral loads, including wind loads, acting on the pole. The length of the caisson should also be sufficient to counteract frost jacking (upward) forces.

An equivalent caisson width equal to two (2) times the caisson diameter may be assumed for lateral resistance calculations. Appropriate load and resistance factors should be applied for caisson design.

7.2 Caisson Installation

Caisson installation should generally be carried out in accordance with OPSS.PROV 903.

The contract documents should contain an NSSP alerting the contract bidders of the specific aspects relating to caisson construction for foundation supports at this site. Suggested wordings for this NSSP are provided in Appendix D.

Caisson installation equipment must be able to dislodge, handle, remove cobbles and boulders, to penetrate obstructions within the fill, and to drill through hard or very dense layers, where encountered.

The short-term groundwater levels generally ranged between 2 m and 3 m depths below existing ground surface (see Table 1). Groundwater levels may be higher during construction. Soil sloughing and water seepage may occur in unsupported holes especially in sands and silts below the groundwater level. Caving of cohesionless soils were noted in the majority of boreholes. The cohesionless soils would also be susceptible to disturbance (basal and



sidewall instability) under conditions of unbalanced hydrostatic head. Temporary liners must be available to support the caisson sidewalls and to provide seepage cut-off where required. Any accumulated water may have to be pumped out from the hole prior to placing concrete. A balancing water/slurry head should be used inside the caisson hole in cases where the caisson base is within water-bearing sands and silts. Should it be considered impractical to remove the accumulated water/slurry inside the hole, it is recommended that the concrete be placed by the tremie method. Suggested wording for an NSSP to cover the above aspects are provided in Appendix D.

7.3 Construction Concerns

Concerns during caisson construction mainly involve the handling and removal of cobbles or boulders, or other obstructions in the fill, drilling through hard/very dense soils, soil sloughing and water seepage from caisson sidewalls, and basal instability primarily due to unbalanced hydrostatic head. Recommendations on how to address these issues have been outlined in the previous section.

7.4 Construction Inspection and Testing

Caisson construction should be monitored by qualified geotechnical personnel as per OPSS.PROV 903 to verify the soil conditions and to confirm that those conditions are consistent with the design assumptions in this report.

8. CLOSURE

Engineering analysis and preparation of the foundation design report was carried out by Messrs. Rod de Castro, P.Eng. and Sydney Pang, P.Eng. Dr. P.K. Chatterji, P.Eng., a Designated MTO Contact for Foundations, reviewed the report.



THURBER ENGINEERING LTD.



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Review Principal, Designated MTO Contact

Client: WSP
File No.: 15786
E file: H:\15000-15999\15786 Hwy 404 Widening 2016-E-0014\Reports and Memos\Contract 2\High Mast
Poles\FINAL\15786 HML Contract 2 Hwy 404 FIDR jan 19.docx

Date: January 24, 2019
Page: 17 of 17

TABLE 1
FOUNDATION DESIGN PARAMETERS
HIGH MAST LIGHTING SUPPORTS
HIGHWAY 404 HOV LANE EXPANSION AND REHABILITATION
CONTRACT 2
MARKHAM, ONTARIO
G.W.P. 2930-17-00

HML Station	Reference Boreholes	Reference Simplified Subsurface Stratigraphy For Design	Depth Below Existing Ground Surface (m)	Foundation Design Parameters						
				q_u (kPa)	ϕ' (deg.)	n_h (kN/m ³)	K_p	γ (kN/m ³)	γ' (kN/m ³)	Groundwater Depth (m)
17+317	MS2-09	Silty Sand (Fill)	0.7 – 3.0	-	30	3,000	3.0	20	-	3 (below existing grade)
		Silt	3.0 – 5.5	-	30	2,500	3.0	-	10	
		Silty Clay (Till)	5.5 – 8.5	190	-	-	-	20	-	
		Sand and Silt (Till)	8.5 – 12.8	-	35	8,000	3.7	-	11	
17+169	HMP2-01	Sand and Silt (Fill)	0.5 – 10.0	-	30	3,000	3.0	-	10	3 (below existing grade)
		Sand	10.0 – 12.8	-	34	5,500	3.5	-	11	
17+019	MS2-12	Silty Sand (Fill)	1.0 – 2.5	-	30	3,000	3.0	20	-	2 (below existing grade)
		Silty Clay (Till)	2.5 – 12.3	350	-	-	-	21	-	
16+889	MS2-13, MS2-14	Silty Sand (Fill)	1.0 – 2.2	-	30	3,000	3.0	20	-	2 (below existing grade)
		Silty Clay (Till)	2.2 – 12.6	400	-	-	-	21	-	
16+756	MS2-15	Silt	0.5 – 2.5	-	30	3,000	3.0	20	10	2 (below existing grade)
		Silty Clay (Till)	2.5 – 6.0	150	-	-	-	19	-	
		Silty Clay (Till)	6.0 – 8.0	400	-	-	-	21	-	
16+615	MS2-17	Silty Sand (Fill)	0.5 – 1.5	-	30	3,000	3.0	20	-	2 (below existing grade)
		Sand and Silt	1.5 – 6.0	-	30	3,000	3.0	20	10	
		Silty Clay (Till)	6.0 – 7.0	160	-	-	-	20	-	
		Silty Clay (Till)	7.0 - 8.2	300	-	-	-	21	-	

- Notes: 1. This table must be read in conjunction with the text of this report.
2. In order to take into account frost action and surficial disturbance, the ultimate lateral passive resistance in front of the caisson within the upper 1.4 m below final grade should be neglected in the foundation design.
3. If new fill is placed, some caissons may be partially embedded within the new fill.

HML Station	Reference Boreholes	Reference Simplified Subsurface Stratigraphy For Design	Depth Below Existing Ground Surface (m)	Foundation Design Parameters						
				q_u (kPa)	ϕ' (deg.)	n_h (kN/m ³)	K_P	γ (kN/m ³)	γ' (kN/m ³)	Groundwater Depth (m)
16+470	MS2-18, MS2-19	Silty Sand (Fill)	1.1 – 2.2	-	30	3,000	3.0	20	-	3 (below existing grade)
		Silty Clay (Till)	2.2 – 3.7	180	-	-	-	20	-	
		Silt	3.7 – 6.7	-	30	2,500	3.0	19	9	
16+157	TS2-02	Silty Clay (Till)	1.0 – 4.0	180	-	-	-	19	-	3 (below existing grade)
		Sand and Silt	4.0 – 9.0	-	30	2,500	3.0	-	10	
		Sand and Silt (Till)	9.0 – 11.7	-	35	7,000	3.7	-	11	
16+033	MS2-21	Silty Clay (Till)	1.5 – 4.0	160	-	-	-	19	-	3 (below existing grade)
		Silty Sand	4.0 – 7.0	-	31	3,000	3.1	-	10	
		Silty Clay (Till)	7.0 – 12.8	180	-	-	-	20	-	
15+894	MS2-22	Silty Clay (Till)	1.0 – 3.0	150	-	-	-	18	-	2 (below existing grade)
		Silty Sand	3.0 – 4.0	-	31	3,000	3.1	-	10	
		Silty Clay (Till)	4.0 – 6.7	160	-	-	-	19	-	
15+785	MS2-24, MS2-25	Silty Clay (Till)	1.0 – 2.5	180	-	-	-	19	-	2 (below existing grade)
		Silt	2.5 – 5.5	-	30	2,500	3.0	-	10	
		Sandy Silt (Till)	5.5 – 8.2	-	33	5,000	3.4	-	11	
15+675	MS2-26	Silty Clay (Till)	1.0 – 2.0	120	-	-	-	18	-	2 (below existing grade)
		Silt	2.0 – 4.0	-	30	2,500	3.0	-	10	
		Silty Clay (Till)	4.0 – 12.6	300	-	-	-	21	-	
15+565	MS2-27	Silty Clay (Till)	0.7 – 1.5	120	-	-	-	18	-	2 (below existing grade)
		Silt	1.5 – 4.0	-	30	2,500	3.0	-	10	
		Silty Clay (Till)	4.0 – 8.2	300	-	-	-	21	-	
15+455	MS2-28, MS2-29	Silty Clay (Fill)	0.7 – 1.5	100	-	-	-	18	-	2 (below existing grade)
		Silt	1.5 – 4.0	-	30	2,500	3.0	-	10	
		Silt	4.0 – 7.0	-	33	4,500	3.4	-	11	
		Silty Clay (Till)	7.0 – 8.5	200	-	-	-	21	-	
		Sand and Silt (Till)	8.5 – 12.8	-	35	7,000	3.7	-	11	

- Notes: 1. This table must be read in conjunction with the text of this report.
2. In order to take into account frost action and surficial disturbance, the ultimate lateral passive resistance in front of the caisson within the upper 1.4 m below final grade should be neglected in the foundation design.
3. If new fill is placed, some caissons may be partially embedded within the new fill.

HML Station	Reference Boreholes	Reference Simplified Subsurface Stratigraphy For Design	Depth Below Existing Ground Surface (m)	Foundation Design Parameters						
				q_u (kPa)	ϕ' (deg.)	n_h (kN/m ³)	K_p	γ (kN/m ³)	γ' (kN/m ³)	Groundwater Depth (m)
15+345	MS2-30	Silty Sand (Fill)	1.0 – 1.5	-	30	3,000	3.0	20	-	2 (below existing grade)
		Silty Clay (Till)	1.5 – 3.0	160	-	-	-	19	-	
		Sand and Silt	3.0 – 4.5	-	30	2,500	3.0	-	10	
		Sand and Silt (Till)	4.5 – 12.3	-	35	7,000	3.7	-	11	
15+236	MS2-31	Silty Clay (Till)	0.7 – 5.5	120	-	-	-	18	-	3 (below existing grade)
		Sand and Silt	5.5 – 7.0	-	31	2,500	3.1	-	10	
		Sand and Silt (Till)	7.0 – 8.2	-	35	7,000	3.7	-	11	
15+126	MS2-32	Silty Clay (Till)	1.5 – 4.0	100	-	-	-	18	-	2 (below existing grade)
		Sandy Silt	4.0 – 7.0	-	30	2,500	3.0	-	10	
		Sand and Silt (Till)	7.0 – 10.0	-	34	5,500	3.5	-	11	
		Silty Clay (Till)	10.0 – 12.5	300	-	-	-	21	-	
15+016	HMP2-02	Silty Clay (Fill)	0.7 – 4.0	100	-	-	-	18	-	2 (below existing grade)
		Sand and Silt	4.0 – 7.0	-	30	2,500	3.0	-	10	
		Silty Clay (Till)	7.0 – 8.5	180	-	-	-	20	-	
		Sand and Silt (Till)	8.5 – 10.0	-	31	3,000	3.1	-	10	
		Sand and Silt (Till)	10.0 – 12.8	-	34	5,500	3.5	-	11	
-	New Fill (see Note 3)	Variable height above ground surface	-	-	30	3,000	3.0	20	-	Below base of new fill

LEGEND

- q_u = Unconfined Compressive Strength (= 2 x C_u , undrained shear strength) (kPa)
 ϕ' = Angle of Internal Friction (degrees)
 n_h = Coefficient of Horizontal Subgrade Reaction (MN/m³ or x 10³ kN/m³)
 K_p = Coefficient of Passive Earth Pressure
 γ = Soil Unit Weight (kN/m³)
 γ' = Submerged Soil Unit Weight (kN/m³) – to be used only for cohesionless soils below the groundwater table

- Notes: 1. This table must be read in conjunction with the text of this report.
 2. In order to take into account frost action and surficial disturbance, the ultimate lateral passive resistance in front of the caisson within the upper 1.4 m below final grade should be neglected in the foundation design.
 3. If new fill is placed, some caissons may be partially embedded within the new fill.



Appendix A
Record of Borehole Sheets

SYMBOLS, ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES

1. TEXTURAL CLASSIFICATION OF SOILS

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

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

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

3. TERMS DESCRIBING CONSISTENCY (COHESIVE SOILS ONLY)

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

NOTE: Hierarchy of Soil Strength Prediction

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


4. TERMS DESCRIBING DENSITY (COHESIONLESS SOILS ONLY)

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

5. LEGEND FOR RECORDS OF BOREHOLES

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

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


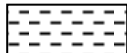



 Water Level
 Shear Strength Determination by Pocket Penetrometer

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

UNIFIED SOILS CLASSIFICATION

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

EXPLANATION OF ROCK LOGGING TERMS

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

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

<u>TERMS</u>	
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.

RECORD OF BOREHOLE No MS 2-09

1 OF 2

METRIC

W.P. 2930-17-00 LOCATION N 4 859 442.5 E 314 610.6 ORIGINATED BY KK
 HWY 404 BOREHOLE TYPE Solid Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.07.29 - 2018.07.29 LATITUDE 43.874890 LONGITUDE -79.377926 CHECKED BY RD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
204.0	GROUND SURFACE							20	40	60	80	100					
0.0	ASPHALT: (150mm)							20	40	60	80	100					
0.2	SAND and GRAVEL, trace silt, trace clay (FILL)		1	SS													
203.3																	
0.7	Silty SAND, some gravel, trace clay Dense to Compact Brown Moist (FILL)		2	SS	45		203										
			3	SS	30		202										
			4	SS	24												
201.0							201										
3.0	SILT, some clay Compact Brown Moist		5	SS	14												
							200										
			6	SS	12		199									0 0 88 12	
198.3																	
5.6	Silty CLAY, trace sand, trace gravel Very Stiff to Hard Brown Moist (TILL)		7	SS	22		198										
							197										
			8	SS	35		196									2 9 42 47	
195.4																	
8.5	SAND and SILT, trace gravel, trace clay Very Dense Brown Moist (TILL)		9	SS	89		195										
							194										

Continued Next Page

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

RECORD OF BOREHOLE No MS 2-09

2 OF 2

METRIC

W.P. 2930-17-00 LOCATION N 4 859 442.5 E 314 610.6 ORIGINATED BY KK
 HWY 404 BOREHOLE TYPE Solid Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.07.29 - 2018.07.29 LATITUDE 43.874890 LONGITUDE -79.377926 CHECKED BY RD

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

RECORD OF BOREHOLE No HMP 2-01

1 OF 2

METRIC

W.P. 2930-17-00 LOCATION N 4 859 306.0 E 314 635.2 ORIGINATED BY SJ
 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.07.23 - 2018.07.23 LATITUDE 43.873661 LONGITUDE -79.377624 CHECKED BY RD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
203.2	GROUND SURFACE							20	40	60	80	100			
0.0	ASPHALT: (175mm)														
203.0	SAND and GRAVEL, trace silt, trace clay Grey Moist (FILL)														
0.2															
0.3	SAND and SILT, trace clay Dense to Compact Brown Moist (FILL)		1	SS	31										
			2	SS	40										
			3	SS	26										
			4	SS	25										
			5	SS	15										
	Some clay		6	SS	10										
				7	SS	31									
			8	SS	11										

Continued Next Page

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

RECORD OF BOREHOLE No HMP 2-01

2 OF 2

METRIC

W.P. 2930-17-00 LOCATION N 4 859 306.0 E 314 635.2 ORIGINATED BY SJ
 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.07.23 - 2018.07.23 LATITUDE 43.873661 LONGITUDE -79.377624 CHECKED BY RD

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 (%)			
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE												
	Continued From Previous Page	⊗				▽		20	40	60	80	100		20	40	60				
193.0	SAND and SILT , trace clay	⊗					193													
10.2	SAND , trace gravel, trace clay Dense to Very Dense Grey Wet	⋈	9	SS	31		192								○					
						191								○						
190.4			10	SS	61															
12.8	END OF BOREHOLE AT 12.8m. WATER LEVEL AT 10.7m BEFORE BOREHOLE CAVING TO 7.6m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO 0.2m, THEN COLD PATCH ASPHALT TO SURFACE.																			




ONTMT452 MTO-15786.GPJ 2017TEMPLATE(MTO).GDT 1/8/19

RECORD OF BOREHOLE No MS 2-12

1 OF 2

METRIC

W.P. 2930-17-00 LOCATION N 4 859 126.0 E 314 688.9 ORIGINATED BY BL
 HWY 404 BOREHOLE TYPE Solid Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.07.19 - 2018.07.19 LATITUDE 43.872040 LONGITUDE -79.376958 CHECKED BY RD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
								20 40 60 80 100					
202.0	GROUND SURFACE												
0.0	ASPHALT: (150mm)												
0.2	SAND and GRAVEL, trace silt, trace clay Dense to Compact Brown Moist (FILL)		1	SS	42								
201.0													
0.9													
	Silty SAND, trace gravel, trace clay Compact Brown Moist (FILL)		2	SS	20								
			3	SS	28								
199.4			4	SS	15								
2.6	Silty CLAY, with sand, trace gravel Hard Grey Moist (TILL)												
			5	SS	47								
			6	SS	71								
			7	SS	72								
			8	SS	45								
			9	SS	90								

Continued Next Page

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

RECORD OF BOREHOLE No MS 2-12

2 OF 2

METRIC

W.P. 2930-17-00 LOCATION N 4 859 126.0 E 314 688.9 ORIGINATED BY BL
 HWY 404 BOREHOLE TYPE Solid Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.07.19 - 2018.07.19 LATITUDE 43.872040 LONGITUDE -79.376958 CHECKED BY RD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
	Continued From Previous Page							20 40 60 80 100							
								○ UNCONFINED + FIELD VANE							
								● QUICK TRIAXIAL × LAB VANE							
								WATER CONTENT (%)							
								20 40 60 80 100							
								PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT							
								W _p W W _L							
189.7	Silty CLAY , with sand, trace gravel Hard Grey Moist (TILL)		10	SS	100/ 0.275		191								
							190								
12.3	END OF BOREHOLE AT 12.3m. BOREHOLE CAVED TO 11.0m AND WATER LEVEL AT 8.5m DEPTH UPON COMPLETION. Piezometer installation consists of 50mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2018.09.30 8.1 193.8 2018.11.23 8.1 193.9		11	SS	100/ 0.100										

RECORD OF BOREHOLE No MS 2-13

1 OF 1

METRIC

W.P. 2930-17-00 LOCATION N 4 859 037.7 E 314 705.3 ORIGINATED BY BL
 HWY 404 BOREHOLE TYPE Solid Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.07.10 - 2018.07.10 LATITUDE 43.871245 LONGITUDE -79.376756 CHECKED BY RD

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 (%)
201.4	GROUND SURFACE							20	40	60	80	100					GR SA SI CL
0.0	ASPHALT: (125mm)							20	40	60	80	100					
0.1	SAND and GRAVEL, trace silt, trace clay Brown Moist (FILL)		1	SS	15		201										
200.4																	
0.9	Silty CLAY, with sand, trace gravel Hard Brown Moist (TILL)		2	SS	35		200										
			3	SS	32												
			4	SS	100/ 0.200		199										2 30 45 23
	Grey																
			5	SS	100/ 0.075		198										
							197										
			6	SS	100/ 0.225		196										1 31 40 28
							195										
194.9			7	SS	100/ 0.275												
6.5	END OF BOREHOLE AT 6.5m. BOREHOLE CAVED TO 4.9m AND WATER LEVEL AT 4.6m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 3.7m, AUGER CUTTINGS TO 0.7m, BENTONITE HOLEPLUG TO 0.1m, THEN COLD PATCH ASPHALT TO SURFACE.																

ONTMT452 MTO-15786.GPJ 2017TEMPLATE(MTO).GDT 1/8/19

RECORD OF BOREHOLE No MS 2-14

1 OF 2

METRIC

W.P. 2930-17-00 LOCATION N 4 858 978.4 E 314 716.3 ORIGINATED BY BL
 HWY 404 BOREHOLE TYPE Solid Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.07.17 - 2018.07.17 LATITUDE 43.870711 LONGITUDE -79.376621 CHECKED BY RD

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									
200.9	GROUND SURFACE							20	40	60	80	100					
0.0	ASPHALT: (125mm)							20	40	60	80	100					
0.1	SAND and GRAVEL, trace silt, trace clay Compact Brown Moist (FILL)		1	SS	27		200										29 60 11 (SI+CL)
199.8			2	SS	37												
1.1	Silty SAND, trace gravel, trace clay Dense to Very Dense Brown Moist (FILL)		3	SS	52		199										
198.7			4	SS	100/ 0.300		198										
2.2	Silty CLAY, with sand, trace gravel Hard Grey Wet (TILL)		5	SS	100/ 0.250		197										
			6	SS	100/ 0.150		196										
			7	SS	66		195										
			8	SS	86		193										
			9	SS	100/ 0.300		192										
							191										

Continued Next Page

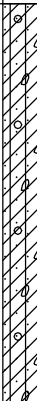
+³, ×³: Numbers refer to Sensitivity
 20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No MS 2-14

2 OF 2

METRIC

W.P. 2930-17-00 LOCATION N 4 858 978.4 E 314 716.3 ORIGINATED BY BL
HWY 404 BOREHOLE TYPE Solid Stem Augers COMPILED BY MP
DATUM Geodetic DATE 2018.07.17 - 2018.07.17 LATITUDE 43.870711 LONGITUDE -79.376621 CHECKED BY RD

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										
	Continued From Previous Page							20	40	60	80	100						
	Silty CLAY , with sand, trace gravel Hard Grey Wet (TILL)																	
			10	SS	100/ 0.275		190											
							189											
188.3			11	SS	100/ 0.300													
12.6	END OF BOREHOLE AT 12.6m. WATER LEVEL AT 6.1m DEPTH BEFORE BOREHOLE CAVING TO 2.1m DEPTH UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.9m, AUGER CUTTINGS TO 0.7m, BENTONITE HOLEPLUG TO 0.1m, THEN COLD PATCH ASPHALT TO SURFACE.																	

RECORD OF BOREHOLE No MS 2-15

1 OF 1

METRIC

W.P. 2930-17-00 LOCATION N 4 858 865.4 E 314 717.2 ORIGINATED BY SJ
 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.07.24 - 2018.07.25 LATITUDE 43.869694 LONGITUDE -79.376611 CHECKED BY RD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa											
199.9	GROUND SURFACE							20	40	60	80	100							
0.0	ASPHALT: (175mm)																		
0.2 199.5	SAND and GRAVEL Grey Moist (FILL)																		
0.4	SILT, some sand, trace gravel, trace clay Compact Brown Moist		1	SS	23		199												
			2	SS	23		198											2	13 77 8
197.7																			
2.2	Silty CLAY, with sand, trace gravel Very Stiff to Hard Grey Moist (TILL)		3	SS	15		197												
			4	SS	15													3	30 39 28
							196												
			5	SS	16		195												
							194												
			6	SS	101/ 0.275		193												
191.9			7	SS	100/ 0.250		192												
8.0	END OF BOREHOLE AT 8.0m. BOREHOLE OPEN AND DRY UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 2.1m, AUGER CUTTINGS TO 0.2m, THEN COLD PATCH ASPHALT TO SURFACE.																		

ONTMT452 MTO-15786.GPJ 2017TEMPLATE(MTO).GDT 1/8/19

+³, ×³: Numbers refer to
Sensitivity

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(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No MS 2-17

1 OF 1

METRIC

W.P. 2930-17-00 LOCATION N 4 858 748.0 E 314 735.1 ORIGINATED BY SJ
 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.07.24 - 2018.07.24 LATITUDE 43.868637 LONGITUDE -79.376391 CHECKED BY RD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa												
199.0	GROUND SURFACE							20	40	60	80	100								
0.0	ASPHALT: (155mm)																			
198.6	SAND and GRAVEL, trace silt, trace clay Brown Moist (FILL)																			
0.4	Silty SAND, trace gravel, trace clay Compact Brown Moist (FILL)		1	SS	30		198													
197.6	SAND and SILT, trace clay Compact Brown Moist		2	SS	28		197													
1.4			3	SS	15															
196.1							196													
2.9	Loose		4	SS	8															
194.9							195													
4.1			5	SS	12		194													
192.9							193													
6.1	Silty CLAY, with sand, trace gravel Very Stiff to Hard Grey Moist (TILL)		6	SS	18		192													
			7	SS	84		191													
190.9																				
8.2	END OF BOREHOLE AT 8.2m. BOREHOLE CAVED TO 3.0m AND WATER LEVEL AT 2.1m DEPTH UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO 0.2m, THEN COLD PATCH ASPHALT TO SURFACE.																			

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

RECORD OF BOREHOLE No MS 2-18

1 OF 2

METRIC

W.P. 2930-017-00 LOCATION N 4 858 656.3 E 314 775.4 ORIGINATED BY BL
 HWY 404 BOREHOLE TYPE Solid Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.07.10 - 2018.07.10 LATITUDE 43.867811 LONGITUDE -79.375891 CHECKED BY RD

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

Continued Next Page


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

RECORD OF BOREHOLE No MS 2-18

2 OF 2

METRIC

W.P. 2930-17-00 LOCATION N 4 858 656.3 E 314 775.4 ORIGINATED BY BL
 HWY 404 BOREHOLE TYPE Solid Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.07.10 - 2018.07.10 LATITUDE 43.867811 LONGITUDE -79.375891 CHECKED BY RD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
	Continued From Previous Page							20 40 60 80 100						
								○ UNCONFINED + FIELD VANE						
								● QUICK TRIAXIAL × LAB VANE						
								20 40 60 80 100						
								PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT						
								W P W W L						
								WATER CONTENT (%)						
								20 40 60						
185.4	Silty CLAY , with sand, trace gravel Hard Brown to Grey Moist (TILL)		10	SS	37		188							
							187							
			11	SS	37		186							
12.8	END OF BOREHOLE AT 12.8m. BOREHOLE CAVED TO 5.5m AND WATER LEVEL AT 3.0m DEPTH UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 4.3m, AUGER CUTTINGS TO 0.7m, BENTONITE HOLEPLUG TO 0.1m, THEN COLD PATCH ASPHALT TO SURFACE.													

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

RECORD OF BOREHOLE No MS 2-19

1 OF 1

METRIC

W.P. 2930-17-00 LOCATION N 4 858 555.0 E 314 790.6 ORIGINATED BY BL
 HWY 404 BOREHOLE TYPE Solid Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.07.09 - 2018.07.09 LATITUDE 43.866899 LONGITUDE -79.375704 CHECKED BY RD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	W _P W W _L	WATER CONTENT (%)						
197.3	GROUND SURFACE															
0.0	ASPHALT: (125mm)															
0.1	SAND and GRAVEL Compact Brown Moist (FILL)		1	SS	21		197									
196.2			2	SS	39											
1.1	Silty SAND, trace gravel, trace clay Dense to Compact Brown Moist (FILL)		3	SS	16		196									
195.1																
2.2	Silty CLAY, with sand, trace gravel Very Stiff Brown Moist (TILL)		4	SS	16		195									
			5	SS	28		194									
193.6																
3.7	SILT, some sand, some clay Compact Grey Wet		6	SS	17		193									
			7	SS	14		192									
			8	SS	21		191									
190.6																
6.7	END OF BOREHOLE AT 6.7m. WATER LEVEL AT 4.6m DEPTH BEFORE BOREHOLE CAVING TO 4.0m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 2.7m, AUGER CUTTINGS TO 0.1m, THEN COLD PATCH ASPHALT TO SURFACE.															

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

RECORD OF BOREHOLE No TS 2-02

1 OF 2

METRIC

W.P. 2930-17-00 LOCATION N 4 858 301.1 E 314 836.0 ORIGINATED BY BL
 HWY 404 BOREHOLE TYPE Solid Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.07.30 - 2018.07.30 LATITUDE 43.864613 LONGITUDE -79.375144 CHECKED BY RD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
195.3	GROUND SURFACE							20 40 60 80 100					
0.0	ASPHALT: (150mm)							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE					
0.2	SAND and GRAVEL Compact Brown Moist (FILL)		1	SS	25		195						
194.5													
0.8	Silty CLAY, some sand, trace gravel Very Stiff Brown Moist (TILL)		2	SS	26		194						
			3	SS	22								
			4	SS	21		193						
			5	SS	28		192						
191.2													
4.1	SAND and SILT, trace clay Compact Grey Moist to Wet		6	SS	14		191						
							190						
			7	SS	11		189						
							188						
			8	SS	11								
							187						
186.6													
8.7	SAND and SILT, trace clay, trace gravel Very Dense Grey Moist to Wet (TILL)		9	SS	100/ 0.275		186						

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity


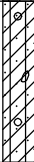
20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No TS 2-02

2 OF 2

METRIC

W.P. 2930-17-00 LOCATION N 4 858 301.1 E 314 836.0 ORIGINATED BY BL
 HWY 404 BOREHOLE TYPE Solid Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.07.30 - 2018.07.30 LATITUDE 43.864613 LONGITUDE -79.375144 CHECKED BY RD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
	Continued From Previous Page							20 40 60 80 100							
	SAND and SILT , trace clay Very Dense Grey Wet (TILL)		10	SS	100/ 0.300		185								
183.5							184								
11.7	Silty CLAY , with sand, trace gravel Hard Grey Moist (TILL)		11	SS	54		183								
182.5															
12.8	END OF BOREHOLE AT 12.8m. BOREHOLE CAVED TO 4.6m AND WATER LEVEL AT 4.6m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.2m, THEN COLD PATCH ASPHALT TO SURFACE.														

RECORD OF BOREHOLE No MS 2-21

1 OF 2

METRIC

W.P. 2930-17-00 LOCATION N 4 858 137.9 E 314 846.0 ORIGINATED BY KK
 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.07.24 - 2018.07.24 LATITUDE 43.863144 LONGITUDE -79.375022 CHECKED BY RD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				WATER CONTENT (%)							
								20 40 60 80 100				w _p w w _L							
194.0	GROUND SURFACE																		
0.0	ASPHALT: (150mm)																		
0.2	SAND and GRAVEL, trace clay, trace silt Compact Brown Moist (FILL)		1	SS	13														
			2	SS	14														
192.6																			
1.4	Silty CLAY, trace sand, trace gravel Very Stiff Brown Moist (TILL)		3	SS	16														
			4	SS	15														
			5	SS	18														
189.9																			
4.1	Silty SAND, trace gravel, trace clay Compact Grey Moist		6	SS	16														
			7	SS	18														
186.9																			
7.2	Silty CLAY , with sand, trace gravel Very Stiff Grey Moist (TILL)		8	SS	22														
			9	SS	16														

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No MS 2-21

2 OF 2

METRIC

W.P. 2930-17-00 LOCATION N 4 858 137.9 E 314 846.0 ORIGINATED BY KK
 HWY 404 BOREHOLE TYPE Hollow Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.07.24 - 2018.07.24 LATITUDE 43.863144 LONGITUDE -79.375022 CHECKED BY RD

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									20 40 60		
Continued From Previous Page							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE												
181.2	Silty CLAY , with sand, trace gravel Hard Grey Moist (TILL)		10	SS	34		183								2 22 41 35				
							182												
12.8	END OF BOREHOLE AT 12.8m. WATER LEVEL AT 3.6m UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG AND AUGER CUTTINGS TO 0.2m, THEN COLD PATCH ASPHALT TO SURFACE.		11	SS	36														

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

METRIC[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No MS 2-24

1 OF 2

METRIC

W.P. 2930-17-00 LOCATION N 4 857 978.0 E 314 894.1 ORIGINATED BY KK
 HWY 404 BOREHOLE TYPE Solid Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.07.25 - 2018.07.25 LATITUDE 43.861704 LONGITUDE -79.374426 CHECKED BY RD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE				WATER CONTENT (%) w _P w w _L				GR	SA	SI	CL
192.6	GROUND SURFACE																		
0.0	ASPHALT: (125mm)																		
0.1	SAND and GRAVEL Compact Brown Moist (FILL)		1	SS	17		192												
191.5			2	SS	20														
1.1	Silty CLAY, trace sand, trace gravel Hard to Stiff Brown Moist (TILL)		3	SS	31		191												
			4	SS	12		190												
189.9			5	SS	18		189												
2.7	SILT, some clay, trace sand, trace gravel Compact Grey Moist to wet		6	SS	8		188												
	Loose						187												
187.0			7	SS	48		186												
5.6	SAND and SILT, trace gravel, trace clay Dense to Very Dense Grey Moist (TILL)		8	SS	57		185												
184.0			9	SS	83		184												
8.5	Silty CLAY, with sand, trace gravel Hard Grey Moist (TILL)						183												

Continued Next Page



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

RECORD OF BOREHOLE No MS 2-24

2 OF 2

METRIC

W.P. 2930-17-00 LOCATION N 4 857 978.0 E 314 894.1 ORIGINATED BY KK
 HWY 404 BOREHOLE TYPE Solid Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.07.25 - 2018.07.25 LATITUDE 43.861704 LONGITUDE -79.374426 CHECKED BY RD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE						
	Continued From Previous Page						20 40 60 80 100							
	Silty CLAY , with sand, trace gravel Hard Grey Moist (TILL)		10	SS	75									2 23 45 30
179.8			11	SS	58									
12.8	END OF BOREHOLE AT 12.8m. WATER LEVEL AT 4.6m DEPTH BEFORE BOREHOLE CAVING TO 3.0m DEPTH UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.1m, THEN COLD PATCH ASPHALT TO SURFACE.													

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No MS 2-25

1 OF 1

METRIC

W.P. 2930-17-00 LOCATION N 4 857 856.6 E 314 914.9 ORIGINATED BY BL
 HWY 404 BOREHOLE TYPE Solid Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.07.25 - 2018.07.25 LATITUDE 43.860611 LONGITUDE -79.374170 CHECKED BY RD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	
191.4	GROUND SURFACE											
0.0	ASPHALT: (125mm)											
0.1	SAND and GRAVEL Compact Brown Moist (FILL)		1	SS	17		191					
190.6	Silty CLAY, trace sand, trace gravel Very Stiff Brown Moist (TILL)		2	SS	19		190					
0.8			3	SS	21							
188.9			4	SS	14		189					
2.5	Sandy SILT, trace to some clay, trace gravel Compact to Dense Grey Moist (TILL)		5	SS	19		188					1 20 61 18
			6	SS	23		187					
			7	SS	33		185					
	Becoming SAND and SILT		8	SS	20		184					5 37 43 15
183.2	END OF BOREHOLE AT 8.2m. WATER LEVEL AT 4.6m DEPTH BEFORE BOREHOLE CAVING TO 3.0m DEPTH UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.1m, THEN COLD PATCH ASPHALT TO SURFACE.											
8.2												

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

RECORD OF BOREHOLE No MS 2-26

1 OF 2

METRIC

W.P. 2930-17-00 LOCATION N 4 857 811.8 E 314 902.1 ORIGINATED BY BL
 HWY 404 BOREHOLE TYPE Solid Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.08.01 - 2018.08.01 LATITUDE 43.860208 LONGITUDE -79.374330 CHECKED BY RD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
191.3	GROUND SURFACE												
0.0	ASPHALT: (150mm)												
0.2	SAND and GRAVEL, trace silt, trace clay Compact Brown Moist (FILL)		1	SS	27		191						
190.3													
1.0	Silty CLAY, some sand, trace gravel Stiff to Very Stiff Brown Moist (TILL)		2	SS	12		190						
			3	SS	17								
189.1							189						
2.2	SILT, trace to some clay, trace sand Compact Grey Wet		4	SS	20								
			5	SS	18		188						
187.2							187						
4.1	Silty CLAY, with sand, trace gravel Very Stiff to Hard Grey Moist (TILL)		6	SS	29								
							186						
			7	SS	100/ 0.150		185						
							184						
			8	SS	100/ 0.200		183						
							182						
			9	SS	82								

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15 10 5 0
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No MS 2-26

2 OF 2

METRIC

W.P. 2930-17-00 LOCATION N 4 857 811.8 E 314 902.1 ORIGINATED BY BL
 HWY 404 BOREHOLE TYPE Solid Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.08.01 - 2018.08.01 LATITUDE 43.860208 LONGITUDE -79.374330 CHECKED BY RD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT							UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa												
								20 40 60 80 100												
	Continued From Previous Page							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE							PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W P W W L WATER CONTENT (%) 20 40 60					
	Silty CLAY , with sand, trace gravel Hard Grey Moist (TILL)		10	SS	77		181													
							180													
178.7			11	SS	100/ 0.275		179							○						
12.6	END OF BOREHOLE AT 12.6m. BOREHOLE CAVED TO 2.4m AND WATER LEVEL AT 2.3m DEPTH UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.2m, THEN COLD PATCH ASPHALT TO SURFACE.																			

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

RECORD OF BOREHOLE No MS 2-27

1 OF 1

METRIC

W.P. 2930-17-00 LOCATION N 4 857 704.3 E 314 924.2 ORIGINATED BY KK
 HWY 404 BOREHOLE TYPE Solid Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.08.01 - 2018.08.01 LATITUDE 43.859240 LONGITUDE -79.374058 CHECKED BY RD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
190.5	GROUND SURFACE							20 40 60 80 100					
0.0	ASPHALT: (150mm)							20 40 60 80 100					
0.2	SAND and GRAVEL, trace silt, trace clay (FILL)		1	GS			190						
189.8													
0.7	Silty CLAY, some sand, trace gravel Stiff Brown Moist (TILL)		2	SS	12		189						1 14 27 58
189.0													
1.4	SILT, trace to some clay, trace sand, trace gravel Compact to Loose Grey Moist		3	SS	13		188						0 9 84 7
			4	SS	12								
			5	SS	9		187						0 10 78 12
186.3													
4.1	Silty CLAY, with sand, trace gravel Hard Grey Moist (TILL)		6	SS	58		186						1 36 41 22
							185						
			7	SS	100/ 0-200		184						
							183						
182.2			8	SS	31								
8.2	END OF BOREHOLE AT 8.2m. BOREHOLE CAVED TO 3.1m DEPTH UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 1.5m, AUGER CUTTINGS TO 0.2m, THEN COLD PATCH ASPHALT TO SURFACE.												

ONTMT452 MTO-15786.GPJ 2017TEMPLATE(MTO).GDT 1/8/19

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

RECORD OF BOREHOLE No MS 2-28

1 OF 2

METRIC

W.P. 2930-17-00 LOCATION N 4 857 651.2 E 314 931.2 ORIGINATED BY BL
 HWY 404 BOREHOLE TYPE Solid Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.08.02 - 2018.08.02 LATITUDE 43.858762 LONGITUDE -79.373971 CHECKED BY RD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
								20 40 60 80 100					
								20 40 60 80 100					
						○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL x LAB VANE				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			
						WATER CONTENT (%)							
190.2	GROUND SURFACE												
0.0	ASPHALT: (150mm)												
0.2	SAND and GRAVEL Brown Moist (FILL)		1	GS			190						
189.5													
0.7	Silty CLAY, trace sand, trace gravel Firm to Stiff Brown Moist (FILL)		2	SS	8		189						
188.7													
1.4	SILT, some sand, trace clay Loose to Compact Grey Moist		3	SS	7		188						
			4	SS	10		187						
			5	SS	15		186						
186.1													
4.1	Very Dense		6	SS	76		185						
			7	SS	100/ 0.200		184						
183.2	Silty CLAY, with sand, trace gravel Hard Grey Moist (TILL)		8	SS	31		183						
7.0													
							182						
181.7	SAND and SILT, some gravel, trace clay Very Dense Grey Moist (TILL)		9	SS	87		181						
8.5													

Continued Next Page

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

METRIC

[illegible]

+³, ×³: Numbers refer to Sensitivity

RECORD OF BOREHOLE No MS 2-29

1 OF 1

METRIC

W.P. 2930-17-00 LOCATION N 4 857 556.4 E 314 971.5 ORIGINATED BY BL
 HWY 404 BOREHOLE TYPE Solid Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.07.26 - 2018.07.26 LATITUDE 43.857909 LONGITUDE -79.373472 CHECKED BY RD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									WATER CONTENT (%)
189.7	GROUND SURFACE							20	40	60	80	100					
0.0	ASPHALT: (150mm)							20	40	60	80	100					
0.2	SAND and GRAVEL Compact Brown Moist (FILL)		1	SS	20		189										
188.7			2	SS	19												
1.1	Silty CLAY, some sand to with sand, trace gravel Very Stiff to Stiff Brown Wet (TILL)		3	SS	19		188										
187.5																	
2.2	Firm		4	SS	4		187										
186.8																	
3.0			5	SS	11		186										
	Grey Moist		6	SS	23		185										
184.1																	
5.6	Hard						184										
			7	SS	70		183										
181.9			8	SS	100/		182										
7.9	END OF BOREHOLE AT 7.9m. WATER LEVEL AT 4.6m DEPTH BEFORE BOREHOLE CAVING TO 6.1m DEPTH UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen.				0.200												
	WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2018.09.30 2.4 187.3 2018.11.23 2.2 187.5																

+³, ×³: Numbers refer to
Sensitivity

20
15
10

(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No MS 2-30

1 OF 2

METRIC

W.P. 2930-17-00 LOCATION N 4 857 490.3 E 314 981.3 ORIGINATED BY BL
 HWY 404 BOREHOLE TYPE Solid Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.07.24 - 2018.07.24 LATITUDE 43.857313 LONGITUDE -79.373351 CHECKED BY RD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
								20 40 60 80 100					
189.5	GROUND SURFACE												
0.0	ASPHALT: (125mm)												
0.1	SAND and GRAVEL, trace silt, trace clay Compact Brown Moist (FILL)		1	SS	25		189						
188.6													
1.0	Silty SAND, trace gravel, trace clay Compact Brown Moist (FILL)		2	SS	18								
188.1													
1.4	Silty CLAY, some sand, trace gravel Very Stiff to Stiff Brown Moist (TILL)		3	SS	28		188						
			4	SS	11		187						
186.3													
3.2	SAND and SILT, trace clay Compact Brown to Grey Moist		5	SS	30		186						
185.0													
4.5	SAND and SILT, trace gravel, trace clay Very Dense Grey Moist to Wet (TILL)		6	SS	12		185						
			7	SS	67		183						
			8	SS	100/ 0.275		182						
			9	SS	100/ 0.125		181						
							180						

Continued Next Page

+³, ×³: Numbers refer to
Sensitivity

20
15
10
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No MS 2-30

2 OF 2

METRIC

W.P. 2930-17-00 LOCATION N 4 857 490.3 E 314 981.3 ORIGINATED BY BL
 HWY 404 BOREHOLE TYPE Solid Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.07.24 - 2018.07.24 LATITUDE 43.857313 LONGITUDE -79.373351 CHECKED BY RD

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									WATER CONTENT (%)
	Continued From Previous Page																
	SAND and SILT, some gravel, trace clay Very Dense Brown Moist to Wet (TILL)		10	SS	100/		179										
				0.150													
177.2			11	SS	100/		178										
12.3	END OF BOREHOLE AT 12.3m. BOREHOLE CAVED TO 3.4m AND WATER LEVEL AT 3.4m DEPTH UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.1m, THEN COLD PATCH ASPHALT TO SURFACE.				0.150												

RECORD OF BOREHOLE No MS 2-31

1 OF 1

METRIC

W.P. 2930-17-00 LOCATION N 4 857 433.4 E 314 973.3 ORIGINATED BY BL
 HWY 404 BOREHOLE TYPE Solid Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.08.02 - 2018.08.02 LATITUDE 43.856801 LONGITUDE -79.373452 CHECKED BY RD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
								20 40 60 80 100					
								20 40 60 80 100					
189.4	GROUND SURFACE												
0.0	ASPHALT: (150mm)												
0.2	SAND and GRAVEL Grey Moist (FILL)			GS			189						
188.7			1	SS	13								
0.7	Silty CLAY, some sand, trace gravel Stiff to Very Stiff Brown Moist (TILL)		2	SS	15								
			3	SS	14								
			4	SS	11								
			5	SS	23								
183.8			6	SS	31								
5.6	SAND and SILT, trace clay Dense Grey Moist		7	SS	65								
182.3													
7.2	SAND and SILT, trace clay Very Dense Grey Moist (TILL)												
181.2													
8.2	END OF BOREHOLE AT 8.2m. WATER LEVEL AT 3.4m DEPTH UPON COMPLETION. BOREHOLE BACKFILLED WITH BENTONITE HOLEPLUG TO 0.1m, THEN COLD PATCH ASPHALT TO SURFACE.												

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

RECORD OF BOREHOLE No MS 2-32

1 OF 2

METRIC

W.P. 2930-17-00 LOCATION N 4 857 318.0 E 314 994.2 ORIGINATED BY BL
 HWY 404 BOREHOLE TYPE Hollow Stem Augers/Solid Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.08.09 - 2018.08.09 LATITUDE 43.855762 LONGITUDE -79.373194 CHECKED BY RD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa				W _P	W	W _L		
189.5	GROUND SURFACE															
0.0	ASPHALT: (150mm)															
0.2	SAND and GRAVEL, trace silt, trace clay Compact Brown Moist (FILL)		1	SS	12											
			2	SS	18											
188.1																
1.4	Silty CLAY, some sand, trace gravel Very Stiff to Stiff Brown Moist (TILL)		3	SS	28											
	occasional organics at 2.4m		4	SS	8											
			5	SS	8											
185.4																
4.1	Sandy SILT, trace to some clay Compact Grey Wet		6	SS	10											
			7	SS	25											
	trace gravel		8	SS	21											
			9	SS	41											
179.5																

20406080100

20406080100

204060

○ UNCONFINED + FIELD VANE
● QUICK TRIAXIAL × LAB VANE

WATER CONTENT (%)

W_P W W_L

189

188

187

186

185

184

183

182

181

180

0143155

0236710

Borehole was initially terminated at 6.7m and piezometer installed. Another adjacent borehole was advanced without sampling to 6.7m below which sampling was continued.

Borehole was initially terminated at 6.7m and piezometer installed. Another adjacent borehole was advanced without sampling to 6.7m below which sampling was continued.

Continued Next Page

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

METRIC

SOIL PROFILE				SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	20 40 60 80 100	W P W L			
10.0	Continued From Previous Page Silty CLAY , some sand, trace gravel Hard Grey Moist (TILL)		10	SS	62		179						
177.0			11	SS	100/		178						
12.5	END OF BOREHOLE AT 12.5m. WATER LEVEL AT 2.0m DEPTH BEFORE BOREHOLE CAVING TO 1.5m UPON COMPLETION. Piezometer installation consists of 19mm diameter Schedule 40 PVC pipe with a 3.0m slotted screen. WATER LEVEL READINGS DATE DEPTH(m) ELEV.(m) 2018.09.30 2.2 187.3 2018.11.22 2.9 186.6				0.250								

RECORD OF BOREHOLE No HMP 2-02

1 OF 2

METRIC

W.P. 2930-17-00 LOCATION N 4 857 179.5 E 315 020.7 ORIGINATED BY KK
 HWY 404 BOREHOLE TYPE Solid Stem Augers COMPILED BY MP
 DATUM Geodetic DATE 2018.08.08 - 2018.08.08 LATITUDE 43.854515 LONGITUDE -79.372867 CHECKED BY RD

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT				UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					
								20 40 60 80 100					
190.0	GROUND SURFACE												
0.0	ASPHALT: (150mm)												
0.2	SAND and GRAVEL, trace silt, trace clay		1	GS									
189.3	Grey Moist (FILL)												
0.7	Silty CLAY, some sand Stiff to Very Stiff Brown Moist (FILL)		1	SS	15		189						
			2	SS	13		188						
	Firm		3	SS	4		187						
			4	SS	17								0 15 33 52
185.9							186						
4.1	SAND and SILT, trace clay Compact Grey Moist		5	SS	23		185						0 54 42 4
							184						
			6	SS	14		183						
182.8	Silty CLAY, some sand, trace gravel Very Stiff Grey Moist (TILL)		7	SS	27		182						
181.3							181						
8.7	SAND and SILT, trace gravel Compact Grey Wet (TILL)		8	SS	16								

Continued Next Page

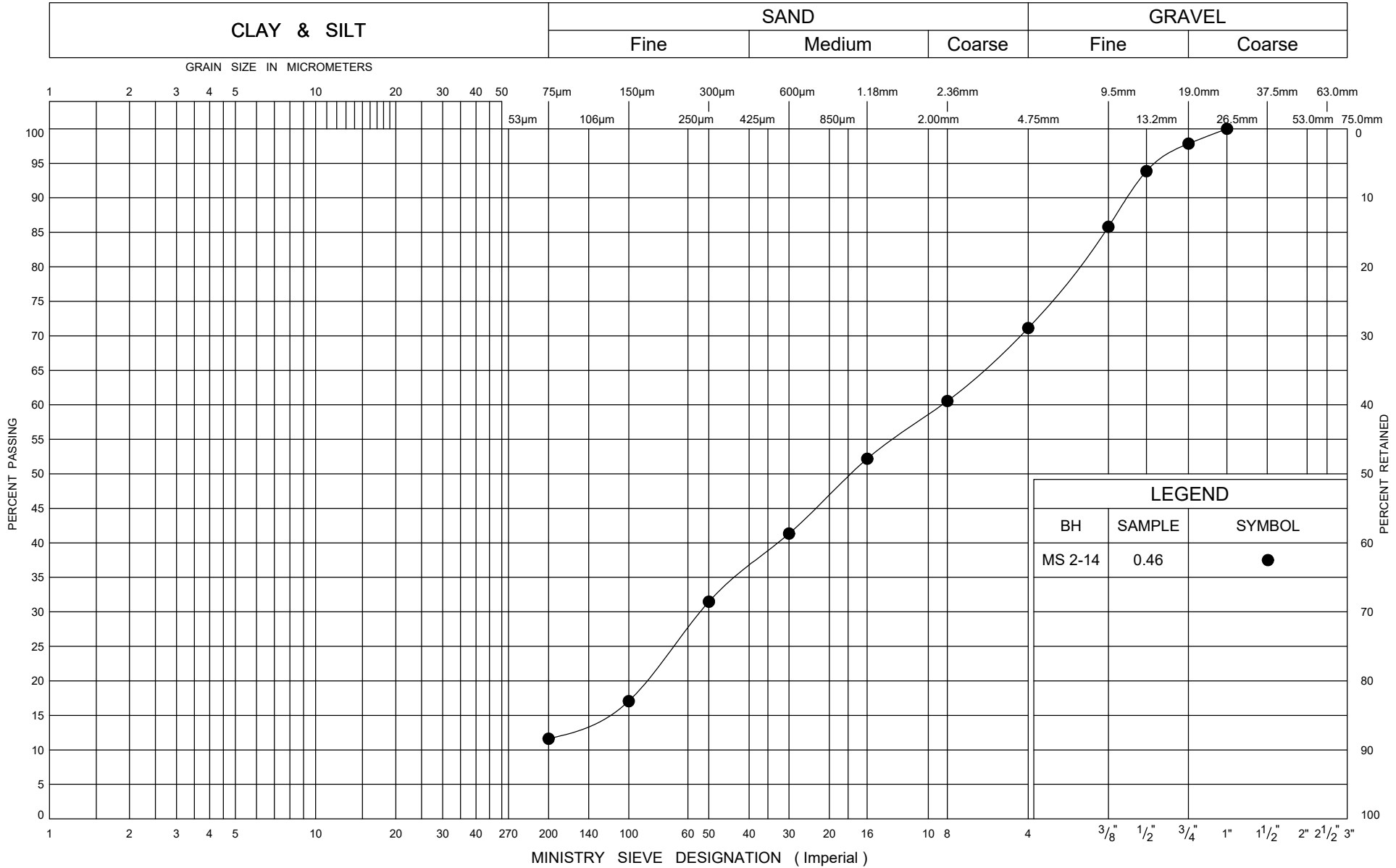
+³, ×³: Numbers refer to Sensitivity 20 15 10 5 (%) STRAIN AT FAILURE

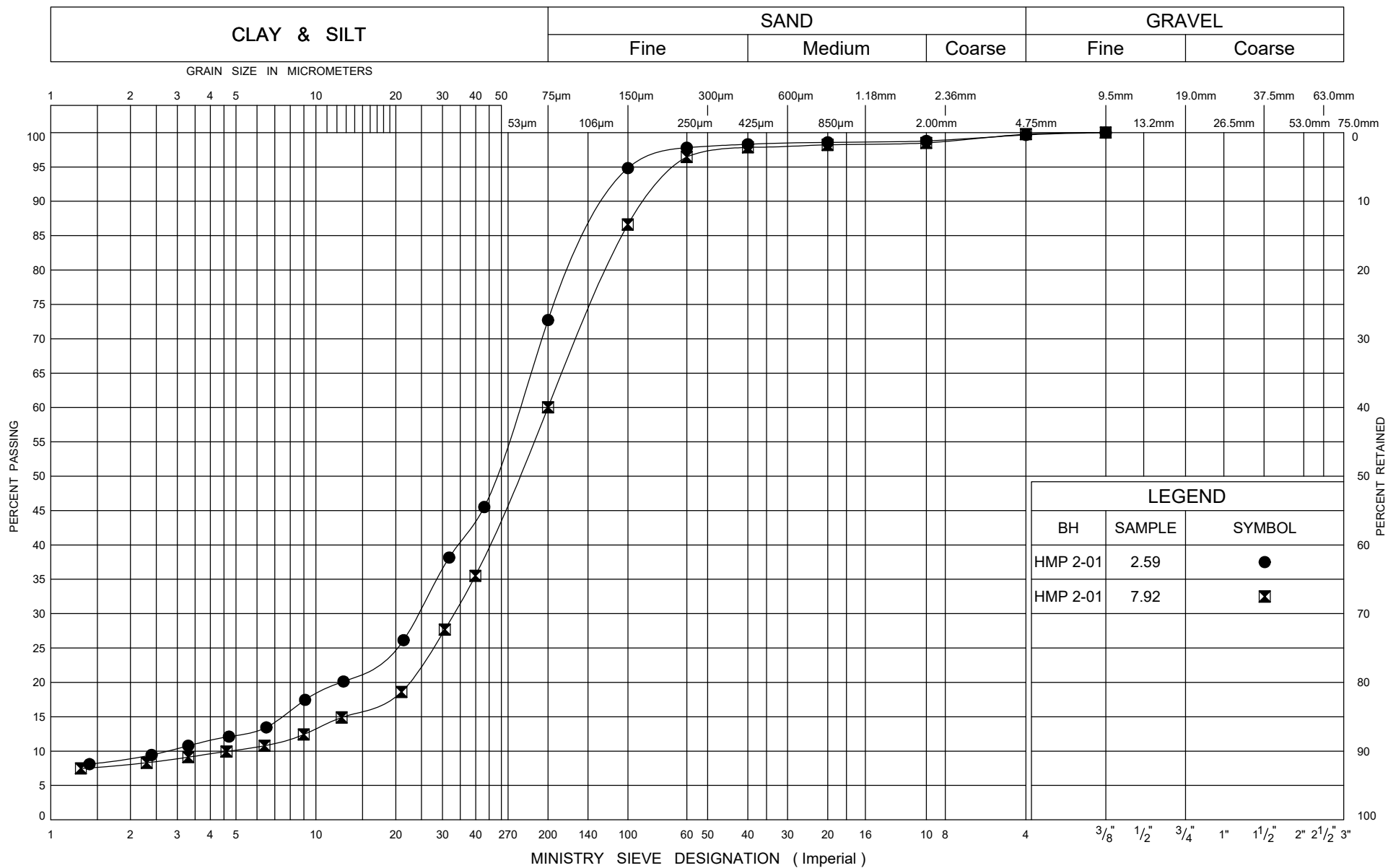
METRIC

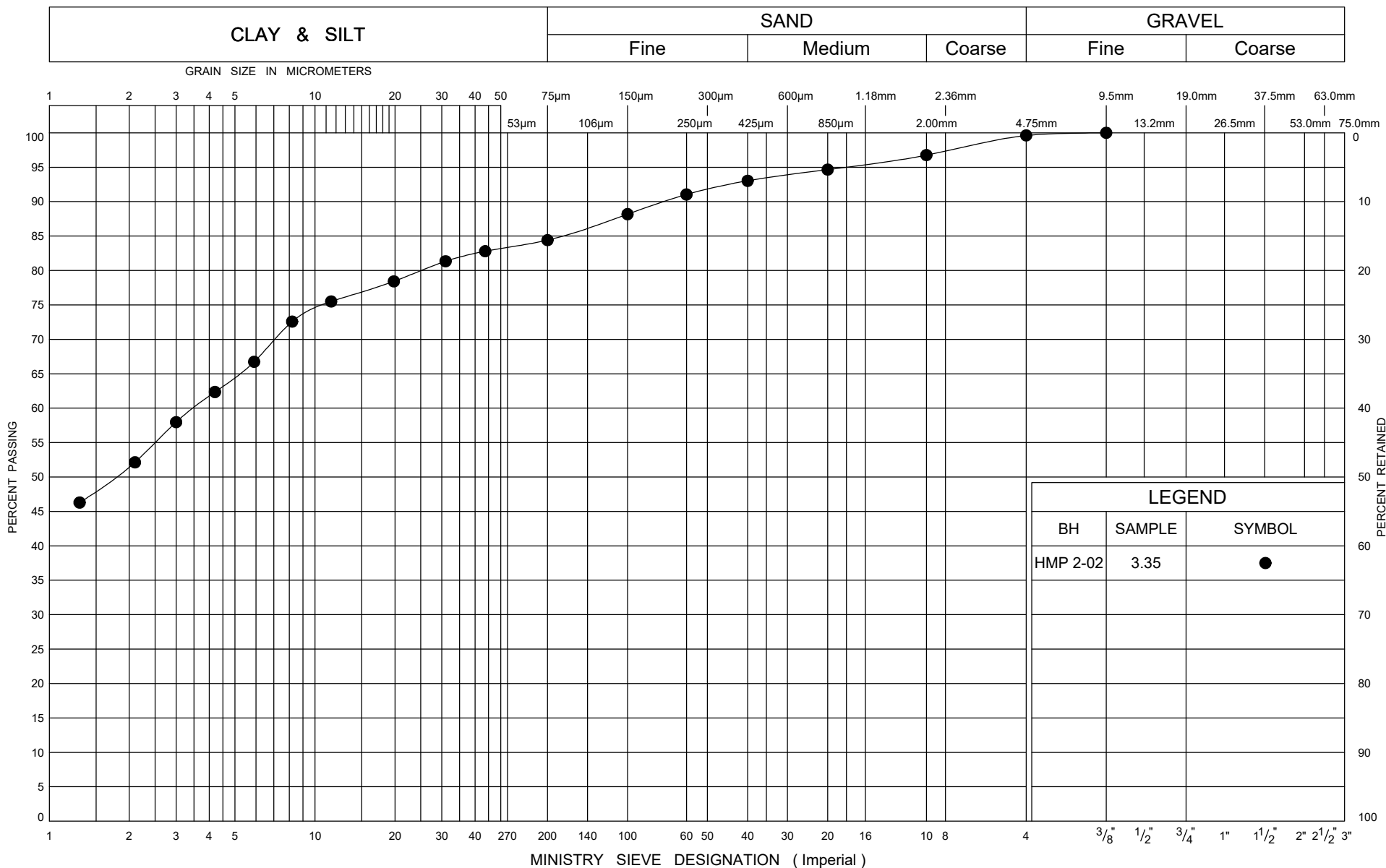
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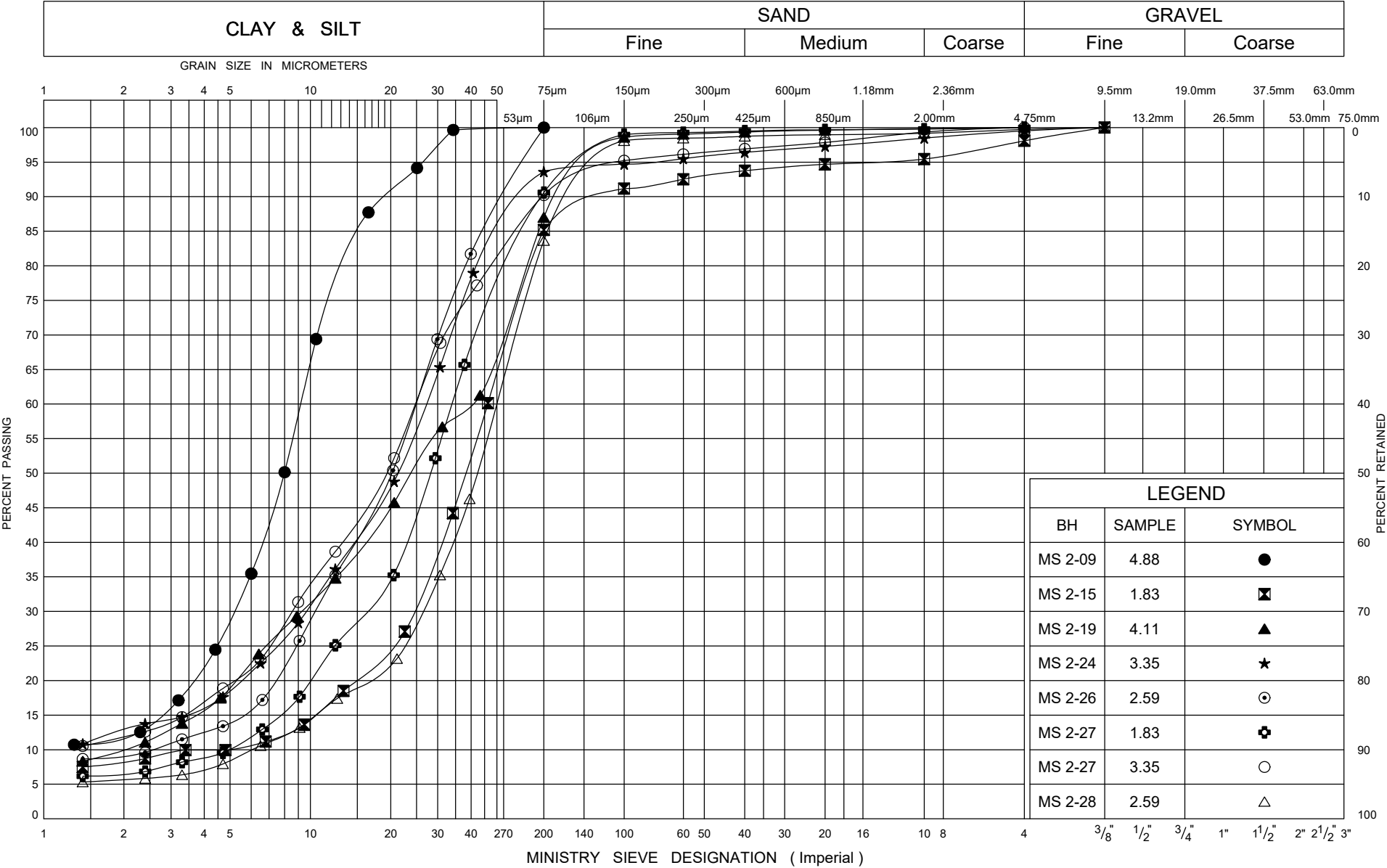
Appendix B

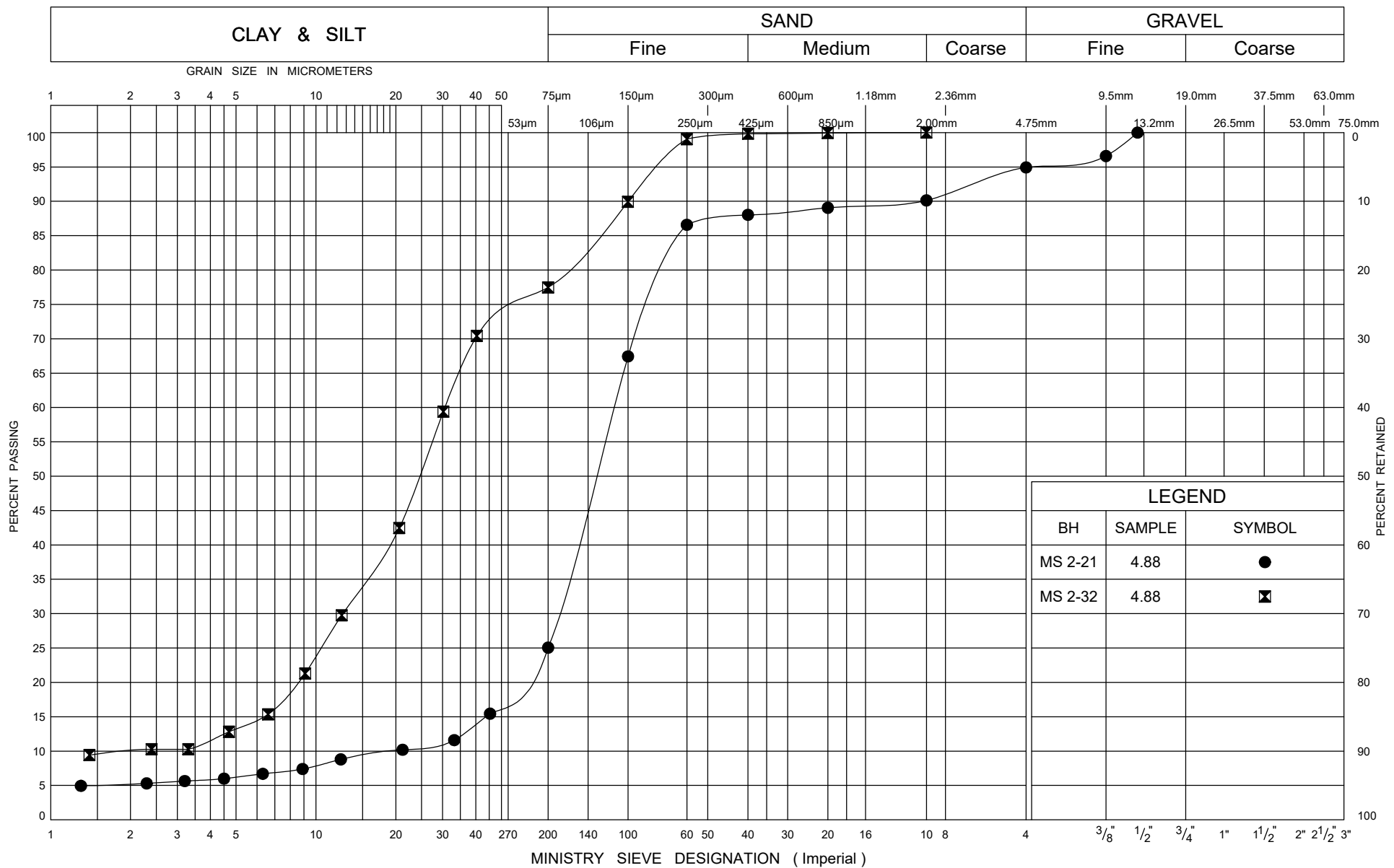
Geotechnical Laboratory Test Results

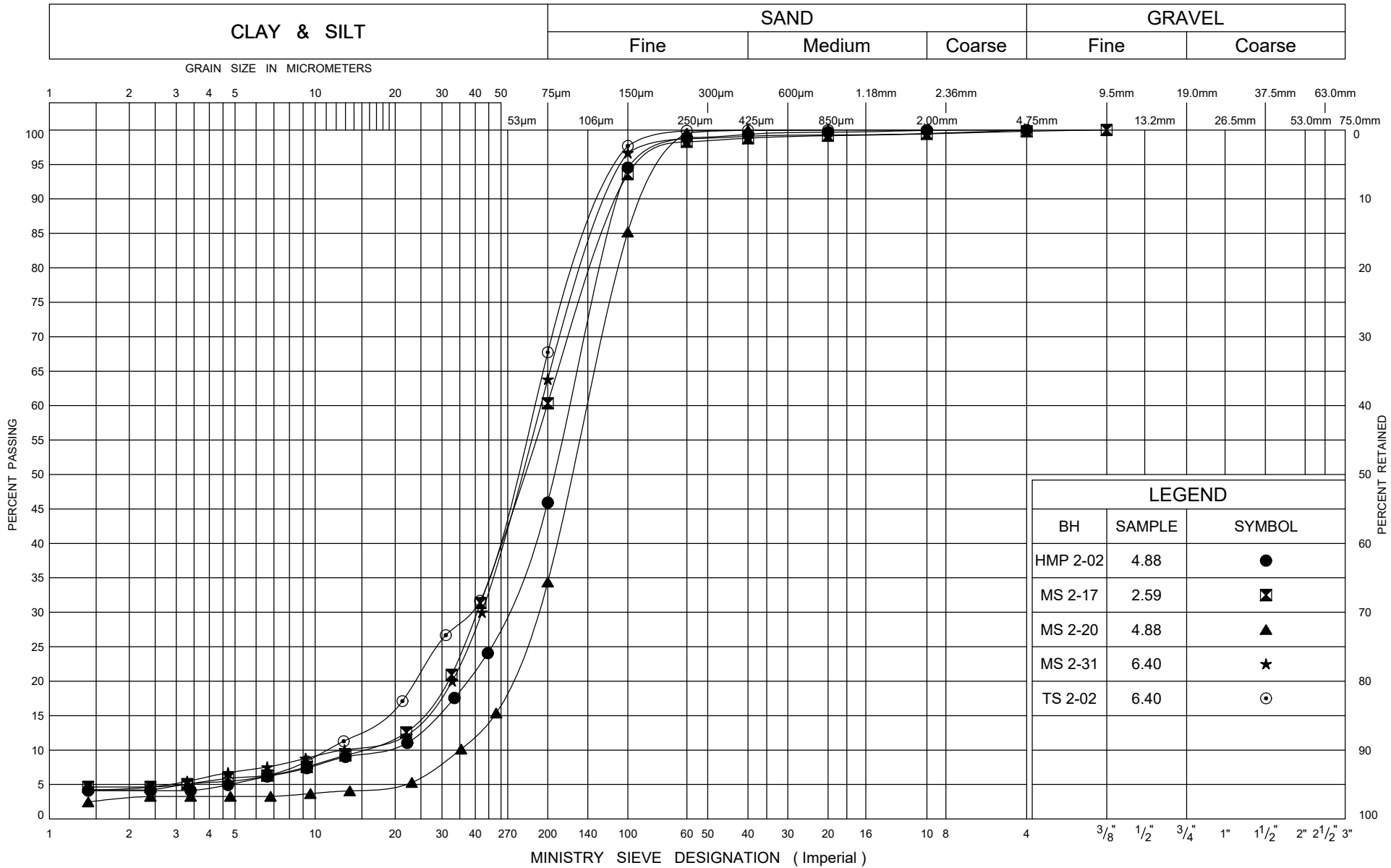


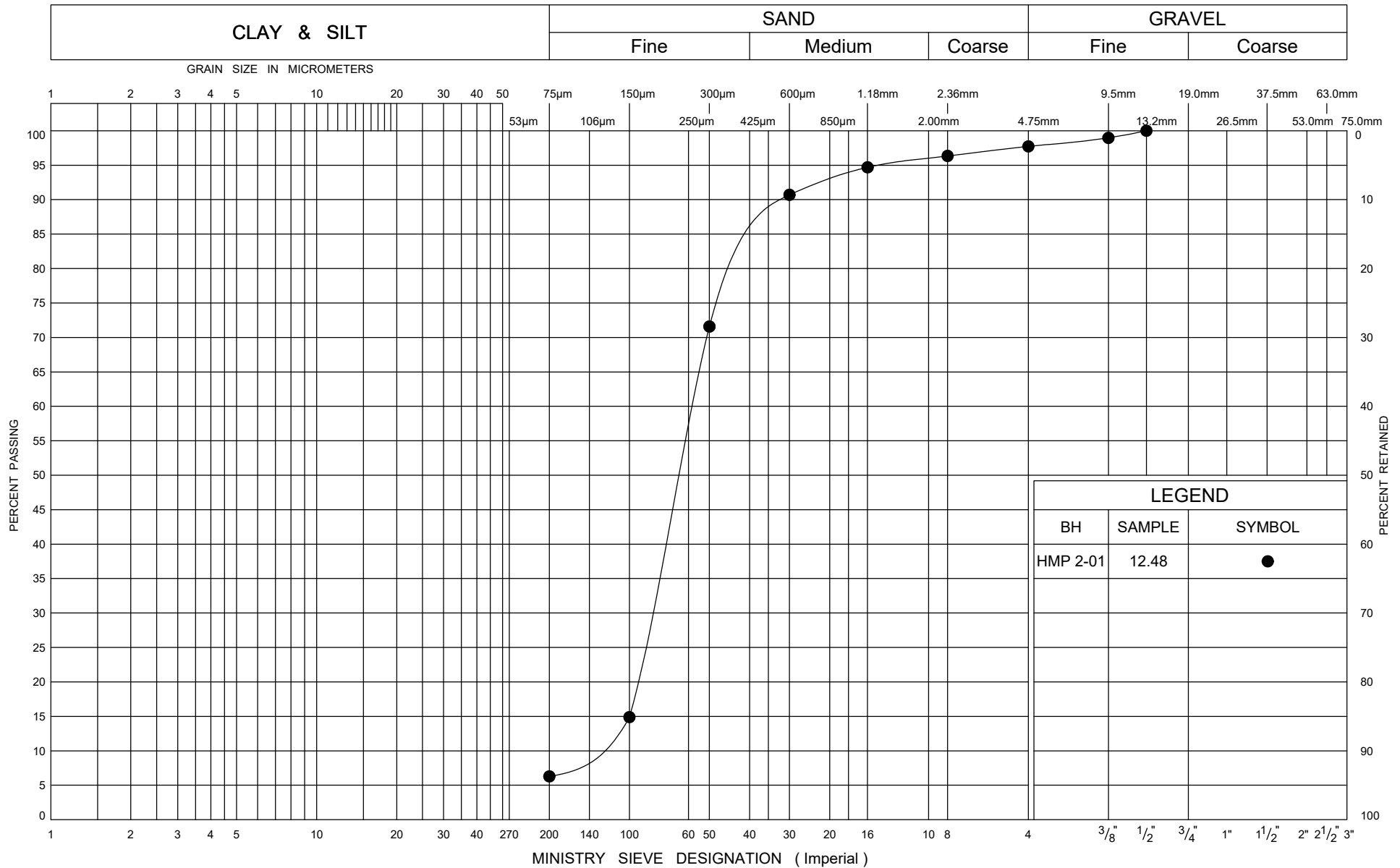










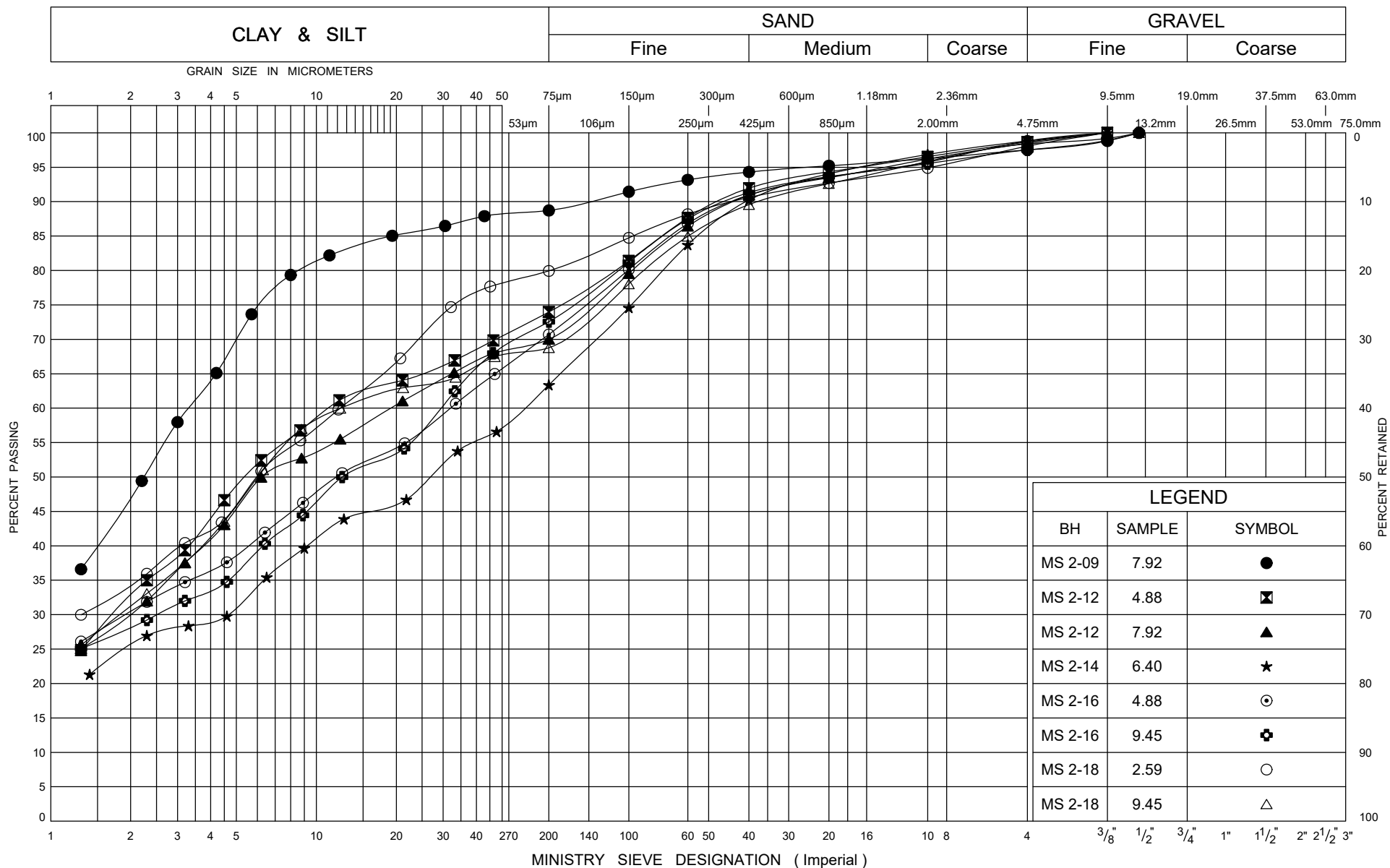


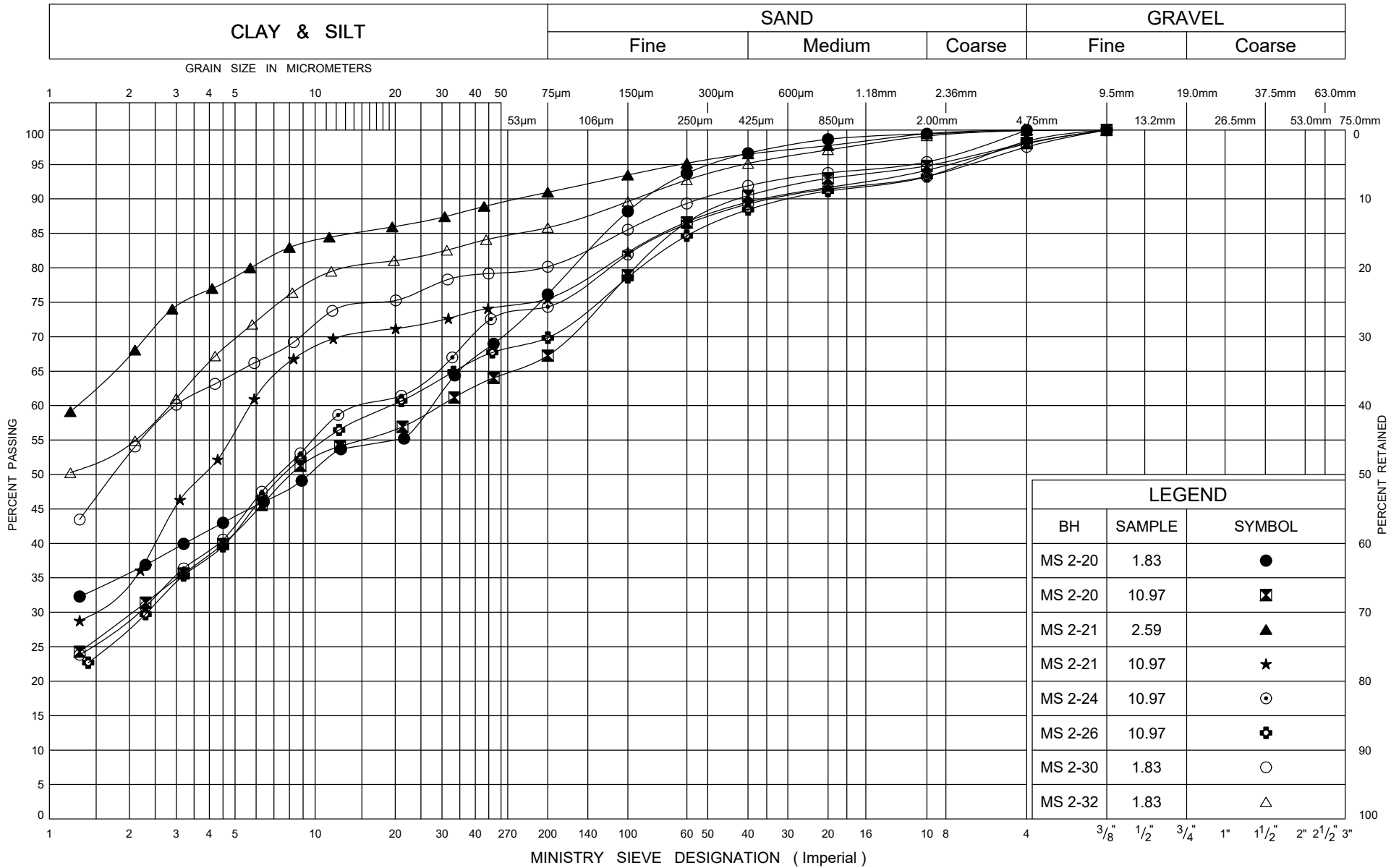
Ministry of
Transportation

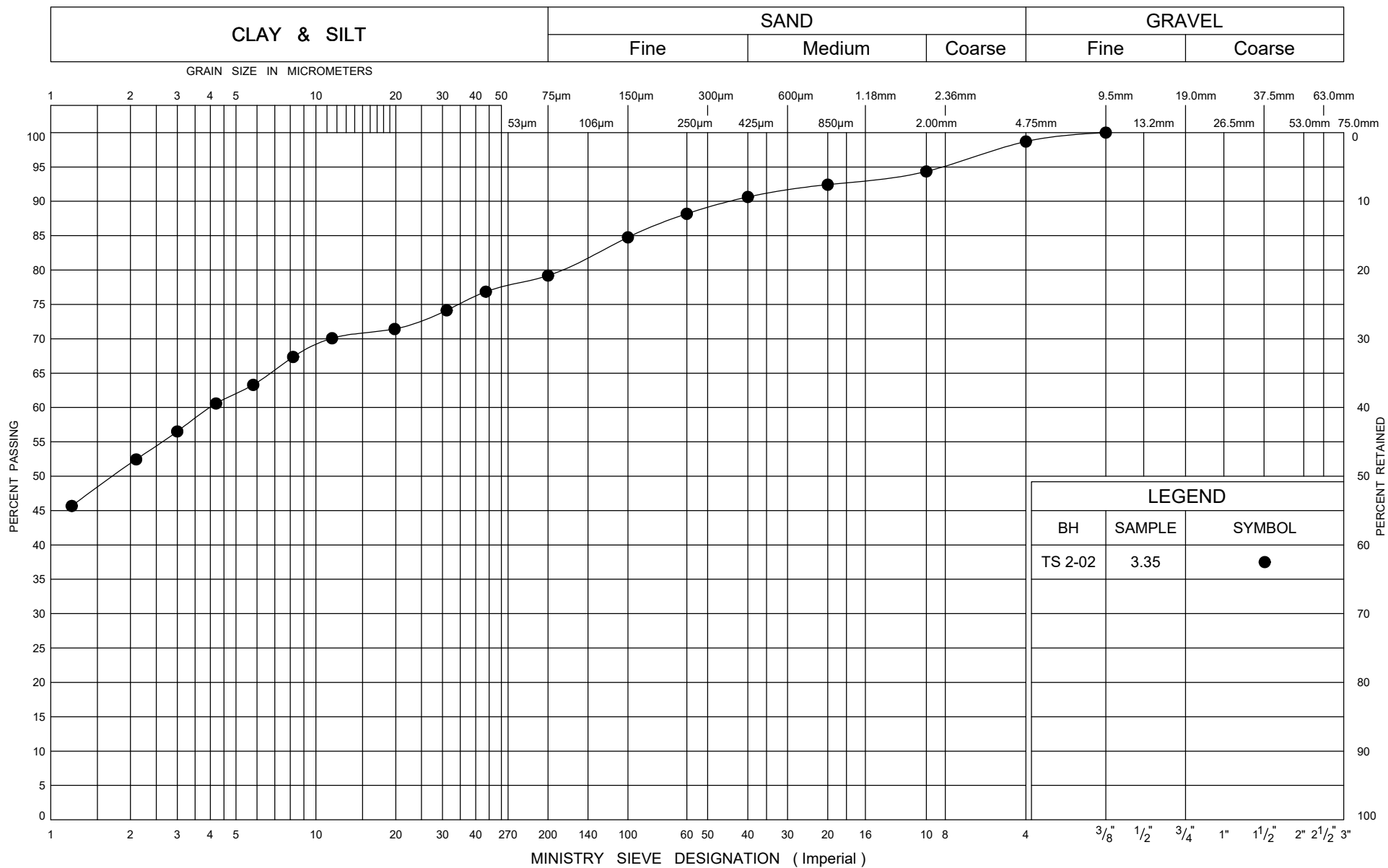
GRAIN SIZE DISTRIBUTION SAND

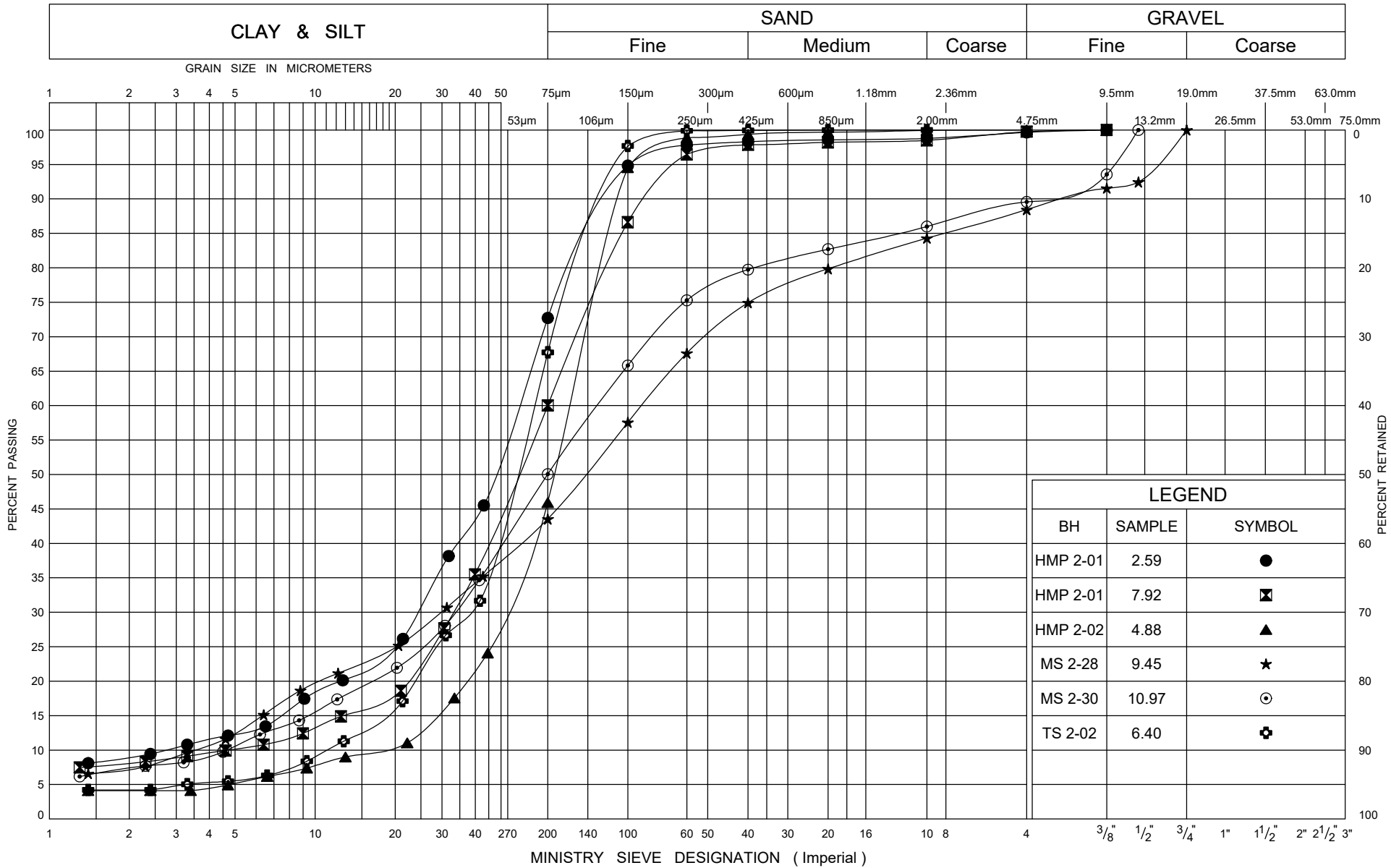
FIG No B7

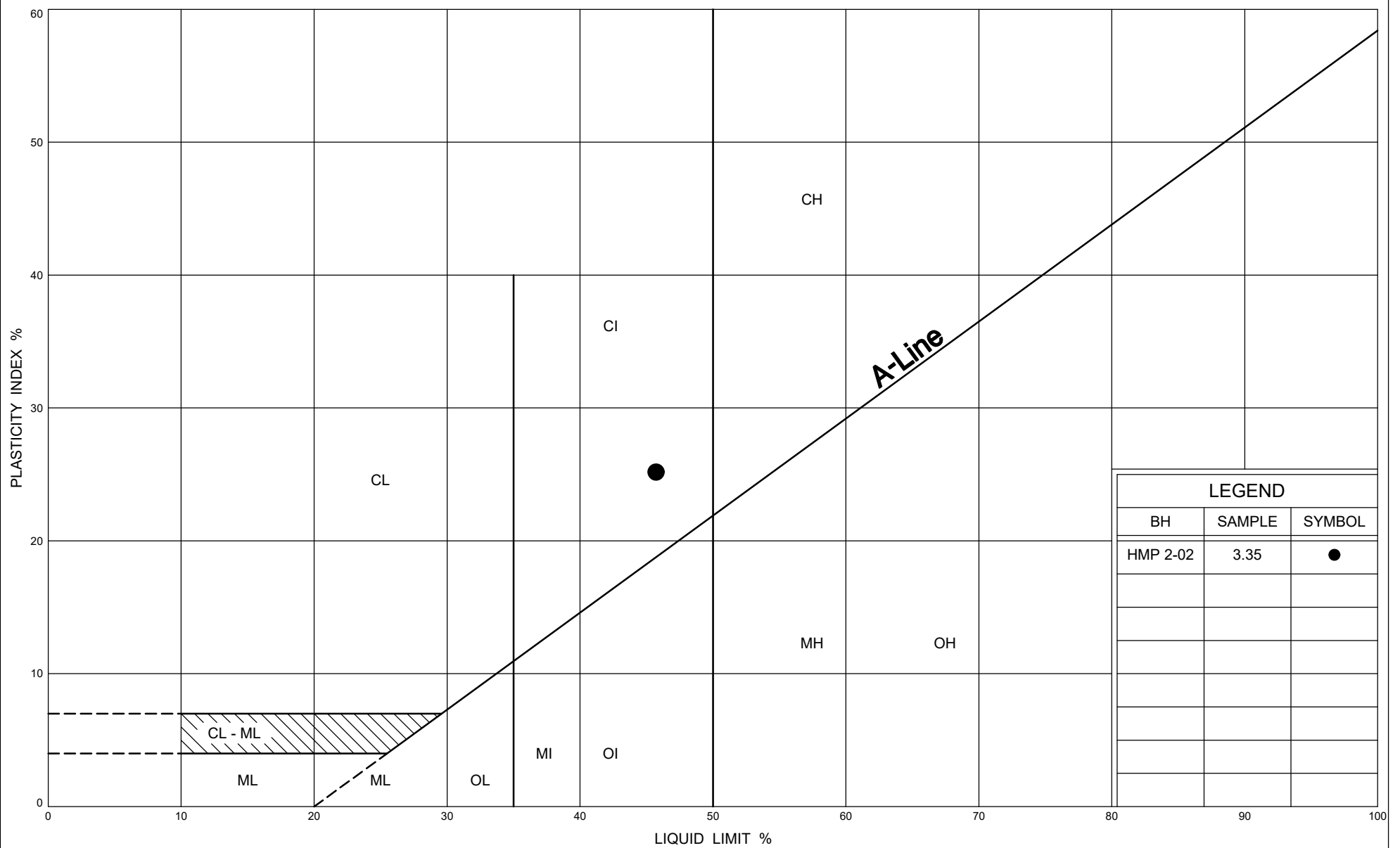
W P 2930-17-00











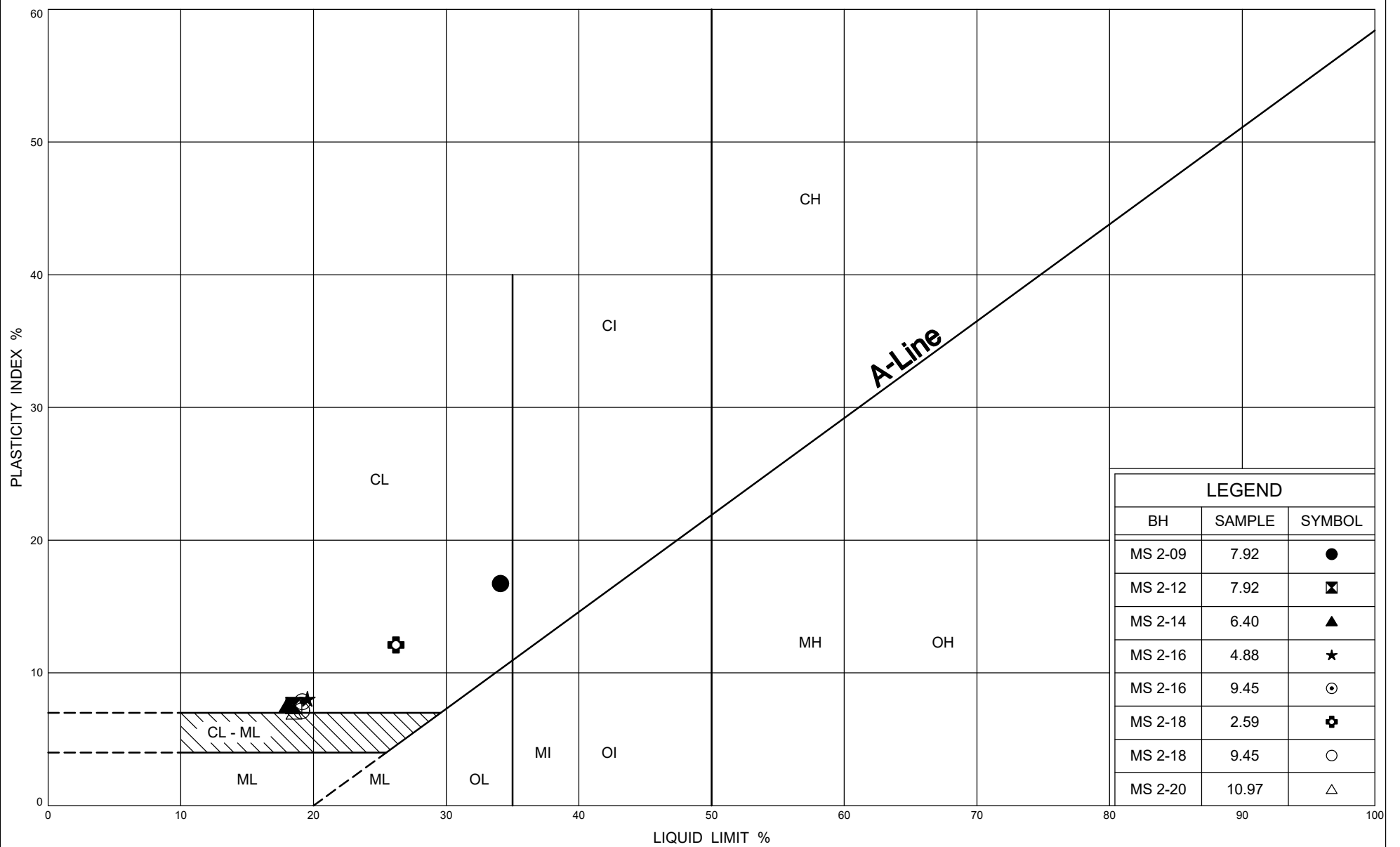
LEGEND		
BH	SAMPLE	SYMBOL
HMP 2-02	3.35	●

PLASTICITY CHART Silty CLAY FILL

FIG No B12

W P 2930-17-00





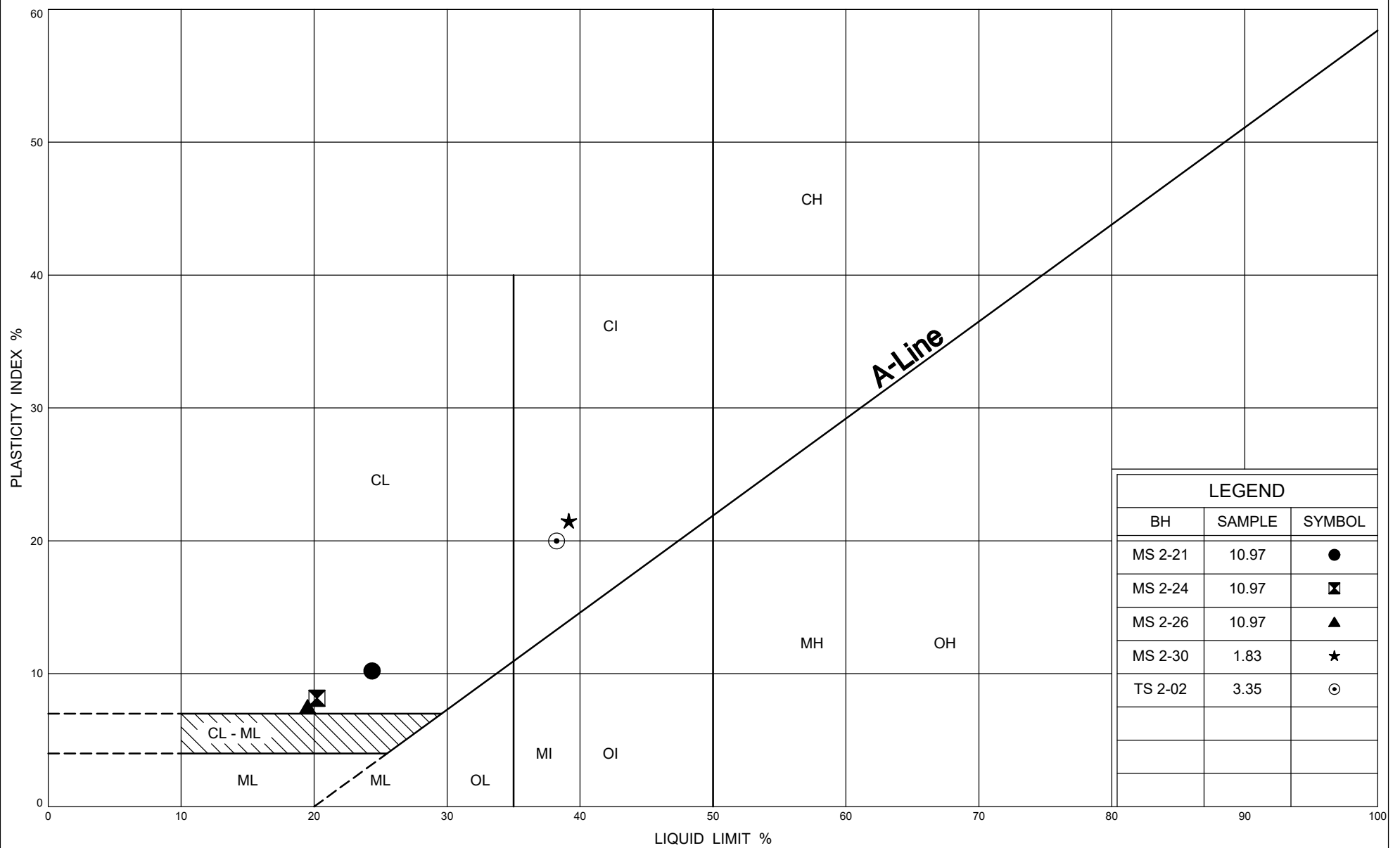
Ministry of
Transportation

PLASTICITY CHART

Silty CLAY TILL

FIG No B13

W P 2930-17-00



LEGEND		
BH	SAMPLE	SYMBOL
MS 2-21	10.97	●
MS 2-24	10.97	⊠
MS 2-26	10.97	▲
MS 2-30	1.83	★
TS 2-02	3.35	⊙



Ministry of
Transportation

PLASTICITY CHART

Silty CLAY TILL

FIG No B14

W P 2930-17-00



Appendix C

Borehole Location Drawings

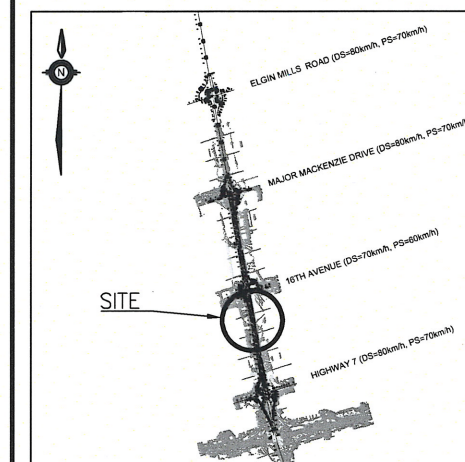
METRIC
DIMENSIONS ARE IN METRES
AND/OR MILLIMETRES
UNLESS OTHERWISE SHOWN

CONT No
GWP No 2930-17-00







SHEET

HIGHWAY 404
HIGHMAST LIGHT POLES
CONTRACT 2
BOREHOLE LOCATIONS PLAN



KEYPLAN

LEGEND

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

NO	ELEVATION	NORTHING	EASTING
407 ETR 2-01	189.8	4 857 612.3	314 923.5
407 ETR 2-02	188.7	4 857 501.1	314 937.5
HMP 2-02	190.0	4 857 179.5	315 020.7
HMS 2-03	192.6	4 857 998.8	314 848.5
MS 2-21	194.0	4 858 137.9	314 846.0
MS 2-22	193.0	4 858 038.5	314 866.2
MS 2-23	192.8	4 857 998.4	314 871.5
MS 2-24	192.6	4 857 978.0	314 894.1
MS 2-25	191.4	4 857 856.6	314 914.9
MS 2-26	191.3	4 857 811.8	314 902.1
MS 2-27	190.5	4 857 704.3	314 924.2
MS 2-28	190.2	4 857 651.2	314 931.2

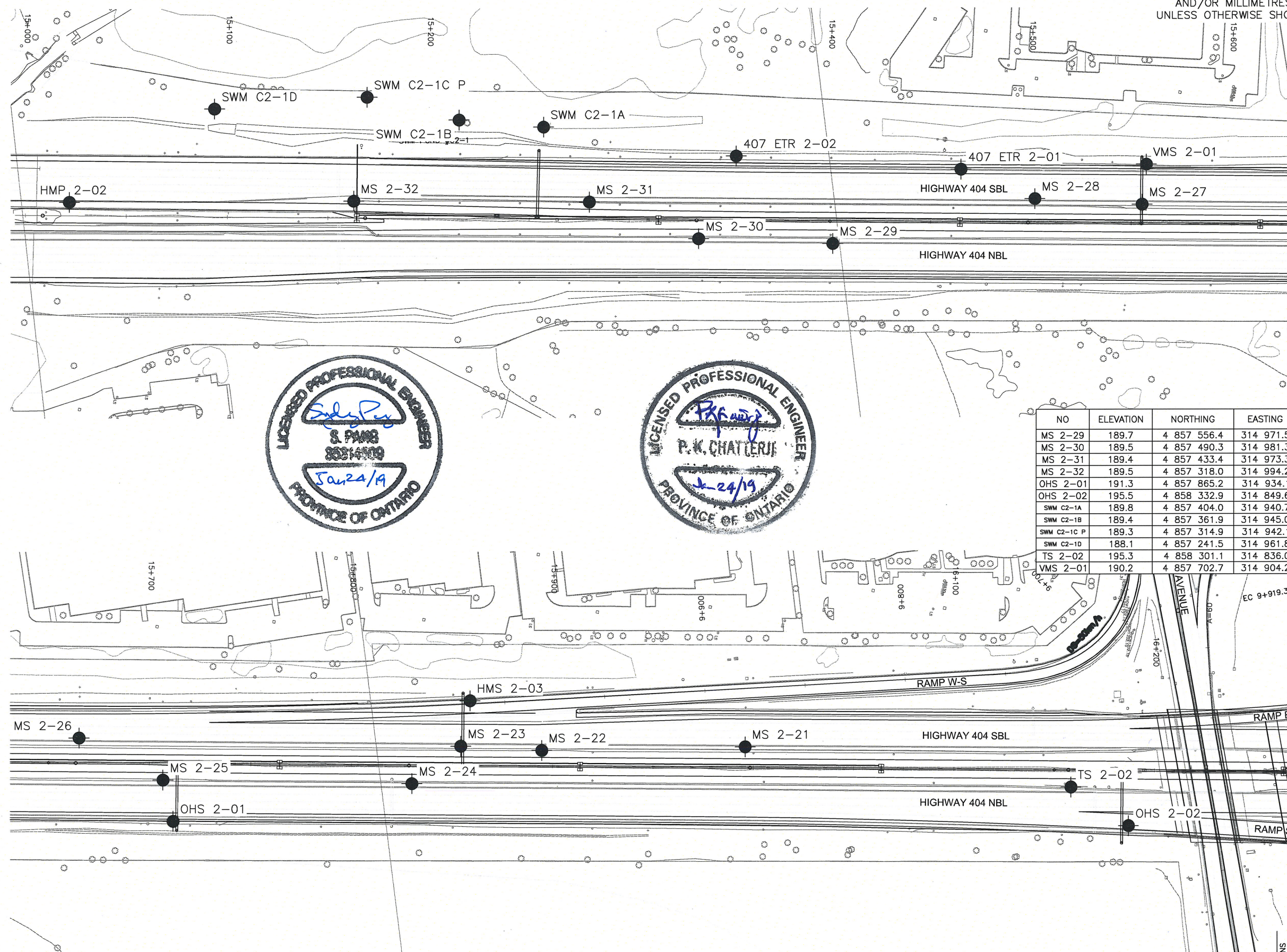
-NOTES-

- 1) The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- 2) This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
- 3) Coordinate system is MTM NAD 83 Zone 10.

GEOCRES No. 30M14-494

[illegible]

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

CONT No
GWP No 2930-17-00

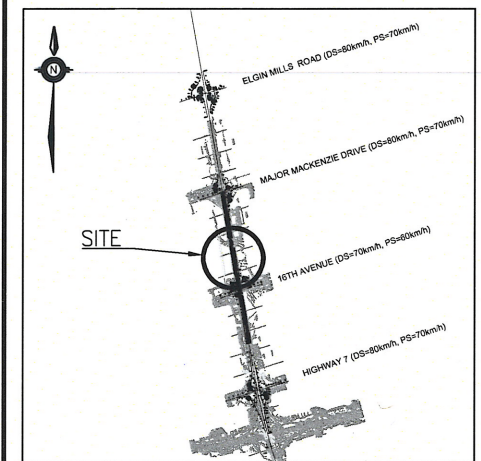
HIGHWAY 404
HIGHEST LIGHT POLES
CONTRACT 2
BOREHOLE LOCATIONS PLAN



SHEET



THURBER ENGINEERING LTD.



KEYPLAN

LEGEND

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

NO	ELEVATION	NORTHING	EASTING
HMP 2-01	203.2	4 859 306.0	314 635.2
HMS 2-04	201.8	4 859 154.8	314 644.4
HMS 2-05	204.2	4 859 532.0	314 638.3
MS 2-07	204.9	4 859 617.6	314 604.8
MS 2-08	204.2	4 859 526.4	314 617.2
MS 2-09	204.0	4 859 442.5	314 610.6
MS 2-10	202.7	4 859 224.3	314 674.7
MS 2-11	202.2	4 859 156.4	314 665.5
MS 2-12	202.0	4 859 126.0	314 688.9
MS 2-13	201.4	4 859 037.7	314 705.3
MS 2-14	200.9	4 858 978.4	314 716.3
MS 2-15	199.9	4 858 865.4	314 717.2

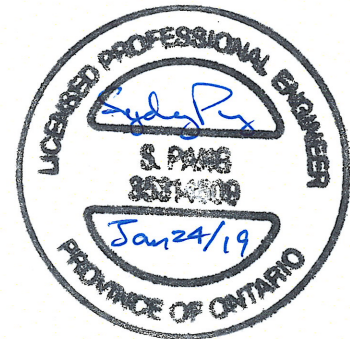
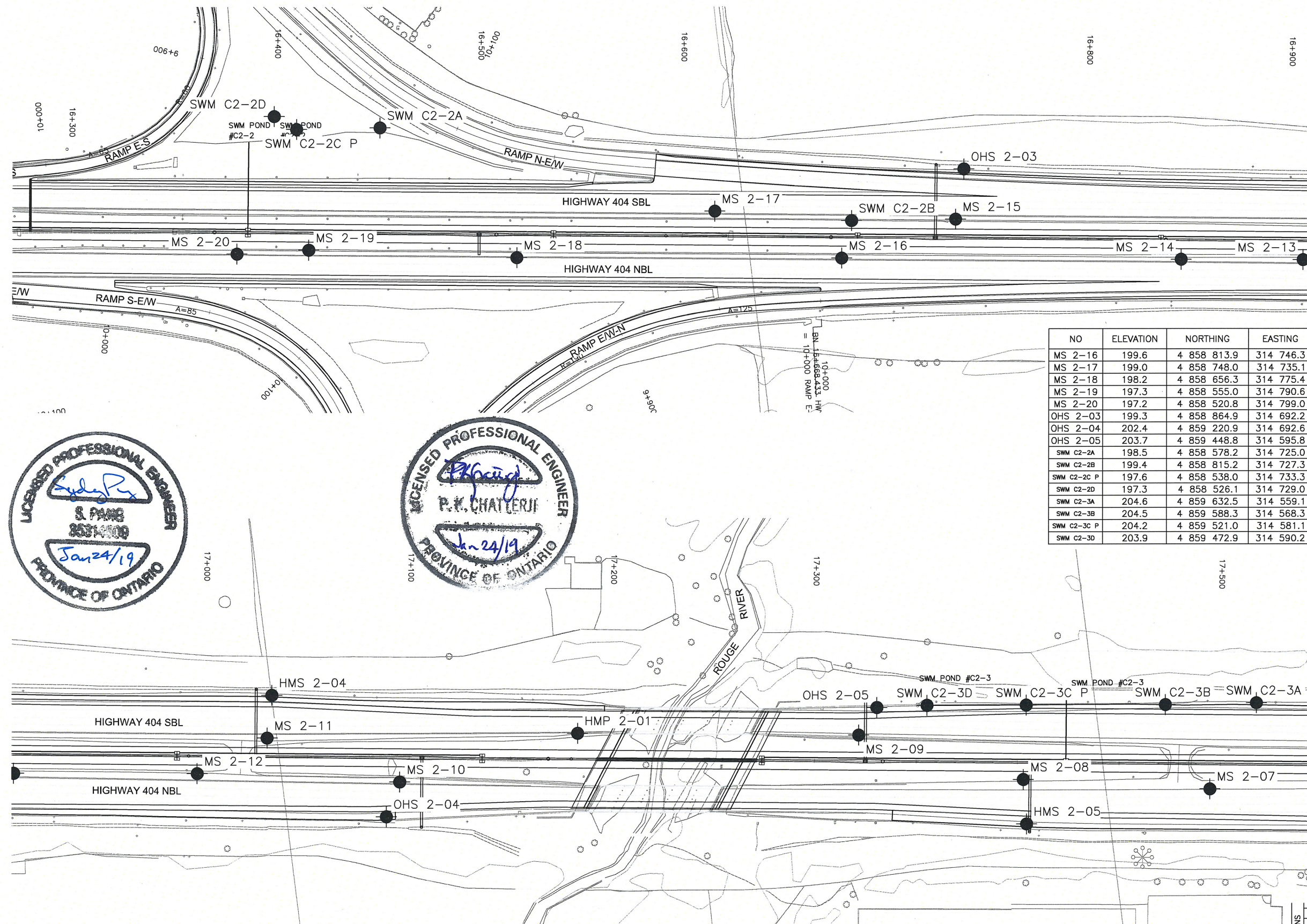
-NOTES-

- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration.
- Coordinate system is MTM NAD 83 Zone 10.

GEOCREs No. 30M14-494

REVISIONS

DATE	BY	DESCRIPTION
DESIGN	RD	CHK SKP CODE
DRAWN	MFA	CHK RD SITE
		LOAD
		STRUCT
		DWG 2
		DATE JAN 2019



40 0 40 80m
SCALE 1:2000



Appendix D

List of Special Provisions

And

Suggested Text for NSSP



List of Special Provisions Referenced in this Report

OPSS.PROV 903

Suggested Text for NSSP on:

“Augered Caisson Construction for High Mast Lighting Support Foundations”

The Contractor is advised that variable types of subsurface materials may be encountered at the locations of the HML support foundations. For additional information regarding subsurface conditions, the Contractor is referred to the Foundation Investigation Report.

The Contractor is alerted to the following:

1. Cobbles, boulders and rock fragments may be encountered within the glacial till deposits. In addition to the above, man-made obstructions may also be present within the embankment fills. The soil matrix is anticipated to become harder or denser with depth. Caisson installation equipment must be able to dislodge, handle, remove or otherwise penetrate these obstructions and hard/very dense layers.
2. Water seepage and/or soil sloughing into the caisson hole will occur from existing fill and cohesionless soils which would be susceptible to disturbance (basal and sidewall) under conditions of unbalanced hydrostatic head. Temporary liners shall be available on site to support the caisson sidewalls and provide partial seepage cut-off where required. A balancing water/slurry head shall be maintained inside the caisson hole where required. A combination of the above along with feasible techniques of advancing the caisson hole shall be employed to minimize disturbance at the base and the sides of the caisson foundation. Consideration should be given to using the tremie technique to place the concrete.

The Contractor is responsible for constructing all the HML support foundations without disturbing the material at the sides or bases of the foundations.